ATTACHMENT 1

2011 Base-Year National Emissions Inventory, version 2
Technical Support Document

U.S. EPA, Clearinghouse for Inventories & Emission Factors, Air Emissions Modeling, Technical Support Document for version 6.2, 2011 Version 6.2 Technical Support Document, Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform (PDF)(204 pp, 6 MB) https://www.epa.gov/sites/production/files/2015-10/documents/2011v6_2_2017_2025_emismod_tsd_aug2015.pdf

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Technical Support Document (TSD)

Preparation of Emissions Inventories for the Version 6.2, 2011 Emissions Modeling Platform

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U.S. Environmental Protection Agency
Office of Air and Radiation
Office of Air Quality Planning and Standards
Air Quality Assessment Division

Contacts:
Alison Eyth, Jeff Vukovich

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Acronyms

AE5	CMAQ Aerosol Module, version 5, introduced in CMAQ v4.7
AE6	CMAQ Aerosol Module, version 6, introduced in CMAQ v5.0
AEO	Annual Energy Outlook
BAFM	Benzene, Acetaldehyde, Formaldehyde and Methanol
BEIS	Biogenic Emissions Inventory System
BELD	Biogenic Emissions Land use Database
Bgal	Billion gallons
BPS	Bulk Plant Storage
BTP	Bulk Terminal (Plant) to Pump
C1/C2	Category 1 and 2 commercial marine vessels
C3	Category 3 (commercial marine vessels)
CAEP	Committee on Aviation Environmental Protection
CAIR	Clean Air Interstate Rule
CAMD	EPA's Clean Air Markets Division
CAM_X	Comprehensive Air Quality Model with Extensions
CAP	Criteria Air Pollutant
CARB	California Air Resources Board
CB05	Carbon Bond 2005 chemical mechanism
CBM	Coal-bed methane
CEC	North American Commission for Environmental Cooperation
CEMS	Continuous Emissions Monitoring System
CEPAM	California Emissions Projection Analysis Model
CISWI	Commercial and Industrial Solid Waste Incineration
Cl	Chlorine
CMAQ	Community Multiscale Air Quality
CMV	Commercial Marine Vessel
CO	Carbon monoxide
CSAPR	Cross-State Air Pollution Rule
E0, E10, E85	0%, 10% and 85% Ethanol blend gasoline, respectively
EBAFM	Ethanol, Benzene, Acetaldehyde, Formaldehyde and Methanol
ECA	Emissions Control Area
EEZ	Exclusive Economic Zone
EF	Emission Factor
EGU	Electric Generating Units
EIS	Emissions Inventory System
EISA	Energy Independence and Security Act of 2007
EPA	Environmental Protection Agency
EMFAC	Emission Factor (California's onroad mobile model)
FAA	Federal Aviation Administration

FAPRI	Food and Agriculture Policy and Research Institute
FASOM	Forest and Agricultural Section Optimization Model
FCCS	Fuel Characteristic Classification System
FF10	Flat File 2010
FIPS	Federal Information Processing Standards
FHWA	Federal Highway Administration
HAP	Hazardous Air Pollutant
HCl	Hydrochloric acid
HDGHG	Heavy-Duty Vehicle Greenhouse Gas
Hg	Mercury
HMS	Hazard Mapping System
HPMS	Highway Performance Monitoring System
HWC	Hazardous Waste Combustion
HWI	Hazardous Waste Incineration
ICAO	International Civil Aviation Organization
ICI	Industrial/Commercial/Institutional (boilers and process heaters)
ICR	Information Collection Request
IDA	Inventory Data Analyzer
I/M	Inspection and Maintenance
IMO	International Marine Organization
IPAMS	Independent Petroleum Association of Mountain States
IPM	Integrated Planning Model
ITN	Itinerant
LADCO	Lake Michigan Air Directors Consortium
LDGHG	Light-Duty Vehicle Greenhouse Gas
LPG	Liquefied Petroleum Gas
MACT	Maximum Achievable Control Technology
MARAMA	Mid-Atlantic Regional Air Management Association
MATS	Mercury and Air Toxics Standards
MCIP	Meteorology-Chemistry Interface Processor
Mgal	Million gallons
MMS	Minerals Management Service (now known as the Bureau of Energy Management, Regulation and Enforcement (BOEMRE)
MOVES	Motor Vehicle Emissions Simulator
MSA	Metropolitan Statistical Area
MSAT2	Mobile Source Air Toxics Rule
MTBE	Methyl tert-butyl ether
MWRPO	Mid-west Regional Planning Organization
NCD	National County Database
NEEDS	National Electric Energy Database System
NEI	National Emission Inventory
NESCAUM	Northeast States for Coordinated Air Use Management
NESHAP	National Emission Standards for Hazardous Air Pollutants
NH_3	Ammonia
NIF	NEI Input Format
NLCD	National Land Cover Database
NLEV	National Low Emission Vehicle program
nm	nautical mile
NMIM	National Mobile Inventory Model
NOAA	National Oceanic and Atmospheric Administration

NODA	Notice of Data Availability
NONROAD	OTAQ's model for estimation of nonroad mobile emissions
NO_X	Nitrogen oxides
NSPS	New Source Performance Standards
NSR	New Source Review
OAQPS	EPA's Office of Air Quality Planning and Standards
OHH	Outdoor Hydronic Heater
OTAQ	EPA's Office of Transportation and Air Quality
ORIS	Office of Regulatory Information System
ORD	EPA's Office of Research and Development
ORL	One Record per Line
OTC	Ozone Transport Commission
PADD	Petroleum Administration for Defense Districts
PF	Projection Factor, can account for growth and/or controls
PFC	Portable Fuel Container
$PM_{2.5}$	Particulate matter less than or equal to 2.5 microns
PM_{10}	Particulate matter less than or equal to 10 microns
ppb, ppm	Parts per billion, parts per million
RBT	Refinery to Bulk Terminal
RFS2	Renewable Fuel Standard
RIA	Regulatory Impact Analysis
RICE	Reciprocating Internal Combustion Engine
RRF	Relative Response Factor
RWC	Residential Wood Combustion
RPO	Regional Planning Organization
RVP	Reid Vapor Pressure
SCC	Source Classification Code
SEMAP	Southeastern Modeling, Analysis, and Planning
SESARM	Southeastern States Air Resource Managers
SESQ	Sesquiterpenes
SMARTFIRE	Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation
SMOKE	Sparse Matrix Operator Kernel Emissions
SO_2	Sulfur dioxide
SOA	Secondary Organic Aerosol
SI	Spark-ignition
SIP	State Implementation Plan
SPDPRO	Hourly Speed Profiles for weekday versus weekend
SPPD	Sector Policies and Programs Division
TAF	Terminal Area Forecast
TCEQ	Texas Commission on Environmental Quality
TOG	Total Organic Gas
TSD	Technical support document
ULSD	Ultra Low Sulfur Diesel
USDA	United States Department of Agriculture
VOC	Volatile organic compounds
VMT	Vehicle miles traveled
VPOP	Vehicle Population
WRAP	Western Regional Air Partnership
WRF	Weather Research and Forecasting Model

1 Introduction

The U.S. Environmental Protection Agency (EPA) developed an air quality modeling platform for 2011 based on the 2011 National Emissions Inventory, version 2 (2011NEIv2). The air quality modeling platform consists of all the emissions inventories and ancillary data files used for emissions modeling, as well as the meteorological, initial condition, and boundary condition files needed to run the air quality model. This document focuses on the emissions modeling component of the 2011 modeling platform, which includes the emission inventories, the ancillary data files, and the approaches used to transform inventories for use in air quality modeling. Many emissions inventory components of this air quality modeling platform are based on the 2011NEIv2, although there are some differences between the platform inventories and the 2011NEIv2 emissions.

This 2011 modeling platform includes all criteria air pollutants and precursors (CAPs) and the following hazardous air pollutants (HAPs): chlorine (Cl), hydrogen chloride (HCl), benzene, acetaldehyde, formaldehyde and methanol. The latter four HAPs are also abbreviated as BAFM. This platform is called the “CAP-BAFM 2011-Based Platform, version 6.2” because it is primarily a CAP platform with BAFM species included. Here, “version 6.2” denotes an evolution from the 2011-based platform, version 6.0, with improvements due to the use of newer data and methods. For the rest of this document, the platform that is described is referred to as the “2011 v6.2 platform” or “2011v6.2”.

The 2011v6.2 platform was used to support ozone transport modeling for the 2008 National Ambient Air Quality Standards (NAAQS), the 2015 NAAQS for ozone, along with other special studies. The air quality model used for these rules is the Comprehensive Air Quality Model with Extensions (CAM_X) model (http://www.camx.com/), version 6.10. However, emissions are first processed into a format compatible with for the Community Multiscale Air Quality (CMAQ) model (http://www.epa.gov/AMD/CMAQ/CMAQdocumentation.html), version 5.0.2 and those emissions are converted to CAM_X-ready format. The 2011 National Air Toxics Assessment (NATA) was developed using a similar modeling platform with some variations such as a focus on toxic air pollutants and will be described in the Technical Support Document (TSD) “EPA’s 2011 National-Scale Air Toxics Assessment”.

Both CAM_X and CMAQ support modeling ozone (O_3) and particulate matter (PM), and require as input hourly and gridded emissions of chemical species that correspond to CAPs and specific HAPs. The chemical mechanism used by CAM_X for this platform is called Carbon Bond version 6 revision 2 (CB6r2) and includes important reactions for simulating ozone formation, NOx cycling, and formation of secondary aerosol species (Hildebrant Ruiz and Yarwood, 2013). CB6 provides several revisions to the previous carbon bond version (CB05) through inclusion of four new explicit organic species: benzene, propane, acetylene and acetone; along with updates to reaction chemistry for those species and several other VOCs. Note that because CMAQ does not currently support CB6, the CMAQ-format emissions produced during the emissions modeling process cannot actually be used to run CMAQ. To create files usable with CMAQ, the inventories would instead need to be processed using CB05 speciation.

The 2011v6.2 platform consists of three ‘complete’ emissions cases: the 2011 base case (i.e., 2011eh_cb6v2_v6), the 2017 base case (i.e., 2017eh_cb6v2_v6) and the 2025 base case (i.e., 2025eh_cb6v2_v6). In the case abbreviations, the 2011, 2017 and 2025 are the year represented by the emissions; the “e” stands for evaluation, meaning that year-specific data for fires and electric generating units (EGUs) are used, and the “h” represents that this was the eighth set of emissions modeled for a 2011-based modeling platform. Table 1-1 provides more information on these emissions cases. The purpose of the 2011 base case is to represent the year 2011 in a manner consistent with the methods used in corresponding future-year cases, including the 2017 and 2025 future year base cases, as well as any additional future year control and source apportionment cases. This 2011v6.2 TSD is available on EPA's Emissions Modeling Clearinghouse (EMCH) website, http://www.epa.gov/ttn/chief/emch/, under the section entitled "2011-based Modeling Platform (2011v6 Platform)".

For regulatory applications, the outputs from the 2011 base case are used in conjunction with the outputs from the 2017 and 2025 base cases in the relative response factor (RRF) calculations to identify future areas of nonattainment. For more information on the use of RRFs and air quality modeling, see "Guidance on the Use of Models and Other Analyses for Demonstrating Attainment of Air Quality Goals for Ozone, PM 2.5, and Regional Haze", available from http://www.epa.gov/ttn/scram/guidance/guide/final-03-pm-rh-guidance.pdf.

Table 1-1. List of cases in the 2011 Version 6 Emissions Modeling Platform

Case Name	**Abbreviation**	**Description**
2011 base case	2011eh_cb6v2_v6	2011 case relevant for air quality model evaluation purposes and for computing relative response factors with 2017 and 2025 scenario(s). Uses 2011NEIv2 and some other inventory data, with hourly 2011 continuous emissions monitoring System (CEMS) data for Electrical Generating Units (EGUs), hourly onroad mobile emissions, and 2011 day-specific wild and prescribed fire data.
2017 base case	2017eh_cb6v2_v6	2017 "base case" scenario, representing the best estimate for 2017 that incorporates estimates of the impact of current "on-the-books" regulations.
2025 base case	2025eh_cb6v2_v6	2025 "base case" scenario, representing the best estimate for 2025 that incorporates estimates of the impact of current "on-the-books" regulations.

All of the above cases use the same version of the 2011 meteorology and the cases are sometimes referred to with "_11g" after the emissions portion of the case name. A special version of the 2017eh_cb6v2_v6 case called 2017eh_ussa_cb6v2_v6_11g was prepared for use with the CAMx OSAT/APCA feature that allowed the contribution of 2017 base case NOX and VOC emissions from all sources in each state to projected 2017 ozone concentrations at air quality monitoring sites to be quantified. The emissions for the case are equivalent to those in the 2017eh_cb6v2_v6 case, except that the emission sources are tagged according to their origin by state or sector. The steps for setting up the 2017eh_cb6v2_v6 source apportionment case included:

1) prepare files for the source groups to track (e.g., anthropogenic emissions from each state, non-geographic sector-specific tags for biogenic, fugitive dust, fire, and non-US emissions);
2) rerun all sectors in SMOKE using the specified source groups;
3) create CAMx point source files for source groups tracked only by sector;
4) convert SMOKE outputs to CAMx point source files using the tags assigned by SMOKE; and
5) merge all of the point source files together into a single CAMx mrgpt file for each day.

More information on processing for source apportionment is available at ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/smoke_scripts_utils/README_smoke_source_apportionment.txt.

The year 2018 was used as the analytic year for the preliminary modeling performed with the 2011v6.0 platform because at the onset of the modeling assessment, that year aligned with the December 2018 attainment date for Moderate ozone nonattainment areas. However, subsequent to the completion of the 2018 modeling, EPA issued the final 2008 Ozone NAAQS SIP Requirements Rule, which revised the attainment deadline for ozone nonattainment areas currently designated as Moderate for the 2008 ozone NAAQS to July 2018. The EPA established this deadline in the 2015 Ozone SIP Requirements Rule after previously establishing a deadline of December 31, 2018, that was vacated by the D.C. Circuit in *Natural Resources Defense Council v. EPA*. In order to demonstrate attainment by the revised attainment deadline, the demonstration would have to be based on design values calculated using 2015 through 2017 ozone season data, since the July 2018 deadline does not afford a full ozone season of measured data. Therefore, the EPA has adopted 2017 as the analytic year for the updated ozone transport modeling in the 2011v6.2 platform. Because projected emission inventories had already been prepared for the year 2018 by the time of the *Natural Resources Defense Council v. EPA* decision, the projected emissions for some sectors were adjusted to the year 2017 using methods appropriate to those sectors.

The emissions data in the 2011v6.2 platform are primarily based on the 2011NEIv2 for point sources, nonpoint sources, commercial marine vessels (CMV), nonroad mobile sources and fires. The onroad mobile source emissions are similar to those in the 2011NEIv2, but were generated using the released 2014 version of the Motor Vehicle Emissions Simulator (MOVES2014) with support for CB6 (http://www.epa.gov/otaq/models/moves/), while the 2011NEIv2 emissions were generated using a slightly earlier version of MOVES2014 and had a different treatment of E-85 vehicles. The 2011v6.2 platform cases implement comments received on the Federal Register notices issued for 2011 and 2018 emissions in the 2011v6.0 platform: 78 FR 70935 and 79 FR 2437, respectively. High-level descriptions of implemented comments are included in the relevant subsections. The 2011v6.2 platform 2011 and 2017 emissions and air quality model results were released for review and comment in the Federal Register notice 80 FR 46271. The updates in the 2011v6.2 platform include the following:

- Emissions updates based on comments submitted during the notices of data availability for the 2011 and 2018 emissions modeling platforms and the development of the 2011NEIv2 that resulted in changes to all sectors of emissions in 2011NEIv2;
- Use of updated EPA emissions data sets in the 2011NEIv2 for many sectors, including oil and gas, residential wood combustion (RWC), commercial marine vessels, and oil platforms in the Gulf of Mexico;
- Use of MOVES 2014 for base and future year onroad mobile source emissions, along with updated input databases based on comments and new EPA data sources, and updates to speciation, spatial surrogates, and temporal profiles for onroad mobile sources;
- Use of the Biogenic Emissions Inventory System (BEIS) version 3.61 for biogenic emissions, including updated land use information;
- Use of the Integrated Planning Model (IPM) version 5.14 for future year EGU emissions and updated EGU temporalization methods;
- Updated emissions for Canada and Mexico; and
- Updated projections for stationary sources.

The primary emissions modeling tool used to create the air quality model-ready emissions was the SMOKE modeling system (http://www.smoke-model.org/). SMOKE version 3.6.5 was used to create emissions files for a 12-km national grid that includes all of the contiguous states "12US2", shown in Figure 3-1. Boundary conditions for this grid were obtained from a 2011 run of GEOS-Chem (http://geos-chem.org/) and were consistent with those used for the 2011v6.1 platform used for the proposed 2015 ozone NAAQS. Electronic copies of the data used as input to SMOKE for the 2011

Platform are available from the Emissions Modeling Clearinghouse website, http://www.epa.gov/ttn/chief/emch/ under the 2011-based modeling platform section.

The gridded meteorological model used for the emissions modeling was developed using the Weather Research and Forecasting Model (WRF, http://wrf-model.org) version 3.4, Advanced Research WRF core (Skamarock, et al., 2008). The WRF Model is a mesoscale numerical weather prediction system developed for both operational forecasting and atmospheric research applications. WRF was run for 2011 over a domain covering the continental United States at a 12km resolution with 35 vertical layers. The WRF data were collapsed to 25 layers prior to running the emissions and air quality models. The run for this platform included high resolution sea surface temperature data from the Group for High Resolution Sea Surface Temperature (GHRSST) (see https://www.ghrsst.org/) and is given the EPA meteorological case label "11g" and are consistent with those used for the 2011v6.1 platform.

This document contains five sections and several appendices. Section 2 describes the 2011 inventories input to SMOKE. Section 3 describes the emissions modeling and the ancillary files used with the emission inventories. Section 4, describes the development of the 2017 and 2025 inventories (projected from 2011). Data summaries comparing the 2011, 2017 and 2025 base cases are provided in Section 5. Section 6 provides references. The Appendices provide additional details about specific technical methods.

2 2011 Emission Inventories and Approaches

This section describes the 2011 emissions data that make up the 2011 platform. The starting point for the 2011 stationary source emission inputs is the 2011NEIv2. Emissions of NO_X, SO_2, VOC and PM emissions decrease from values in the 2008 NEI version 3 for most source sectors, with a couple of notable exceptions including increased industrial NO_X, VOC and CO associated with increased oil and gas sector emissions and improved emission estimates; slightly increased VOC, CO and NH_3 from fuel combustion; and increased wildfire emissions. Documentation for the 2011NEIv2, including a Technical Support Document (TSD), is available at http://www.epa.gov/ttn/chief/net/2011inventory.html#inventorydoc.

The NEI data for CAPs are largely compiled from data submitted by state, local and tribal (S/L/T) air agencies. HAP emissions data are also from the state data, but are often augmented by EPA because they are voluntarily submitted. EPA uses the Emissions Inventory System (EIS) to compile the NEI. EIS includes hundreds of automated QA checks to help improve data quality, and also supports tracking release point (e.g., stack) coordinates separately from facility coordinates. EPA collaborated extensively with S/L/T agencies to ensure a high quality of data in the 2011NEIv2. Tangible benefits of this collaboration are seen in improved data quality, improved completeness and reduced duplication between point and nonpoint source categories such as industrial boilers. Onroad mobile source emissions in the 2011NEIv2 were developed using a pre-release version of MOVES2014; however, the 2011 emissions modeling platform used the released version of MOVES2014, with added support for CB6. When given the same inputs, these two versions of MOVES produce similar emissions estimates for the year 2011.

The 2011 NEI includes five data categories: point sources, nonpoint (formerly called "stationary area") sources, nonroad mobile sources, onroad mobile sources, and events consisting of fires. The 2011NEIv2 uses 60 sectors to further describe the emissions, with an additional biogenic sector generated from a summation of the gridded, hourly 2011 biogenic data used in the modeling platform. In addition to the NEI data, emissions from the Canadian and Mexican inventories and several other non-NEI data sources are included in the 2011 platform.

As explained below, the major differences between the 2011 NEIv2 and the 2011 platform include: a different version of MOVES-based onroad mobile source emissions, meteorologically-adjusted road dust emissions, CEMS data for EGUs, and emissions for areas outside the U.S. In addition, the modeling platform uses more temporally-resolved emissions than the NEI for many sectors.

Fire emissions in 2011NEIv2 were developed based on Version 2 of the Satellite Mapping Automated Reanalysis Tool for Fire Incident Reconciliation (SMARTFIRE) system (Sullivan, et al., 2008). SMARTFIRE2 was the first version of SMARTFIRE to assign all fires as either prescribed burning or wildfire categories. In past inventories, a significant number of fires were published as unclassified, which impacted the emissions values and diurnal emissions pattern. Recent updates to SMARTFIRE include improved emission factors for prescribed burning.

For the purposes of preparing the air quality model-ready emissions, the 2011NEIv2 was split into finer-grained sectors used for emissions modeling. The significance of an emissions modeling or "platform sector" is that the data are run through all of the SMOKE programs except the final merge (Mrggrid) independently from the other sectors. The final merge program then combines the sector-specific gridded, speciated, hourly emissions together to create CMAQ-ready emission inputs. For CAMx applications, the CMAQ-ready emissions are then converted into the format needed by CAMx using a convertor program.

Table 2-1 presents the sectors in the 2011 platform and how they generally relate to the 2011NEIv2 as a starting point. As discussed in greater detail in Table 2-2, the emissions in some of these sectors were modified from the 2011NEIv2 emissions for the 2011 modeling platform. The platform sector abbreviations are provided in italics. These abbreviations are used in the SMOKE modeling scripts, inventory file names, and throughout the remainder of this document.

Table 2-1. Platform sectors for the 2011 emissions modeling platform

Platform Sector: *abbreviation*	**NEI Data Category**	**Description and resolution of the data input to SMOKE**
EGU non-peaking units: *ptegu*	Point	2011NEIv2 point source EGUs. The 2011NEIv2 emissions are replaced with hourly 2011 CEMS values for NO_X and SO_2, where the units are matched to the NEI. Other pollutants are scaled from 2011NEIv2 using CEMS heat input. Emissions for all sources not matched to CEMS data come from 2011NEIv2. For future year emissions, these units are mapped to the Integrated Planning Model (IPM) model results using a cross reference to the National Electric Energy Database System (NEEDS) version 5.14. Annual resolution for non-matched sources, hourly for CEMS sources.
Point source oil and gas: *pt_oilgas*	Point	2011NEIv2 point sources that include oil and gas production emissions processes. Annual resolution.
Remaining non-EGU point: *ptnonipm*	Point	All 2011NEIv2 point source records not matched to the ptegu or pt_oilgas sectors, except for offshore point sources that are in the othpt sector. Includes all aircraft emissions and some rail yard emissions. Annual resolution.
Agricultural: *ag*	Nonpoint	NH_3 emissions from 2011NEIv2 nonpoint livestock and fertilizer application, county and annual resolution.
Agricultural fires: *agfire*	Nonpoint	2011NEIv2 agricultural fire sources. County and monthly resolution.
Area fugitive dust: *afdust*	Nonpoint	PM_{10} and $PM_{2.5}$ fugitive dust sources from the 2011NEIv2 nonpoint inventory; including building construction, road construction, agricultural dust, and road dust; however, unpaved and paved road dust emissions differ from the NEI in that do not have a precipitation adjustment. Instead, the emissions modeling adjustment applies a transport fraction and a meteorology-based (precipitation and snow/ice cover) zero-out. County and annual resolution.
Biogenic: *Beis*	Nonpoint	Year 2011, hour-specific, grid cell-specific emissions generated from the BEIS3.61 model within SMOKE, including emissions in Canada and Mexico.
Category 1 & 2 CMV and locomotives: *c1c2rail*	Nonpoint	Locomotives and category 1 (C1) and category 2 (C2) commercial marine vessel (CMV) emissions sources from the 2011NEIv2 nonpoint inventory. County and annual resolution.
commercial marine: *c3marine*	Nonpoint	Category 3 (C3) CMV emissions from the 2011NEIv2 from the 2011NEIv2; see othpt sector for all non-U.S. emissions.
Remaining nonpoint: *nonpt*	Nonpoint	2011NEIv2 nonpoint sources not included in other platform sectors; county and annual resolution.
Nonpoint source oil and gas: *np_oilgas*	Nonpoint	2011NEIv2 nonpoint sources from oil and gas-related processes. County and annual resolution.

Platform Sector: *abbreviation*	NEI Data Category	Description and resolution of the data input to SMOKE
Residential Wood Combustion: ***rwc***	Nonpoint	2011NEIv2 NEI nonpoint sources with Residential Wood Combustion (RWC) processes. County and annual resolution.
Nonroad: ***nonroad***	Nonroad	2011NEIv2 nonroad equipment emissions developed with the National Mobile Inventory Model (NMIM) using NONROAD2008 version NR08a. NMIM was used for all states except California and Texas, which submitted their own emissions for the 2011NEIv2. County and monthly resolution.
Onroad: ***onroad***	Onroad	2011 onroad mobile source gasoline and diesel vehicles from parking lots and moving vehicles. Includes the following modes: exhaust, extended idle, auxiliary power units, evaporative, permeation, refueling, and brake and tire wear. For all states except California, based on monthly MOVES emissions tables from MOVES2014. California emissions are based on Emission Factor (EMFAC). MOVES-based emissions computed for each hour and model grid cell using monthly and annual activity data (e.g., VMT, vehicle population).
Point source fires: ***ptprescfire***	Fires	Point source day-specific prescribed fires for 2011 computed using SMARTFIRE2, except for Georgia and Florida-submitted emissions. Consistent with 2011NEIv2. Note that CMAQ requires all fire emissions to be in a single sector (ptfire) to receive the fire-specific treatment for plume rise, so prescribed and wild must be merged.
Point source fires: ***ptwildfire***	Fires	Point source day-specific wildfires for 2011 computed using SMARTFIRE2, except for Georgia and Florida-submitted emissions. Consistent with 2011NEIv2.
Other dust sources not from the 2011 NEI: ***Othafdust***	N/A	Fugitive dust sources from Canada's 2010 inventory.
Other point sources not from the 2011 NEI: ***othpt***	N/A	Point sources from Canada's 2010 inventory and Mexico's 2008 inventory, annual resolution. Also includes all non-U.S. C3 CMV and U.S. offshore oil production.
Other non-NEI nonpoint and nonroad: ***othar***	N/A	Annual year 2010 Canada (province resolution) and year 2008 Mexico (municipio resolution) nonpoint and nonroad mobile inventories.
Other non-NEI onroad sources: ***othon***	N/A	Year 2010 Canada (province resolution) and year 2008 Mexico (municipio resolution) onroad mobile inventories, annual resolution.

Table 2-2 provides a brief by-sector overview of the most significant differences between the 2011 emissions platform and the 2011NEIv2. Only those sectors with significant differences between the 2011NEIv2 and the 2011 emissions modeling platform are listed. The specific by-sector updates to the 2011 platform are described in greater detail later in this section under each by-sector subsection.

Table 2-2. Summary of differences between 2011v6.2 platform and 2011NEIv2 emissions by sector

Platform Sector	Summary of Significant Inventory Differences of 2011 Platform vs. 2011NEIv2
Area fugitive dust: ***afdust***	1) Replaced EPA-provided emission estimates for paved and unpaved road dust with "non-meteorologically-adjusted" emissions, then adjusted emissions to reflect land use (transport) and meteorological effects such as rain and snow cover which significantly reduces PM emissions. These adjusted emissions are known as the afdust_adj sector.
Biogenic: ***beis***	1) Biogenic emissions changed from 3.60 to 3.61
Remaining nonpoint sector: ***nonpt***	1) Split the 2011NEIv2 nonpoint file into the platform sectors afdust, ag, agfire, beis, np_oilgas, rwc, c3marine, and c1c2rail. 2) Used agricultural fires emissions from a daily inventory aggregated to monthly values, whereas the NEI only stores annual values.
Nonroad sector: ***nonroad***	1) Monthly rather than annual emissions that match 2011NEIv2 totals. 2) Texas: replaced with annual 2011 Texas data apportioned to months using EPA's 2011 nonroad estimates.
Onroad sector: ***Onroad***	1) For all states except California: Year 2011 emissions based on emission factors from the released version of MOVES2014, as opposed to the early MOVES2014 which was used for the 2011NEIv2. Developed with SMOKE-MOVES using 2011 meteorology. 2) Platform contains correction to diesel refueling emissions 3) Platform uses E-85 activity data and emission factors, where for NEI E-85 was not included. 4) For California: merged in 2011 California data to post-adjust SMOKE-MOVES data (discussed later).
EGUs: ***ptegu***	1) Based on 2011NEIv2 and 2011 CEMS data analysis by EPA and states, added ORIS Boiler IDs to some units (greater than 1,000 tons of NO_X or SO_2) with missing or incorrect values to allow for hourly CEMS data processing. 2) Added CEMS matches to additional units identified as CEMS sources. Hourly NO_X and SO_2 CEMS data replaces annual NO_X and SO_2 NEI data in the air quality model inputs for 2011 and scaled hourly data in future years.
Non-EGUs sector: ***ptnonipm***	1) Additional matches to IPM_YN codes and ORIS facility codes caused several sources to move out of ptnonipm and into the ptegu sector. The goal is to prevent double counting of EGU emissions in the future years.

The emission inventories in SMOKE input format for the 2011 base case are available from the Emissions Modeling Clearinghouse website http://www.epa.gov/ttn/chief/emch/index.html#2011. The 2011v6.2 "readme" file indicates the particular zipped files associated with each platform sector. A number of reports were developed for the 2011 platform. Descriptions of the available data and reports are available from the FTP site at ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform. The types of reports include state summaries of inventory pollutants and model species by modeling platform sector, county annual totals by modeling platform sector, daily NOx and VOC emissions by sector and total, and state-SCC-sector summaries. . A comparison of the complete list of inventory files, ancillary files, and parameter settings for the 2011v6.2 platform modeling cases is also available.

The remainder of Section 2 provides details about the data contained in each of the 2011 platform sectors. Different levels of detail are provided for different sectors depending on the availability of reference information for the data, the degree of changes or manipulation of the data needed to prepare it for input to SMOKE, and whether the 2011 platform emissions are significantly different from the 2011NEIv2.

2.1 2011 NEI point sources (ptegu, pt_oilgas and ptnonipm)

Point sources are sources of emissions for which specific geographic coordinates (e.g., latitude/longitude) are specified, as in the case of an individual facility. A facility may have multiple emission release points, which may be characterized as units such as boilers, reactors, spray booths, kilns, etc. A unit may have multiple processes (e.g., a boiler that sometimes burns residual oil and sometimes burns natural gas). With a couple of minor exceptions, this section describes only NEI point sources within the contiguous United States. The offshore oil platform (othpt sector) and category 3 CMV emissions (c3marine and othpt sectors) are processed by SMOKE as point source inventories, as described in Section 2.5.1 and Section 2.4.2, respectively. A comprehensive description of how EGU emissions were characterized and estimated in the 2011 NEI can be found in Section 3.10 in the 2011NEIv2 TSD.

The point source file used for the modeling platform is exported from EIS into the Flat File 2010 (FF10) format that is compatible with SMOKE (see http://www.cmascenter.org/smoke/documentation/3.5.1/html/ch08s02s10.html#d0e44906). After moving offshore oil platforms into the othpt sector, and dropping sources without true locations (i.e., their FIPS code ends in 777), initial versions of the other four platform point source sectors were created from the remaining 2011NEIv2 point sources. The point sectors are: the EGU sector for non-peaking units (ptegu), point source oil and gas extraction -related emissions (pt_oilgas) and the remaining non-EGU sector also called the non-IPM (ptnonipm) sector. The EGU emissions are split out from the other sources to facilitate the use of distinct SMOKE temporal processing and future-year projection techniques. The oil and gas sector emissions (pt_oilgas) were processed separately for summary tracking purposes and distinct future-year projection techniques from the remaining non-EGU emissions (ptnonipm).

The inventory pollutants processed through SMOKE for all point source sectors were: CO, NO_X, VOC, SO_2, NH_3, PM_{10}, and $PM_{2.5}$ and the following HAPs: HCl (pollutant code = 7647010), and Cl (code = 7782505). The inventory BAFM from these sectors was not used, instead VOC was speciated to these pollutants without any use (i.e., integration) of the VOC HAP pollutants from the inventory (VOC integration is discussed in detail in Section 0).

The ptnonipm and pt_oilgas sector emissions were provided to SMOKE as annual emissions. For those ptegu sources with CEMS data (that could be matched to the 2011NEIv2), 2011 hourly CEMS NO_X and SO_2 emissions were used rather than NEI emissions, and for all other pollutants annual emissions were used as-is from the NEI, but were allocated to hourly values using heat input CEMS data. For the non-CEMS sources in the ptegu sector, daily emissions were created using an approach described in Section 2.1.1, and IPM region- and pollutant-specific diurnal profiles were applied to create hourly emissions.

Changes made to the point-based sectors from the 2011NEIv2 for the 2011 platform were described in Table 2-2. Some of these changes involved splitting the stacks, units and facilities into the ptnonipm, pt_oilgas and ptegu sectors. Sources were included in the ptegu sector only when it was determined that these sources were reflected in the future-year IPM output data. These changes and other updates to the point source sectors for the 2011 platform are discussed in the following sections.

2.1.1 EGU sector (ptegu)

The ptegu sector contains emissions from EGUs in the 2011NEIv2 point inventory that could be matched to units found in the NEEDS v5.14 database. It was necessary to put these EGUs into separate sectors in the platform because IPM projects future emissions for the EGUs defined in the NEEDS database, and emissions for sources in the ptegu sector are replaced with IPM outputs in the future year modeling case. Sources not matched to units found in NEEDS are placed into the pt_oilgas (see Section 2.1.2) or ptnonipm (see Section 2.1.3) sectors and are projected to the future year using projection and control factors. It is important that the matching between the NEI and NEEDS database be as complete as possible because there can be double counting of emissions in the future year if emissions for units are projected by IPM are not properly matched to the units in the NEI. The 2011v6.1 platform included a ptegu_pk sector, but this was determined not to add significant information and therefore all identified EGUs are in the ptegu sector in the 2011v6.2 platform.

In the SMOKE point flat file, emission records for sources that have been matched to the NEEDS database have a value filled into the IPM_YN column. Many of these matches are stored within EIS. In some cases, it was difficult to match the sources between the databases due to different facility names in the two data systems and due to differences in how the units are defined, thereby resulting in matches that are not always one-to-one. Some additional matches were made in the modeling platform to accommodate some of these situations as described later in this section. The NEEDS v5.14 database can be found at http://www.epa.gov/powersectormodeling/psmodel514.html , along with additional information about IPM. The cross reference between NEEDS 5.14 units and those in the NEI can be found here: ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/reports/ipm_to_flat_file_xref_2011NEIv2_IPM5.14_20150113.xlsx and is used when IPM outputs are postprocessed to create flat files for modeling. An updated version with additional matches to be used with later versions of IPM called ipm_to_flat_file_xref_2011NEIv2_Updated_20150710.xlsx is also available.

Some units in the ptegu sector are matched to CEMS data via ORIS facility codes and boiler ID. Many additional units were matched to CEMS data than were matched for the 2011v6.1 platform. For matched units, SMOKE replaces the 2011 emissions of NO_X and SO_2 with the CEMS emissions, thereby ignoring the annual values specified in the NEI. For other pollutants, the hourly CEMS heat input data are used to allocate the NEI annual emissions to hourly values. All stack parameters, stack locations, and SCC codes for these sources come from the NEI. Because these attributes are obtained from the NEI, the chemical speciation of VOC and $PM_{2.5}$ for the sources is selected based on the SCC or in some cases, based on unit-specific data. If CEMS data exists for a unit, but the unit is not matched to the NEI, the CEMS data for that unit is not used in the modeling platform. However, if the source exists in the NEI and is not matched to a CEMS unit, the emissions from that source are still modeled using the annual emission value in the NEI. EIS stores many matches from EIS units to the ORIS facility codes and boiler IDs used to reference the CEMS data. Some additional matches were made in the modeling platform as described later in this section.

In the SMOKE point flat file, emission records for point sources matched to CEMS data have values filled into the ORIS_FACILITY_CODE and ORIS_BOILER_ID columns. The CEMS data in SMOKE-ready format is available at http://ampd.epa.gov/ampd/ near the bottom of the "Prepackaged Data" tab. Many smaller emitters in the CEMS program are not identified with ORIS facility or boiler IDs that can be matched to the NEI due to inconsistencies in the way a unit is defined between the NEI and CAMD datasets, or due to uncertainties in source identification such as inconsistent plant names in the two data systems. Also, the NEEDS database of units modeled by IPM includes many smaller emitting EGUs that are not included in the CAMD hourly CEMS programs. Therefore, there will be more units in the NEEDS database than have CEMS data. The temporalization of EGU units matched to CEMS is based on the CEMS data in the base and future years are based on the base year CEMS data for those units, whereas regional profiles are used for the remaining units. More detail can be found in Section 3.3.2.

For sources not matched to CEMS data, daily emissions were computed from the NEI annual emissions using average CEMS data profiles specific to fuel type, pollutant[2], and IPM region. To allocate emissions to each hour of the day, diurnal profiles were created using average CEMS data for heat input specific to fuel type and IPM region. For future-year scenarios, there are no CEMS data available for specific units, but the shape of the CEMS profiles is preserved for sources that are carried into the future year. This method keeps the temporal behavior of the base and future year cases as consistent as possible. See Section 3.3.2 for more details on the temporalization approach for ptegu sources.

Finding additional matches between the NEI, NEEDS, and CEMS data

Several analytical steps were performed to better link the NEEDS units to the 2011NEIv2, along with implementing better matching to the CEMS data cross-referenced using "ORIS" facility and boiler IDs. The steps described in the 2011NEIv2 TSD have some detail on how the values in the IPM_YN column were assigned. For the modeling platform, an initial ptegu/ptnonipm split was determined using the values in the SMOKE point source flat file variable "IPM_YN", which is populated based on an EIS alternative facility identifier. Because EIS expects the matches to be one-to-one for an entire unit, if the units are not defined in the same way in EIS and NEEDS, one-to-many or many-to-many matches can only be stored in EIS with specified "end dates" and will not export directly to the flat file. However, one-to-many and many-to-many matches to the IPM_YN values were placed into the SMOKE input file through a postprocessing step. This requires the additional of additional "dummy" records in the SMOKE file that will be overlaid with CEMS data when SMOKE is run.

Additional matches between the NEI and NEEDS were identified by identifying units in IPM outputs that were not yet matched to NEI data, and by looking for units identified in the NEI with facility type codes identifying them as EGUs or facility names that indicated they were EGUs. In each case, priority was given to units with larger emissions (e.g., > 300TPY of NO_x or SO_2). The units in each data set that did not yet have matches within the same county were compared to one another on the basis of their plant names and locations. In some cases, IDs were similar but were mismatched only due to a missing leading zero in one of the databases. In other cases, a facility level match was specified, but a unit/boiler level match was not yet identified and therefore the units at the facility were compared to one another on the basis of design capacity and naming. For any new matches that were found, values that represented the NEEDS IDs were filled in to the IPM_YN in the modeling platform flat files. When possible, these matches were loaded into EIS.

A similar matching process was used to identify additional matches between the 2011NEIv2 and CEMS data. To determine whether a NEI unit matched a CEMS unit, the CEMS units were compared to facilities in the NEI that were not yet identified as a CEMS unit on the basis of their county FIPS codes, locations, and total emissions of NO_x and SO_2. Additional CEMS matches that were found were applied to the FF10 file by specifying values for ORIS_FACILITY_CODE, ORIS_BOILER_ID. Because IPM uses a concatenation of the ORIS facility code and boiler ID, values were also filled in to the IPM_YN field for these units.

As a result of identifying additional matches through this analysis, many EGUs that otherwise would have remained in the ptnonipm sector were moved to the ptegu sector. Many new CEMS assignments

[2] The year to day profiles use NOx and SO2 CEMS for NOx and SO2, respectively. For all other pollutants, they use heat input CEMS data.

were loaded into EIS for use in future inventories. Note that SMOKE can perform matches of CEMS data down to the stack or release point-level, which is finer than unit-level.

2.1.2 Point source oil and gas sector (pt_oilgas)

The pt_oilgas sector was separated from the ptnonipm sector by selecting sources with specific NAICS codes shown in Table 2-3. This was done differently than in the 2011v6.1 platform and resulted in more sources and emissions in the pt_oilgas sector and fewer sources and emissions in the ptnonipm sector. The emissions and other source characteristics in the pt_oilgas sector are submitted by states, while EPA developed a dataset of nonpoint oil and gas emissions for each county in the U.S. with oil and gas activity that was available for states to use. Nonpoint oil and gas emissions can be found in the np_oilgas sector. More information on the development of the 2011 oil and gas emissions can be found in Section 3.20 of the 2011NEIv2 TSD.

Table 2-3. Point source oil and gas sector NAICS Codes

NAICS	NAICS description
2111	Oil and Gas Extraction
2212	Natural Gas Distribution
4862	Pipeline Transportation of Natural Gas
21111	Oil and Gas Extraction
22121	Natural Gas Distribution
48611	Pipeline Transportation of Crude Oil
48621	Pipeline Transportation of Natural Gas
211111	Crude Petroleum and Natural Gas Extraction
211112	Natural Gas Liquid Extraction
213111	Drilling Oil and Gas Wells
213112	Support Activities for Oil and Gas Operations
221210	Natural Gas Distribution
486110	Pipeline Transportation of Crude Oil
486210	Pipeline Transportation of Natural Gas

2.1.3 Non-IPM sector (ptnonipm)

Except for some minor exceptions, the non-IPM (ptnonipm) sector contains the 2011NEIv2 point sources that are not in the ptegu or pt_oilgas sectors. For the most part, the ptnonipm sector reflects the non-EGU sources of the NEI point inventory; however, it is likely that some small low-emitting EGUs not matched to the NEEDS database or to CEMS data are present in the ptnonipm sector. The sector includes some ethanol plants that have been identified by EPA and require special treatment in the future cases as they are impacted by mobile source rules.

The ptnonipm sector contains a small amount of fugitive dust PM emissions from vehicular traffic on paved or unpaved roads at industrial facilities, coal handling at coal mines, and grain elevators. Sources with state/county FIPS code ending with “777” are in the 2011NEIv2 but are not included in any modeling sectors. These sources typically represent mobile (temporary) asphalt plants that are only reported for some states, and are generally in a fixed location for only a part of the year and are therefore difficult to allocate to specific places and days as is needed for modeling. Therefore, these sources are dropped from the point-based sectors in the modeling platform.

EPA estimates for ethanol facilities

Ethanol plants are important facilities for mobile source rules that have impact development work, EPA developed a list of corn ethanol facilities for 2011. Ethanol facilities that were not in 2011NEIv1 were added into 2011NEIv2. Locations and FIPS codes for these ethanol plants were verified using web searches and Google Earth. EPA believes that some of these sources were not originally included in the NEI as point sources because they do not meet the 100 ton/year potential-to-emit threshold for NEI point sources. Emission rates for the ethanol plants were obtained from EPA's updated spreadsheet model for upstream impacts developed for the Renewable Fuel Standard (RFS2) rule (EPA, 2010a). Plant emission rates for criteria pollutants used to estimate impacts for years 2011 (and are assumed to be the same in 2018 and 2025) are given in Table 2-4.

Table 2-4. Corn Ethanol Plant Criteria Pollutant Emission Factors (grams per gallon produced)

Corn Ethanol Plant Type	**VOC**	**CO**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**SO_2**	**NH_3**
Dry Mill Natural Gas (NG)	2.29	0.58	0.99	0.94	0.23	0.01	0.00
Dry Mill NG (wet distillers grains with solubles (DGS))	2.27	0.37	0.63	0.91	0.20	0.00	0.00
Dry Mill Biogas	2.29	0.62	1.05	0.94	0.23	0.01	0.00
Dry Mill Biogas (wet DGS)	2.27	0.39	0.67	0.91	0.20	0.00	0.00
Dry Mill Coal	2.31	2.65	4.17	3.81	1.71	4.52	0.00
Dry Mill Coal (wet DGS)	2.31	2.65	2.65	2.74	1.14	2.87	0.00
Dry Mill Biomass	2.42	2.55	3.65	1.28	0.36	0.14	0.00
Dry Mill Biomass (wet DGS)	2.35	1.62	2.32	1.12	0.28	0.09	0.00
Wet Mill NG	2.35	1.62	1.77	1.12	0.28	0.09	0.00
Wet Mill Coal	2.33	1.04	5.51	4.76	2.21	5.97	0.00

Air toxic emission rates were estimated by applying toxic to VOC ratios in Table 2-5 were multiplied by facility production estimates for 2011 and 2018 based on analyses performed for the industry characterization described in Chapter 1 of the RFS2 final rule regulatory impact analysis. For air toxics except ethanol, the toxic-to-VOC ratios were developed using emission inventory data from the 2005 NEI (EPA, 2009a).

Table 2-5. Toxic-to-VOC Ratios for Corn Ethanol Plants

	Acetaldehyde	**Acrolein**	**Benzene**	**1,3-Butadiene**	**Formaldehyde**
Wet Mill NG	0.02580	0.00131	0.00060	2.82371E-08	0.00127
Wet Mill Coal	0.08242	0.00015	0.00048	2.82371E-08	0.00108
Dry Mill NG	0.01089	0.00131	0.00060	2.82371E-08	0.00127
Dry Mill Coal	0.02328	0.00102	0.00017	2.82371E-08	0.00119

2.2 2011 nonpoint sources (afdust, ag, agfire, np_oilgas, rwc, nonpt)

Several modeling platform sectors were created from the 2011NEIv2 nonpoint inventory. This section describes the *stationary* nonpoint sources. Locomotives, C1 and C2 CMV, and C3 CMV are also included the 2011NEIv2 nonpoint data category, but are mobile sources that are described in Sections 2.4.1 and 2.4.2 as the c1c2rail and c3marine sectors, respectively. The 2011NEIv2 TSD available from http://www.epa.gov/ttn/chief/net/2011inventory.html includes documentation for the nonpoint sector of the 2011NEIv2.

The nonpoint tribal-submitted emissions are dropped during spatial processing with SMOKE due to the configuration of the spatial surrogates. Part of the reason for this is to prevent possible double-counting with county-level emissions and also because spatial surrogates for tribal data are not currently available. These omissions are not expected to have an impact on the results of the air quality modeling at the 12-km scales used for this platform.

The following subsections describe how the sources in the 2011NEIv2 nonpoint inventory were separated into 2011 modeling platform sectors, along with any data that were updated replaced with non-NEI data.

2.2.1 Area fugitive dust sector (afdust)

The area-source fugitive dust (afdust) sector contains PM_{10} and $PM_{2.5}$ emission estimates for nonpoint SCCs identified by EPA staff as dust sources. Categories included in the afdust sector are paved roads, unpaved roads and airstrips, construction (residential, industrial, road and total), agriculture production, and mining and quarrying. It does not include fugitive dust from grain elevators, coal handling at coal mines, or vehicular traffic on paved or unpaved roads at industrial facilities because these are treated as point sources so they are properly located.

The afdust sector is separated from other nonpoint sectors to allow for the application of a "transport fraction," and meteorological/precipitation reductions. These adjustments are applied with a script that applies land use-based gridded transport fractions followed by another script that zeroes out emissions for days on which at least 0.01 inches of precipitation occurs or there is snow cover on the ground. The land use data used to reduce the NEI emissions determines the amount of emissions that are subject to transport. This methodology is discussed in (Pouliot, et al., 2010), http://www.epa.gov/ttn/chief/conference/ei19/session9/pouliot_pres.pdf, and in "Fugitive Dust Modeling for the 2008 Emissions Modeling Platform" (Adelman, 2012). Both the transport fraction and meteorological adjustments are based on the gridded resolution of the platform (e.g., 12km grid cells); therefore, different emissions will result if the process were applied to different grid resolutions. A limitation of the transport fraction approach is the lack of monthly variability that would be expected with seasonal changes in vegetative cover. While wind speed and direction are not accounted for in the emissions processing, the hourly variability due to soil moisture, snow cover and precipitation is accounted for in the subsequent meteorological adjustment.

The sources in the afdust sector are for SCCs and pollutant codes (i.e., PM_{10} and $PM_{2.5}$) that are considered to be "fugitive" dust sources. These SCCs are provided in Table 2-6.

Table 2-6. SCCs in the afdust platform sector

SCC	SCC Description
2275085000	Mobile Sources;Aircraft;Unpaved Airstrips;Total
2294000000	Mobile Sources;Paved Roads;All Paved Roads;Total: Fugitives
2294000002	Mobile Sources;Paved Roads;All Paved Roads;Total: Sanding/Salting - Fugitives
2296000000	Mobile Sources;Unpaved Roads;All Unpaved Roads;Total: Fugitives
2296005000	Mobile Sources;Unpaved Roads;Public Unpaved Roads;Total: Fugitives
2296010000	Mobile Sources;Unpaved Roads;Industrial Unpaved Roads;Total: Fugitives
2311000000	Industrial Processes;Construction: SIC 15 - 17;All Processes;Total
2311010000	Industrial Processes;Construction: SIC 15 - 17;Residential;Total
2311020000	Industrial Processes;Construction: SIC 15 - 17;Industrial/Commercial/Institutional;Total

SCC	SCC Description
2311030000	Industrial Processes;Construction: SIC 15 - 17;Road Construction;Total
2311040000	Industrial Processes;Construction: SIC 15 - 17;Special Trade Construction;Total
2325000000	Industrial Processes;Mining and Quarrying: SIC 14;All Processes;Total
2325020000	Industrial Processes;Mining and Quarrying: SIC 14;Crushed and Broken Stone;Total
2325030000	Industrial Processes;Mining and Quarrying: SIC 14;Sand and Gravel;Total
2801000000	Miscellaneous Area Sources;Agriculture Production - Crops;Agriculture - Crops;Total
2801000002	Miscellaneous Area Sources;Agriculture Production - Crops;Agriculture - Crops;Planting
2801000003	Miscellaneous Area Sources;Agriculture Production - Crops;Agriculture - Crops;Tilling
2801000005	Miscellaneous Area Sources;Agriculture Production - Crops;Agriculture - Crops;Harvesting
2801000008	Miscellaneous Area Sources;Agriculture Production - Crops;Agriculture - Crops;Transport
2805001000	Miscellaneous Area Sources;Agriculture Production - Livestock;Beef cattle - finishing operations on feedlots (drylots);Dust Kicked-up by Hooves (use 28-05-020, -001, -002, or -003 for Waste

The dust emissions in the modeling platform are not the same as the 2011NEIv2 emissions because the NEI paved and unpaved road dust emissions include a built-in precipitation reduction that is based on average meteorological data, which is at a coarser temporal and spatial resolution than the modeling platform meteorological adjustment. Due to this, in the platform the paved and unpaved road emissions data used did not include any precipitation-based reduction. This allows the entire sector to be processed consistently so that the same grid-specific transport fractions and meteorological adjustments can be applied. Where states submitted afdust data, it was assumed that the state-submitted data were not met-adjusted and therefore the meteorological adjustments were still applied. Thus, it is possible that these sources may have been adjusted twice. Even with that possibility, air quality modeling shows that in general, dust is frequently overestimated in the air quality modeling results.

The total impacts of the transport fraction and meteorological adjustments for the 2011NEIv2 are shown in Table 2-7, where the starting inventory numbers include unadjusted paved and unpaved road dust, so they do not match the NEI values because those include a different type of adjustment. The amount of the reduction ranges from about 7% in New Hampshire to about 72% in Nevada.

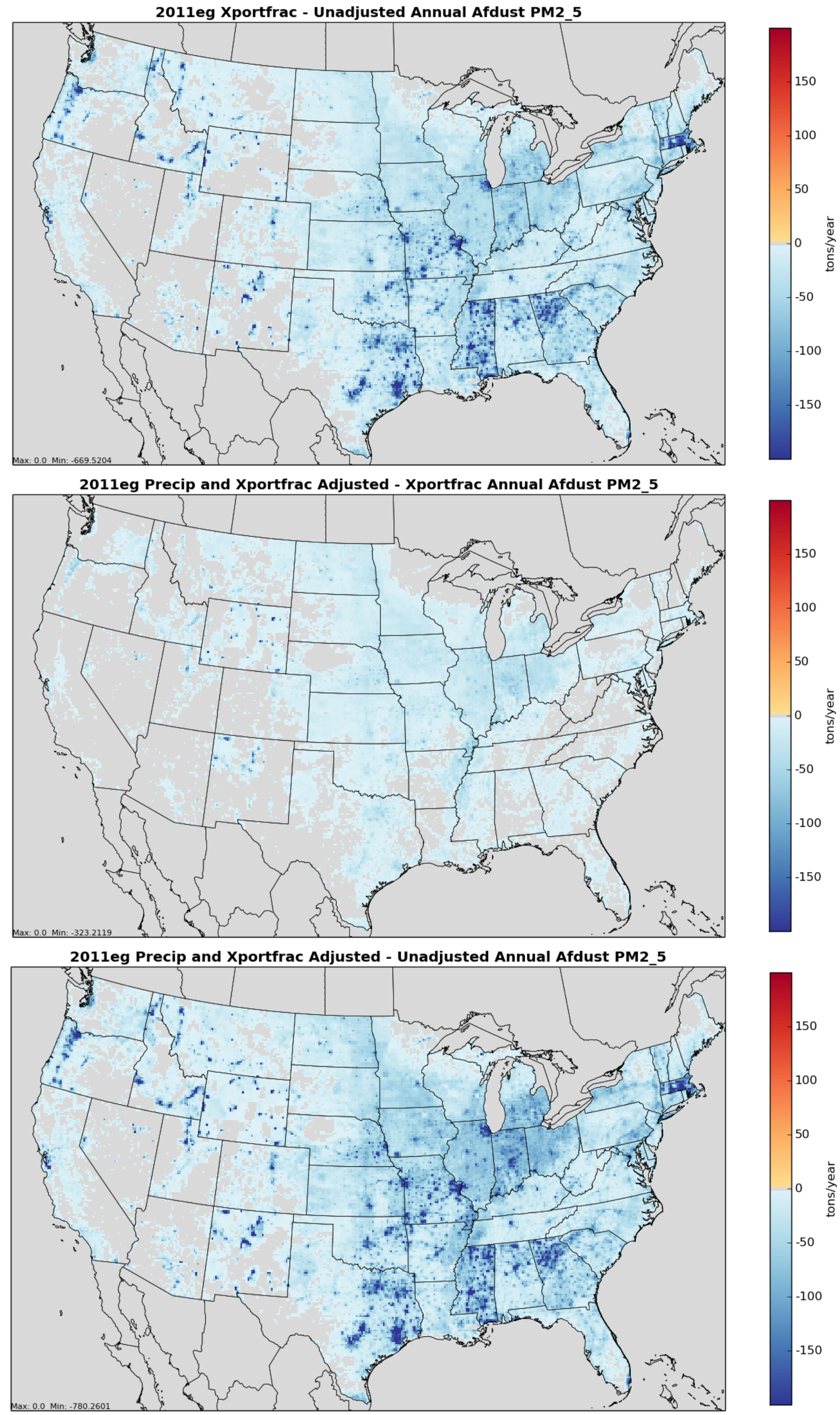
Table 2-7. Total Impact of Fugitive Dust Adjustments to Unadjusted 2011 Inventory

State	Unadjusted PM10	Unadjusted PM2_5	Change in PM10	Change in PM2_5	PM10 Reduction	PM2_5 Reduction
Alabama	378,874	47,158	-310,750	-38,597	18%	18%
Arizona	237,361	30,015	-78,519	-9,778	67%	67%
Arkansas	421,958	58,648	-305,611	-40,757	28%	31%
California	255,889	38,664	-119,035	-17,930	54%	54%
Colorado	244,630	40,421	-130,598	-20,991	47%	48%
Connecticut	29,067	4,393	-25,877	-3,912	11%	11%
Delaware	11,548	1,968	-8,219	-1,396	29%	29%
D.C.	2,115	337	-1,596	-254	25%	25%
Florida	292,797	39,637	-181,017	-24,333	38%	39%
Georgia	733,478	90,041	-593,644	-72,028	19%	20%
Idaho	432,116	49,294	-291,880	-32,897	33%	33%
Illinois	763,665	123,680	-472,806	-76,086	38%	39%

State	Unadjusted PM10	Unadjusted PM2_5	Change in PM10	Change in PM2_5	PM10 Reduction	PM2_5 Reduction
Indiana	603,152	85,151	-435,027	-60,660	28%	29%
Iowa	590,528	96,070	-339,349	-54,855	43%	43%
Kansas	747,242	118,726	-352,559	-54,760	53%	54%
Kentucky	199,744	29,496	-160,640	-23,511	20%	20%
Louisiana	236,787	35,730	-162,780	-24,086	31%	33%
Maine	50,547	7,016	-43,643	-6,078	14%	13%
Maryland	65,701	10,215	-49,481	-7,691	25%	25%
Massachusetts	205,561	22,444	-177,808	-19,370	14%	14%
Michigan	462,324	61,969	-353,225	-47,137	24%	24%
Minnesota	336,791	64,253	-217,036	-41,145	36%	36%
Mississippi	956,702	107,965	-782,249	-86,685	18%	20%
Missouri	1,063,992	130,995	-780,488	-94,576	27%	28%
Montana	385,541	50,583	-266,046	-33,521	31%	34%
Nebraska	591,457	85,206	-316,918	-45,198	46%	47%
Nevada	160,699	20,477	-47,147	-5,688	71%	72%
New Hampshire	25,540	3,766	-23,836	-3,515	7%	7%
New Jersey	24,273	5,412	-19,215	-4,255	21%	21%
New Mexico	924,497	95,871	-352,117	-36,344	62%	62%
New York	274,114	37,493	-236,431	-31,990	14%	15%
North Carolina	186,650	33,409	-146,918	-26,184	21%	22%
North Dakota	354,107	59,113	-218,630	-36,286	38%	39%
Ohio	414,902	64,609	-319,831	-49,298	23%	24%
Oklahoma	733,750	87,864	-385,344	-44,585	48%	49%
Oregon	348,093	40,596	-268,605	-30,516	23%	25%
Pennsylvania	208,246	30,344	-179,991	-26,158	14%	14%
Rhode Island	4,765	731	-3,628	-564	24%	23%
South Carolina	259,350	31,494	-198,175	-24,002	24%	24%
South Dakota	262,935	44,587	-155,938	-26,215	41%	41%
Tennessee	139,731	25,357	-107,964	-19,514	23%	23%
Texas	2,573,687	304,551	-1,278,053	-146,122	50%	52%
Utah	196,551	21,589	-113,837	-12,464	42%	42%
Vermont	67,690	7,563	-61,423	-6,855	9%	9%
Virginia	131,798	19,374	-108,700	-15,895	18%	18%
Washington	174,969	27,999	-99,720	-15,425	43%	45%
West Virginia	85,956	10,652	-79,745	-9,888	7%	7%
Wisconsin	239,851	41,669	-164,113	-28,542	32%	32%
Wyoming	434,090	45,350	-264,580	-27,467	39%	39%
Domain Total	**18,525,814**	**2,489,943**	**-11,790,743**	**-1,566,004**	**36%**	**37%**

Figure 2-1 shows the impact of each step of the adjustment for 2011. The reductions due to the transport fraction adjustments alone are shown at the top of Figure 2-1. The reductions due to the precipitation adjustments are shown in the middle of Figure 2-1. The cumulative emission reductions after both transport fraction and meteorological adjustments are shown at the bottom of Figure 2-1. The top plot shows how the transport fraction has a larger reduction effect in the east, where forested areas are more effective at reducing PM transport than in many western areas. The middle plot shows how the meteorological impacts of precipitation, along with snow cover in the north, further reduce the dust emissions.

Figure 2-1. Impact of adjustments to fugitive dust emissions due to transport fraction, precipitation, and cumulative



2.2.2 Agricultural ammonia sector (ag)

The agricultural NH_3 (ag) sector includes livestock and agricultural fertilizer application emissions from the 2011NEIv2 nonpoint inventory. The livestock and fertilizer emissions in this sector are based only on the SCCs listed in Table 2-8 and Table 2-9. The "ag" sector includes all of the NH_3 emissions from fertilizer from the NEI. However, the "ag" sector does not include all of the livestock ammonia emissions, as there are also a small amount of NH_3 emissions from livestock feedlots in the ptnonipm inventory (as point sources) in California (175 tons) and Wisconsin (125 tons).

Table 2-8. Livestock SCCs extracted from the NEI to create the ag sector

SCC	SCC Description*
2805001100	Beef cattle - finishing operations on feedlots (drylots);Confinement
2805001200	Beef cattle - finishing operations on feedlots (drylots);Manure handling and storage
2805001300	Beef cattle - finishing operations on feedlots (drylots);Land application of manure
2805002000	Beef cattle production composite;Not Elsewhere Classified
2805003100	Beef cattle - finishing operations on pasture/range;Confinement
2805007100	Poultry production - layers with dry manure management systems;Confinement
2805007300	Poultry production - layers with dry manure management systems;Land application of manure
2805008100	Poultry production - layers with wet manure management systems;Confinement
2805008200	Poultry production - layers with wet manure management systems;Manure handling and storage
2805008300	Poultry production - layers with wet manure management systems;Land application of manure
2805009100	Poultry production - broilers;Confinement
2805009200	Poultry production - broilers;Manure handling and storage
2805009300	Poultry production - broilers;Land application of manure
2805010100	Poultry production - turkeys;Confinement
2805010200	Poultry production - turkeys;Manure handling and storage
2805010300	Poultry production - turkeys;Land application of manure
2805018000	Dairy cattle composite;Not Elsewhere Classified
2805019100	Dairy cattle - flush dairy;Confinement
2805019200	Dairy cattle - flush dairy;Manure handling and storage
2805019300	Dairy cattle - flush dairy;Land application of manure
2805020000	Cattle and Calves Waste Emissions;Milk Total
2805020002	Cattle and Calves Waste Emissions:Beef Cows
2805021100	Dairy cattle - scrape dairy;Confinement
2805021200	Dairy cattle - scrape dairy;Manure handling and storage
2805021300	Dairy cattle - scrape dairy;Land application of manure
2805022100	Dairy cattle - deep pit dairy;Confinement
2805022200	Dairy cattle - deep pit dairy;Manure handling and storage
2805022300	Dairy cattle - deep pit dairy;Land application of manure
2805023100	Dairy cattle - drylot/pasture dairy;Confinement
2805023200	Dairy cattle - drylot/pasture dairy;Manure handling and storage
2805023300	Dairy cattle - drylot/pasture dairy;Land application of manure
2805025000	Swine production composite;Not Elsewhere Classified (see also 28-05-039, -047, -053)
2805030000	Poultry Waste Emissions;Not Elsewhere Classified (see also 28-05-007, -008, -009)
2805030003	Poultry Waste Emissions;Layers
2805030004	Poultry Waste Emissions;Broilers
2805030007	Poultry Waste Emissions;Ducks
2805030008	Poultry Waste Emissions;Geese
2805030009	Poultry Waste Emissions;Turkeys
2805035000	Horses and Ponies Waste Emissions;Not Elsewhere Classified
2805039100	Swine production - operations with lagoons (unspecified animal age);Confinement
2805039200	Swine production - operations with lagoons (unspecified animal age);Manure handling and storage

SCC	SCC Description*
2805039300	Swine production - operations with lagoons (unspecified animal age);Land application of manure
2805040000	Sheep and Lambs Waste Emissions;Total
2805045000	Goats Waste Emissions;Not Elsewhere Classified
2805045002	Goats Waste Emissions;Angora Goats
2805045003	Goats Waste Emissions;Milk Goats
2805047100	Swine production - deep-pit house operations (unspecified animal age);Confinement
2805047300	Swine production - deep-pit house operations (unspecified animal age);Land application of manure
2805053100	Swine production - outdoor operations (unspecified animal age);Confinement

* All SCC Descriptions begin "Miscellaneous Area Sources;Agriculture Production – Livestock"

Table 2-9. Fertilizer SCCs extracted from the NEI for inclusion in the "ag" sector

SCC	SCC Description*
2801700001	Anhydrous Ammonia
2801700002	Aqueous Ammonia
2801700003	Nitrogen Solutions
2801700004	Urea
2801700005	Ammonium Nitrate
2801700006	Ammonium Sulfate
2801700007	Ammonium Thiosulfate
2801700008	Other Straight Nitrate
2801700009	Ammonium Phosphates
2801700010	N-P-K (multi-grade nutrient fertilizers)
2801700011	Calcium Ammonium Nitrate
2801700012	Potassium Nitrate
2801700013	Diammonium Phosphate
2801700014	Monoammonium Phosphate
2801700015	Liquid Ammonium Polyphosphate
2801700099	Miscellaneous Fertilizers

* All descriptions include "Miscellaneous Area Sources; Agriculture Production – Crops; Fertilizer Application" as the beginning of the description.

2.2.3 Agricultural fires (agfire)

The agricultural fire (agfire) sector contains emissions from agricultural fires. These emissions were placed into the sector based on their SCC code. All SCCs starting with 28015 were included. The first three levels of descriptions for these SCCs are: Fires - Agricultural Field Burning; Miscellaneous Area Sources; Agriculture Production - Crops - as nonpoint; Agricultural Field Burning - whole field set on fire. The SCC 2801500000 does not specify the crop type or burn method, while the more specific SCCs specify field or orchard crops, and in some cases the specific crop being grown. For more information on how emissions for agricultural fires were developed in the 2011NEIv2, see Section 5.2 of the 2011NEIv2 TSD.

2.2.4 Nonpoint source oil and gas sector (np_oilgas)

The nonpoint oil and gas (np_oilgas) sector contains onshore and offshore oil and gas emissions. EPA estimated emissions for all counties with 2011 oil and gas activity data with the Oil and Gas Tool, and many S/L/T agencies also submitted nonpoint oil and gas data. The types of sources covered include drill rigs, workover rigs, artificial lift, hydraulic fracturing engines, pneumatic pumps and other devices, storage tanks, flares, truck loading, compressor engines, and dehydrators. For more information on the development of the oil and gas emissions in the 2011NEIv2, see Section 3.20 of the 2011NEIv2 TSD. A complete list of SCCs for the np_oilgas modeling platform sector is provided in Appendix A. See the pt_oilgas sector (section 2.1.2) for more information on point source oil and gas sources. Updates were made to the speciation, temporalization, and spatial allocation of sources in the 2011v6.2 platform based on comments that were received. Sections 3.2, 3.3, and 3.4 provide additional details.

2.2.5 Residential wood combustion sector (rwc)

The residential wood combustion (rwc) sector includes residential wood burning devices such as fireplaces, fireplaces with inserts (inserts), free standing woodstoves, pellet stoves, outdoor hydronic heaters (also known as outdoor wood boilers), indoor furnaces, and outdoor burning in firepots and chimneas. Free standing woodstoves and inserts are further differentiated into three categories: conventional (not EPA certified); EPA certified, catalytic; and EPA certified, noncatalytic. Generally speaking, the conventional units were constructed prior to 1988. Units constructed after 1988 had to meet EPA emission standards and they are either catalytic or non-catalytic. For more information on the development of the residential wood combustion emissions, see Section 3.14 of the 2011NEIv2 TSD. The SCCs in the rwc sector are shown in Table 2-10. Some reductions to Clark County, NV were implemented in the modeling platform as a result of data review for NATA, but these are not reflected in the 2011NEIv2.

Table 2-10. SCCs in the Residential Wood Combustion Sector (rwc)*

SCC	SCC Description
2104008100	SSFC;Residential;Wood;Fireplace: general
2104008210	SSFC;Residential;Wood;Woodstove: fireplace inserts; non-EPA certified
2104008220	SSFC;Residential;Wood;Woodstove: fireplace inserts; EPA certified; non-catalytic
2104008230	SSFC;Residential;Wood;Woodstove: fireplace inserts; EPA certified; catalytic
2104008300	SSFC;Residential;Wood;Woodstove: freestanding, general
2104008310	SSFC;Residential;Wood;Woodstove: freestanding, non-EPA certified
2104008320	SSFC;Residential;Wood;Woodstove: freestanding, EPA certified, non-catalytic
2104008330	SSFC;Residential;Wood;Woodstove: freestanding, EPA certified, catalytic
2104008400	SSFC;Residential;Wood;Woodstove: pellet-fired, general (freestanding or FP insert)
2104008420	SSFC;Residential;Wood;Woodstove: pellet-fired, EPA certified (freestanding or FP insert)
2104008510	SSFC;Residential;Wood;Furnace: Indoor, cordwood-fired, non-EPA certified
2104008610	SSFC;Residential;Wood;Hydronic heater: outdoor
2104008700	SSFC;Residential;Wood;Outdoor wood burning device, NEC (fire-pits, chimeas, etc)
2104009000	SSFC;Residential;Firelog;Total: All Combustor Types

* SSFC=Stationary Source Fuel Combustion

2.2.6 Other nonpoint sources sector (nonpt)

Stationary nonpoint sources that were not subdivided into the afdust, ag, np_oilgas, or rwc sectors were assigned to the "nonpt" sector. Locomotives and CMV mobile sources from the 2011NEIv2 nonpoint inventory are described in Section 2.4.1. There are too many SCCs to list all of them individually, but the types of sources in the nonpt sector include:

- stationary source fuel combustion, including industrial, commercial, and residential;
- chemical manufacturing;

- industrial processes such as commercial cooking, metal production, mineral processes, petroleum refining, wood products, fabricated metals, and refrigeration;
- solvent utilization for surface coatings such as architectural coatings, auto refinishing, traffic marking, textile production, furniture finishing, and coating of paper, plastic, metal, appliances, and motor vehicles;
- solvent utilization for degreasing of furniture, metals, auto repair, electronics, and manufacturing;
- solvent utilization for dry cleaning, graphic arts, plastics, industrial processes, personal care products, household products, adhesives and sealants;
- solvent utilization for asphalt application and roofing, and pesticide application;
- storage and transport of petroleum for uses such as portable gas cans, bulk terminals, gasoline service stations, aviation, and marine vessels;
- storage and transport of chemicals;
- waste disposal, treatment, and recovery via incineration, open burning, landfills, and composting;
- agricultural burning and orchard heating;
- miscellaneous area sources such as cremation, hospitals, lamp breakage, and automotive repair shops.

2.3 2011 onroad mobile sources (onroad)

Onroad mobile sources include emissions from motorized vehicles that are normally operated on public roadways. These include passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy-duty trucks, and buses. The sources are further divided between diesel, gasoline, E-85, and compressed natural gas (CNG) vehicles. The sector characterizes emissions from parked vehicle processes (e.g. starts, hot soak, and extended idle) as well as from on-network processes (i.e., from vehicles moving along the roads). Except for California, all onroad emissions are generated using the SMOKE-MOVES emissions modeling framework that leverages MOVES generated outputs (http://www.epa.gov/otaq/models/moves/index.htm) and hourly meteorology. The SCCs used in the 2011v6.2 platform are significantly different than what was used in previous platforms. The new onroad SCCs were designed to be more consistent with MOVES. For more details, see the 2011NEIv2 TSD. Updates to speciation, temporal allocation, and spatial allocation for the onroad sector were made in the 2011v6.2 platform as a result of comments received and upgrades to the platform. Sections 3.2, 3.3, and 3.4 contain more details.

2.3.1 Onroad (onroad)

For the continental U.S., EPA used a modeling framework that took into account the temperature sensitivity of the on-road emissions. Specifically, EPA used MOVES inputs for representative counties, vehicle miles traveled (VMT) and vehicle population (VPOP) data for all counties, along with tools that integrated the MOVES model with SMOKE. In this way, it was possible to take advantage of the gridded hourly temperature information available from meteorology modeling used for air quality modeling. The “SMOKE-MOVES” integration tool was developed by EPA in 2010 and is used for regional air quality modeling of onroad mobile sources.

SMOKE-MOVES requires that emission rate “lookup” tables be generated by MOVES which differentiate emissions by process (i.e., running, start, vapor venting, etc.), vehicle type, road type, temperature, speed, hour of day, etc. To generate the MOVES emission rates that could be applied across the U.S., EPA used an automated process to run MOVES to produce emission factors by temperature and speed for a series of "representative counties," to which every other county was mapped. Using the MOVES emission rates, SMOKE selects appropriate emissions rates for each county, hourly temperature, SCC, and speed bin and multiplied the emission rate by activity (VMT (vehicle miles travelled), VPOP (vehicle population)), or HOTELING (hours of extended idle) to produce emissions. These calculations were done for every county and grid cell, in the continental U.S. for each hour of the year.

The SMOKE-MOVES process for creating the model-ready emissions consists of the following steps:

1) Determine which counties will be used to represent other counties in the MOVES runs.
2) Determine which months will be used to represent other month's fuel characteristics.
3) Create MOVES inputs needed only by MOVES. MOVES requires county-specific information on vehicle populations, age distributions, and inspection-maintenance programs for each of the representative counties.
4) Create inputs needed both by MOVES and by SMOKE, including temperatures and activity data.
5) Run MOVES to create emission factor tables for the temperatures found in each county.
6) Run SMOKE to apply the emission factors to activity data (VMT, VPOP, and HOTELING) to calculate emissions based on the gridded hourly temperatures in the meteorological data.
7) Aggregate the results to the county-SCC level for summaries and quality assurance.

The onroad emissions inputs are similar to the emissions in the onroad data category of the 2011NEIv2, described in more detail in Section 4.6 of the 2011NEIv2 TSD. Specifically the platform and 2011NEIv2 have identical:

- MOVES County databases (CDBs)
- Representative counties
- Fuel months
- Meteorology
- Activity data (VMT, VPOP, speed, HOTELING)

There are some key differences between the two onroad emission inventories:

- The 2011 platform used a different post-processor to create EFs for SMOKE because the pollutants needed for speciation and running CMAQ are different than what is needed for the NEI. For example, the NEI needs a much larger set of HAPs and the modeling platform requires emissions for the components of $PM_{2.5}$.

- The 2011 platform had separate activity data for E-85. For the 2011 NEIv2, E-85 VMT and VPOP were combined with gasoline VMT and VPOP because the CDBs were not generating a complete set of EF for the E-85 sources. EPA corrected the seeding script and regenerated the representative CDBs so that the EF tables had a complete set of EF for all fuel types.

- The seeding of some representative counties left out the generation of combination long-haul trucks on rural restricted highways and therefore for no emission factors were generated and as a result hoteling emissions were zero. To mitigate this, the hoteling emission factors were taken from other nearby counties.

- The MOVES code and MOVES default database for the platform were version 20141021cb6 and movesdb20141021cb6, respectively. Also for the platform, EPA updated the internal speciation of TOG to provide revised CB05 and CB6 model-species for air quality modeling.
- The 2011 platform used an updated fuel database: movesdb20141021_fuelsupply.
- The treatment of California emissions differs between the two inventories (see below for more details).
- The list of emission modes and SCCs differ between the two inventories. Both SMOKE-MOVES runs were generated at the same level of detail, but the NEI emissions were aggregated into 2 all-inclusive modes: refueling and all other modes. In addition, the NEI SCCs were aggregated over roads to all parking and all road emissions. The list of modes (or aggregate processes) used in the v6.2 platform and the corresponding MOVES processes mapped to them are listed in Table 2-11.

Table 2-11. Onroad emission aggregate processes

Aggregate process	Description	MOVES process IDs
40	All brake and tire wear	9;10
53	All extended idle exhaust	17;90
62	All refueling	18;19
72	All exhaust and evaporative except refueling and hoteling	1;2;11;12;13;15;16
91	Auxiliary Power Units	91

One reason that brake and tire wear was split out from the other processes was to allow for better modeling of the impacts of electric vehicles in future years, since these vehicles still have brake and tire wear emissions, but do not have exhaust, evaporative, or refueling emissions. For more detailed information on methods used to develop the onroad emissions and input data sets and on running SMOKE-MOVES, see the 2011NEIv2 TSD.

The California onroad emissions were created through a hybrid approach of combining state-supplied annual emissions (from the 2011NEIv2) with EPA developed SMOKE-MOVES runs. Through this approach, the platform was able to reflect California's unique rules, while leveraging the more detailed SCCs and the highly resolved spatial patterns, temporal patterns, and speciation from SMOKE-MOVES. The basic steps involved in temporally allocating California's onroad emissions based on SMOKE-MOVES results were:

1) Run CA using EPA inputs through SMOKE-MOVES to produce hourly 2011 emissions hereafter known as "EPA estimates". These EPA estimates for CA are run in a separate sector called "onroad_ca".
2) Calculate ratios between state-supplied emissions and EPA estimates[3]. For California, these were calculated for each county/comparison SCC6[4]/pollutant combination. These were not

[3] These ratios were created for all matching pollutants. These ratios were duplicated for all appropriate modeling species. For example, EPA used the NO_X ratio for NO, NO_2, HONO and used the $PM_{2.5}$ ratio for PEC, PNO_3, POC, PSO_4etc (For more details on NO_X and PM speciation, see Sections 3.2.3 and 0). For VOC model-species, if there was an exact match (e.g., BENZENE), EPA used that HAP pollutant ratio. For other VOC-based model-species that didn't exist in the NEI inventory, EPA used VOC ratios.

[4] Comparison SCC6 are aggregate codes to classify fuels and vehicle type. These were created to make a consistent comparison between the MOBILE6 era SCCs (2011 NEIv1 and before) and MOVES SCCs (2011 NEIv2). See the 2011 NEIv2 TSD for more details.

calculated at a greater resolution because California's emissions did not provide data for all vehicle types.

3) Create an adjustment factor file (CFPRO) that includes EPA-to-state estimate ratios.
4) Rerun CA through SMOKE-MOVES using EPA inputs and the new adjustment factor file.

Through this process, adjusted model-ready files were created that sum to California's annual totals, but have the temporal and spatial patterns reflecting the highly resolved meteorology and SMOKE-MOVES. After adjusting the emissions, this sector is called "onroad_ca_adj". Note that in emission summaries, the emissions from the "onroad" and "onroad_ca_adj" sectors are summed and designated as the emissions for the onroad sector.

An additional step was taken for the refueling emissions. Colorado submitted point emissions for gasoline refueling for some counties[5]. For these counties, EPA zeroed out the onroad estimates of gasoline refueling (SCC 2201*62) so that the states' point emissions would take precedence. The onroad refueling emissions were zeroed out using the adjustment factor file (CFPRO) and Movesmrg.

2.4 2011 nonroad mobile sources (c1c2rail, c3marine, nonroad)

The nonroad mobile source emission modeling sectors consist of nonroad equipment emissions (nonroad) and locomotive and commercial marine vessel (CMV) emissions divided into two nonroad sectors: "c1c2rail" and "c3marine".

2.4.1 Category 1/Category 2 Commercial Marine Vessels and Locomotives and (c1c2rail)

The c1c2rail sector contains locomotive and smaller CMV sources, except for railway maintenance locomotives. Railway maintenance emissions are included in the nonroad sector. The "c1c2" portion of this sector name refers to the Category 1 and 2 CMV emissions, not the railway emissions. The C3 CMV emissions are in the c3marine and othpt sectors. All emissions in this sector are annual and at the county-SCC resolution. As discussed in Table 2-1 and Table 2-2, the modeling platform emissions for the c1c2rail SCCs were extracted from the 2011NEIv2 nonpoint inventory using the SCCs listed in Table 2-12. The emissions include the offshore portion of the C1 and C2 commercial marine sources, including fishing vessels and oil rig support vessels in the Gulf of Mexico. Emissions that occur outside of state waters are not assigned to states. For more information on CMV and locomotive sources in the NEI, see Section 4.3 and Section 4.4 of the 2011NEIv2 TSD, respectively.

Table 2-12. 2011NEIv2 SCCs extracted for the starting point in c1c2rail development

SCC	Description: Mobile Sources prefix for all
2280002100	Marine Vessels; Commercial; Diesel; Port
2280002200	Marine Vessels; Commercial; Diesel; Underway
2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations
2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations
2285002008	Railroad Equipment; Diesel; Line Haul Locomotives: Passenger Trains (Amtrak)
2285002009	Railroad Equipment; Diesel; Line Haul Locomotives: Commuter Lines
2285002010	Railroad Equipment; Diesel; Yard Locomotives

[5] There were 53 counties in Colorado that had point emissions for gasoline refueling. Outside Colorado, it was determined that refueling emissions in the 2011 NEIv2 point did not significantly overlap the refueling emissions in onroad.

2.4.2 Category 3 commercial marine vessels (c3marine)

The Category 3 (C3) CMV sources in the c3marine sector of the 2011v6.2 platform run on residual oil and use the SCCs 2280003100 and 2280003200 for port and underway emissions, respectively, and are consistent with the 2011NEIv2. Emissions for this sector use state-submitted values and EPA-developed emissions in areas where states did not submit. A change in the 2011v6.2 platform is to restrict this sector only to include emissions in state-waters and to treat the emissions as nonpoint sources instead of point sources. Thus, the c3marine emissions are placed in layer 1 and allocated to grid cells using spatial surrogates. Note that there are no Category 3 CMV emissions in the Great Lakes states, as all the vessels in that region are smaller than C3. The development of the ECA-IMO-based C3 CMV inventory is discussed below. Canadian emissions, C3 CMV emissions outside of state waters, and non-U.S. emissions farther offshore than U.S. waters are processed in the "othpt" sector (see Section 2.5.1).

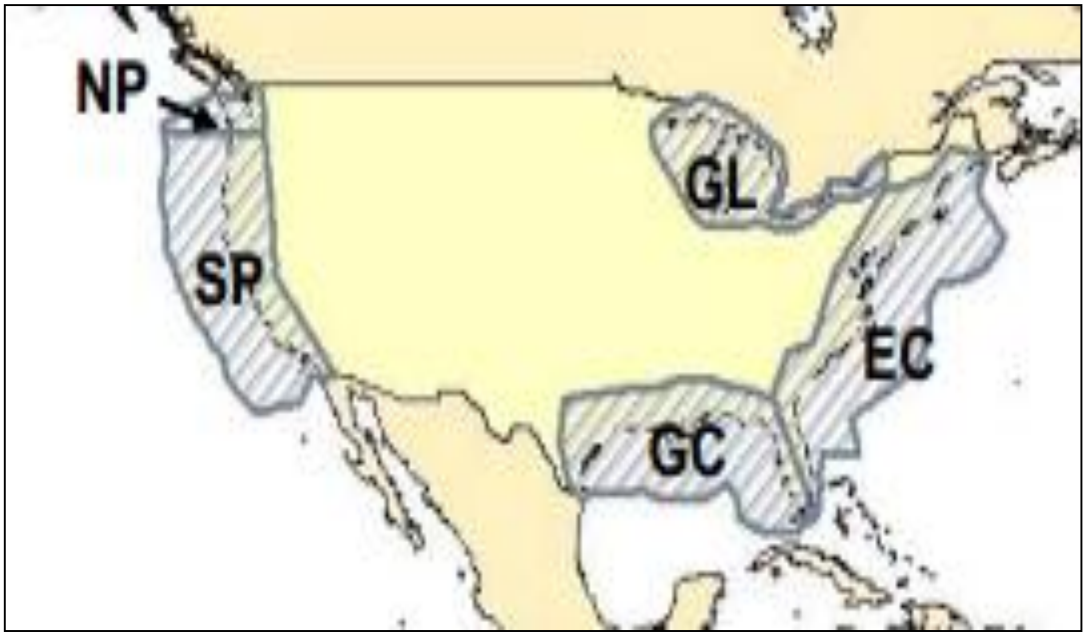
The EPA-estimated C3 CMV emissions were developed based on a 4-km resolution ASCII raster format dataset that preserves shipping lanes. This dataset has been used since the Emissions Control Area-International Marine Organization (ECA-IMO) project began in 2005, although it was then known as the Sulfur Emissions Control Area (SECA). The ECA-IMO emissions consist of large marine diesel engines (at or above 30 liters/cylinder) that until recently were allowed to meet relatively modest emission requirements and as a result these ships would often burn residual fuel in that region. The emissions in this sector are comprised of primarily foreign-flagged ocean-going vessels, referred to as C3 CMV ships. The c3marine inventory includes these ships in several intra-port modes (i.e., cruising, hoteling, reduced speed zone, maneuvering, and idling) and an underway mode, and includes near-port auxiliary engine emissions.

An overview of the C3 ECA Proposal to the International Maritime Organization (EPA-420-F-10-041, August 2010) project and future-year goals for reduction of NO_X, SO_2, and PM C3 emissions can be found at: http://www.epa.gov/oms/regs/nonroad/marine/ci/420r09019.pdf. The resulting ECA-IMO coordinated strategy, including emission standards under the Clean Air Act for new marine diesel engines with per-cylinder displacement at or above 30 liters, and the establishment of Emission Control Areas is available from http://www.epa.gov/oms/oceanvessels.htm. The base year ECA inventory is 2002 and consists of these CAPs: PM_{10}, $PM_{2.5}$, CO, CO_2, NH_3, NO_X, SO_X (assumed to be SO_2), and hydrocarbons (assumed to be VOC). EPA developed regional growth (activity-based) factors that were applied to create the 2011 inventory from the 2002 data. These growth factors are provided in Table 2-13. The geographic regions listed in the table are shown in Figure 2-2. * The East Coast and Gulf Coast regions were divided along a line roughly through Key Largo (longitude 80˚ 26' West). Technically, the EEZ FIPS are not really "FIPS" state-county codes, but are treated as such in the inventory and emissions processing.

Table 2-13. Growth factors to project the 2002 ECA-IMO inventory to 2011

Region	**EEZ FIPS**	**NO_X**	**PM_{10}**	**$PM_{2.5}$**	**VOC**	**CO**	**SO_2**
East Coast (EC)	85004	1.301	0.500	0.496	1.501	1.501	0.536
Gulf Coast (GC)	85003	1.114	0.428	0.423	1.288	1.288	0.461
North Pacific (NP)	85001	1.183	0.467	0.458	1.353	1.353	0.524
South Pacific (SP)	85002	1.367	0.525	0.521	1.565	1.562	0.611
Great Lakes (GL)	n/a	1.072	0.394	0.390	1.177	1.176	0.415
Outside ECA	98001	1.341	1.457	1.457	1.457	1.457	1.457

Figure 2-2. Illustration of regional modeling domains in ECA-IMO study



The emissions were converted to SMOKE point source inventory format as described in http://www.epa.gov/ttn/chief/conference/ei17/session6/mason.pdf, allowing for the emissions to be allocated to modeling layers above the surface layer. As described in the paper, the ASCII raster dataset was converted to latitude-longitude, mapped to state/county FIPS codes that extended up to 200 nautical miles (nm) from the coast, assigned stack parameters, and monthly ASCII raster dataset emissions were used to create monthly temporal profiles. All non-US, non-EEZ emissions (i.e., in waters considered outside of the 200 nm EEZ, and hence out of the U.S. and Canadian ECA-IMO controllable domain) were simply assigned a dummy state/county FIPS code=98001, and were projected to year 2011 using the "Outside ECA" factors in Table 2-13.

The assignment of U.S. state/county FIPS codes was restricted to state-federal water boundaries data from the Mineral Management Service (MMS) that extend approximately 3 to 10 nautical miles (nm) off shore. Emissions outside the 3 to 10 mile MMS boundary, but within the approximately 200 nm EEZ boundaries in Figure 2-2, were projected to year 2011 using the same regional adjustment factors as the U.S. emissions; however, the state/county FIPS codes were assigned as "EEZ" codes and those emissions processed in the "othpt" sector (see Section 2.5.1). Note that state boundaries in the Great Lakes are an exception, extending through the middle of each lake such that all emissions in the Great Lakes are assigned to a U.S. county or Ontario. This holds true for Midwest states and other states such as Pennsylvania and New York. The classification of emissions to U.S. and Canadian FIPS codes is needed to avoid double-counting of C3 CMV U.S. emissions in the Great Lakes because, as discussed in the previous section, all CMV emissions in the Midwest RPO are processed in the "c1c2rail" sector.

The SMOKE-ready data have been cropped from the original ECA-IMO entire northwestern quarter of the globe to cover only the large continental U.S. 36-km "36US1" air quality model domain, the largest domain used by EPA in recent years[6].

[6] The extent of the "36US1" domain is similar to the full geographic region shown in Figure 3-1. Note that this domain is not specifically used in this 2011 platform, although spatial surrogates that can be used with it are provided.

The original ECA-IMO inventory did not delineate between ports and underway emissions (or other C3 modes such as hoteling, maneuvering, reduced-speed zone, and idling). However, a U.S. ports spatial surrogate dataset was used to assign the ECA-IMO emissions to ports and underway SCCs 2280003100 and 2280003200, respectively. This had no effect on temporal allocation or speciation because all C3 CMV emissions, unclassified/total, port and underway, share the same temporal and speciation profiles. See Section 3.2.1.3 for more details on c3marine speciation and Section 3.3.6 for details on temporal allocation.

For California, the ECA-IMO 2011 emissions were scaled to match those provided by CARB for year 2011 because CARB has had distinct projection and control approaches for this sector since 2002. These CARB C3 CMV emissions are documented in a staff report available at: http://www.arb.ca.gov/regact/2010/offroadlsi10/offroadisor.pdf. The CMV emissions obtained from the CARB nonroad mobile dataset include the 2011 regulations to reduce emissions from diesel engines on commercial harbor craft operated within California waters and 24 nautical miles of the California shoreline. These emissions were developed using Version 1 of the California Emissions Projection Analysis Model (CEPAM) that supports various California off-road regulations. The locomotive emissions were obtained from the CARB trains dataset "ARMJ_RF#2002_ANNUAL_TRAINS.txt". Documentation of the CARB offroad mobile methodology, including c1c2rail sector data, is provided at: http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles.

2.4.3 Nonroad mobile equipment sources: (nonroad)

The nonroad equipment emissions are equivalent to the emissions in the nonroad data category of the 2011NEIv2, with the exception that the modeling platform emissions also include monthly totals. All nonroad emissions are compiled at the county/SCC level. NMIM (EPA, 2005) creates the nonroad emissions on a month-specific basis that accounts for temperature, fuel types, and other variables that vary by month. The nonroad sector includes monthly exhaust, evaporative and refueling emissions from nonroad engines (not including commercial marine, aircraft, and locomotives) that EPA derived from NMIM for all states except California and Texas. Additional details on the development of the 2011NEIv2 nonroad emissions are available in Section 4.5 the 2011NEIv2 TSD. Note that the nonroad emissions for 2011NEIv2 are the same as those in the 2011NEIv1 for all states except Delaware.

California year 2011 nonroad emissions were submitted to the 2011NEIv2 and are also documented in a staff report (ARB, 2010a). The nonroad sector emissions in California were developed using a modular approach and include all rulemakings and updates in place by December 2010. These emissions were developed using Version 1 of the CEPAM which supports various California off-road regulations such as in-use diesel retrofits (ARB, 2007), Diesel Risk-Reduction Plan (ARB, 2000) and 2007 State Implementation Plans (SIPS) for the South Coast and San Joaquin Valley air basins (ARB, 2010b).

The CARB-supplied nonroad annual inventory emissions values were converted to monthly values by using the aforementioned EPA NMIM monthly inventories to compute monthly ratios by county, SCC7 (fuel, engine type, and equipment type group), mode, and pollutant. SCC7 ratios were used because the SCCs in the CARB inventory did not align with many of the SCCs in EPA NMIM inventory. By aggregating up to SCC7, the two inventories had a more consistent coverage of sources. Some VOC emissions were added to California to account for situations when VOC HAP emissions were included in the inventory, but there were no VOC emissions. These additional VOC emissions were computed by summing benzene, acetaldehyde, and formaldehyde for the specific sources.

Texas year 2011 nonroad emissions were also submitted to the NEI. The 2011NEIv2 nonroad annual inventory emissions values were converted to monthly values by using EPA's NMIM monthly inventories to compute monthly ratios by county, SCC7, mode, and poll[7].

Some updates to spatial surrogate assignments for the nonroad sector were made in the 2011v6.2 platform in response to comments. Details can be found in Section 3.4.

2.5 "Other Emissions": Offshore Category 3 commercial marine vessels and drilling platforms and non-U.S. sources

The emissions from Canada, Mexico, and non-U.S. offshore Category 3 Commercial Marine Vessels (C3 CMV) and drilling platforms are included as part of three emissions modeling sectors: othpt, othar, and othon. The "oth" refers to the fact that these emissions are usually "other" than those in the U.S. state-county geographic FIPS, and the third and fourth characters provide the SMOKE source types: "pt" for point, "ar" for "area and nonroad mobile", and "on" for onroad mobile.

2.5.1 Point sources from offshore C3 CMV, drilling platforms, Canada and Mexico (othpt)

As discussed in Section 2.4.2, the ECA-IMO-based C3 CMV emissions outside of state waters are processed in the othpt sector. These C3 CMV emissions include those assigned to U.S. federal waters, Canada, those assigned to the Exclusive Economic Zone (EEZ; defined as those emissions beyond the U.S. Federal waters approximately 3-10 miles offshore, and extending to about 200 nautical miles from the U.S. coastline), along with any other offshore emissions. These emissions are developed in the same way as the EPA-dataset described in the c3marine sector (see Section 2.4.2). Emissions in U.S. waters are aggregated into large regions and included in the 2011NEIv2 using special FIPS codes. Because these emissions are treat as point sources, shipping lane routes can be preserved and they may be allocated to air quality model layers higher than layer 1.

For Canadian point sources, 2010 emissions provided by Environment Canada were used. Note that VOC was not provided for Canadian point sources, but any VOC emissions were speciated into CB05 species. Temporal profiles and speciated emissions were also provided. Point sources in Mexico were compiled based on the Inventario Nacional de Emisiones de Mexico, 2008 (ERG, 2014a). The point source emissions in the 2008 inventory were converted to English units and into the FF10 format that could be read by SMOKE, missing stack parameters were gapfilled using SCC-based defaults, and latitude and longitude coordinates were verified and adjusted if they were not consistent with the reported municipality. Note that there are no explicit HAP emissions in this inventory.

The othpt sector also includes point source offshore oil and gas drilling platforms that are beyond U.S. state-county boundaries in the Gulf of Mexico. For these offshore emissions, data from the 2011NEIv2 were used.

2.5.2 Area and nonroad mobile sources from Canada and Mexico (othar, othafdust)

For Canada area and nonroad mobiles sources, year-2010 emissions provided by Environment Canada were used, including C3 CMV emissions. An overlap between these emissions and the U.S. C3 CMV

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[7] If there was no match at county/SCC7/mode/poll, the allocation would fall back to state/SCC7/mode/poll. If that did not find a match, then state/SCC7 was used. For a few situations, that would also fail to match and the monthly emissions were allocated with a similar SCC7.

emissions in the St. Lawrence River resulted in a double count in the 2011v6.2 platform cases. The Canadian inventory included fugitive dust emissions that do not incorporate either a transportable fraction or meteorological-based adjustments. To properly account for these issues, a separate sector called othafdust was created and modeled using the same adjustments as are done for U.S. sources (see Section 2.2.1 for more details). Updated Shapefiles for creating spatial surrogates for Canada were also provided.

Area and nonroad mobile sources in Mexico were compiled from the Inventario Nacional de Emisiones de Mexico, 2008 (ERG, 2014a). The 2008 emissions were quality assured for completeness, SCC assignments were made when needed, the pollutants expected for the various processes were reviewed, and adjustments were made to ensure that PM_{10} was greater than or equal to $PM_{2.5}$. The resulting inventory was written using English units to the nonpoint FF10 format that could be read by SMOKE. Note that unlike the U.S. inventories, there are no explicit HAPs in the nonpoint or nonroad inventories for Canada and Mexico, and therefore all HAPs are created from speciation.

2.5.3 Onroad mobile sources from Canada and Mexico (othon)

Onroad mobile sources in Mexico were compiled from the Inventario Nacional de Emisiones de Mexico, 2008 (ERG, 2014a). SCCs compatible with the 2011NEIv2 were assigned to the 2008 onroad mobile source emissions in Mexico, and it was enforced that PM_{10} be greater than or equal to $PM_{2.5}$. Quality assurance of the onroad mobile source emissions data revealed that Baja California, Michoacán, and Nuevo León had significantly high per capita emissions for all pollutants and should be considered to be outliers. The emissions for these states were replaced with values computed based on the average per capita emissions for the remaining states. The data were written using English units to the nonpoint FF10 format that could be read by SMOKE.

For Canada, year-2010 emissions provided by Environment Canada were used. Note that unlike the U.S. inventories, there are no explicit HAPs in the onroad inventories for Canada and Mexico, and therefore all HAPs are created from speciation.

2.6 Fires (ptwildfire, ptprescfire)

In the 2011v6.2 platform, wildfires are in the ptwildfire sector and prescribed burning emissions are contained in the ptprescfire sector. The sectors were split from the single ptfire sector used in previous emissions to aid in the analysis of the impacts of the different types of fires. Fire emissions are specified at geographic coordinates (point locations) and have daily emissions values. The ptwildfire and ptprescfire sectors exclude agricultural burning and other open burning sources that are included in the nonpt sector. Emissions are day-specific and include satellite-derived latitude/longitude of the fire's origin and other parameters associated with the emissions such as acres burned and fuel load, which allow estimation of plume rise. Emissions for the SCCs listed in Table 2-14 are treated as point sources and are consistent with the fires stored in the Events data category of the 2011NEIv2. Emissions for SCC 2811015000 are in the ptprescfire sector, while the rest are in the ptwildfire sector. For more information on the development of the 2011NEIv2 fire inventory, see Section 5.1 of the 2011NEIv2 TSD.

Table 2-14. 2011 Platform SCCs representing emissions in the ptprescfire and ptwildfire modeling sectors

SCC	SCC Description*
2810001000	Other Combustion; Forest Wildfires; Total
2810001001	Other Combustion; Forest Wildfires; Wildland fire use
2811015000	Other Combustion-as Event; Prescribed Burning for Forest Management; Total

* The first tier level of the SCC Description is "Miscellaneous Area Sources"

The point source day-specific emission estimates for 2011 fires rely on SMARTFIRE 2 (Sullivan, et al., 2008), which uses the National Oceanic and Atmospheric Administration's (NOAA's) Hazard Mapping System (HMS) fire location information as input. Additional inputs include the CONSUMEv3.0 software application (Joint Fire Science Program, 2009) and the Fuel Characteristic Classification System (FCCS) fuel-loading database to estimate fire emissions from wildfires and prescribed burns on a daily basis. The method involves the reconciliation of ICS-209 reports (Incident Status Summary Reports) with satellite-based fire detections to determine spatial and temporal information about the fires. A functional diagram of the SMARTFIRE 2 process of reconciling fires with ICS-209 reports is available in the documentation (Raffuse, et al., 2007). Once the fire reconciliation process is completed, the emissions are calculated using the U.S. Forest Service's CONSUMEv3.0 fuel consumption model and the FCCS fuel-loading database in the BlueSky Framework (Ottmar, et al., 2007).

SMARTFIRE 2 estimates were used directly for all states except Georgia and Florida. For Georgia, the satellite-derived emissions were removed from the ptfire inventory and replaced with a separate state-supplied ptfire inventory. Adjustments were also made to Florida as described in Section 5.1.4 of the 2011NEIv2 TSD. These changes made the data in the ptfire inventory consistent with the data in the 2011NEIv2.

An update in the 2011v6.2 platform was to split fires over 20,000 acres into the respective grid cells that they overlapped. The idea of this was to prevent all emissions from going into a single grid cell, when in reality the fire was more dispersed than a single point. The large fires were each projected as a circle over the area centered on the specified latitude and longitude, and then apportioned into the grid cells they overlapped. The area of each of the "subfires" was computed in proportion to the overlap with that grid cell. These "subfires" were given new names that were the same as the original, but with "_a", "_b", "_c", and "_d" appended as needed. The FIPS state and county codes and fire IDs for the fifteen fires apportioned to multiple grid cells are shown in Table 2-15.

Table 2-15. Large fires apportioned to multiple grid cells

County FIPS	Fire ID
32007	SF11C1774898
32007	SF11C1775252
32013	SF11C1774993
35027	SF11C1760072
35027	SF11C1760460
46065	SF11C1503125
48003	SF11C1718109
48081	SF11C1742329
48125	SF11C1749358

County FIPS	Fire ID
48243	SF11C1738273
48243	SF11C1747162
48353	SF11C1759082
48371	SF11C1750272
48415	SF11C1742358
56013	SF11C1791126

2.7 Biogenic sources (beis)

Biogenic emissions were computed based on the same 11g version of the 2011 meteorology data used for the air quality modeling, and were developed using the Biogenic Emission Inventory System, version 3.61 (BEIS3.61) within SMOKE. This was an update from the emissions in the 2011v6.1 platform that used BEIS 3.14, and from the 2011NEIv2 that used BEIS 3.60. Like BEIS 3.14, BEIS3.61 creates gridded, hourly, model-species emissions from vegetation and soils. It estimates CO, VOC (most notably isoprene, terpene, and sesquiterpene), and NO emissions for the contiguous U.S. and for portions of Mexico and Canada.

BEIS3.61 has some important updates from BEIS 3.14. These include the incorporation of Version 4 of the Biogenic Emissions Land use Database (BELD4), and the incorporation of a canopy model to estimate leaf-level temperatures (Pouliot and Bash, 2015). BEIS version 3.61 includes a two-layer canopy model. Layer structure varies with light intensity and solar zenith angle. Both layers of the canopy model include estimates of sunlit and shaded leaf area based on solar zenith angle and light intensity, direct and diffuse solar radiation, and leaf temperature (Bash et al., 2015). The new algorithm requires additional meteorological variables over previous versions of BEIS. The variables output from the Meteorology-Chemistry Interface Processor (MCIP) that are used to convert WRF outputs to CMAQ inputs are shown in Table 2-16.

BELD4 is based on an updated version of the USDA-USFS Forest Inventory and Analysis (FIA) vegetation speciation based data from 2002 to 2013 from the Forest Inventory and Analysis version 5.1. Canopy coverage is based on the Landsat satellite NLCD product from 2001, since no canopy product was developed for the 2006 NLCD. The FIA includes approximately 250,000 representative plots of species fraction data that are within approximately 75 km of one another in areas identified as forest by the NLCD canopy coverage. The 2006 NLCD provides land cover information with a native data grid spacing of 30 meters. For land areas outside the conterminous United States, 500 meter grid spacing land cover data from the Moderate Resolution Imaging Spectroradiometer (MODIS) is used.

To provide a sense of the scope and spatial distribution of the emissions, plots of annual BEIS outputs for isoprene and NO for 2011 are shown in Figure 2-3 and Figure 2-4, respectively.

Figure 2-3. Annual NO emissions output from BEIS 3.61 for 2011

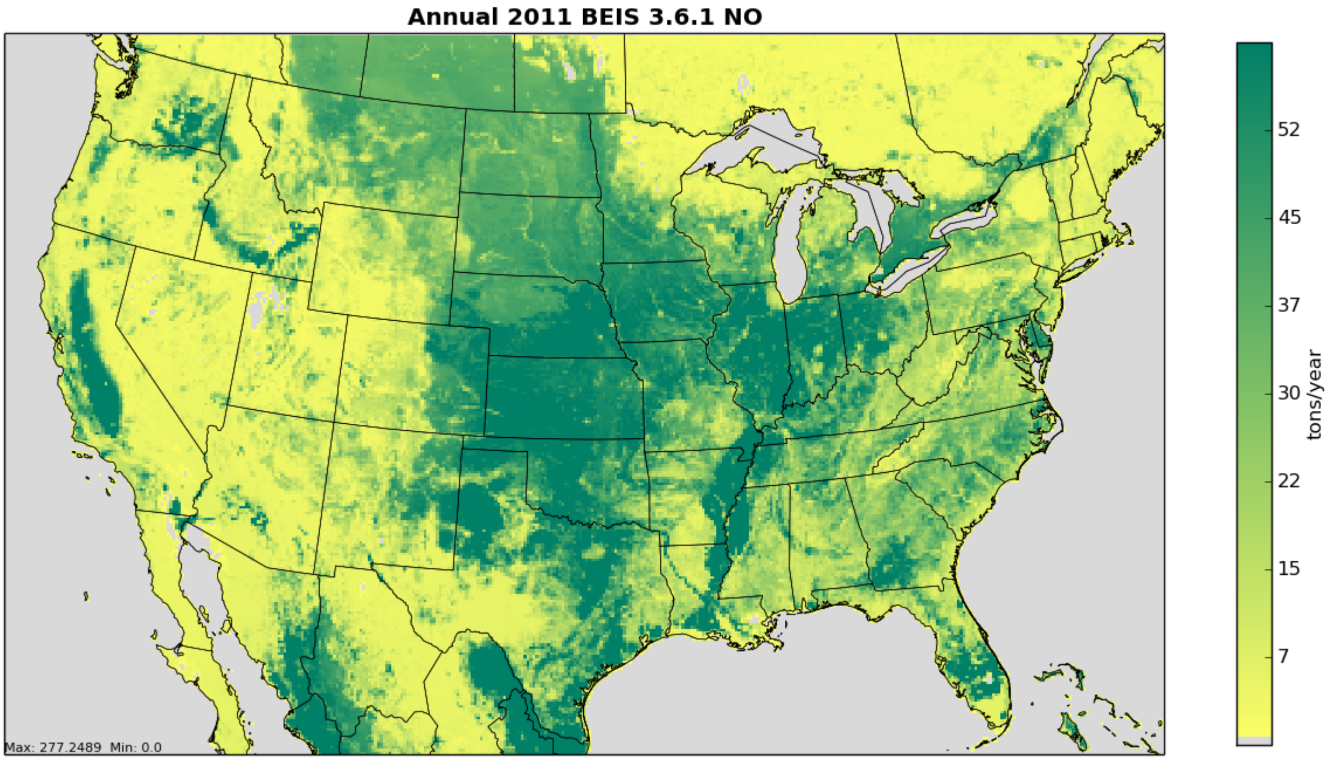


Figure 2-4. Annual isoprene emissions output from BEIS 3.61 for 2011

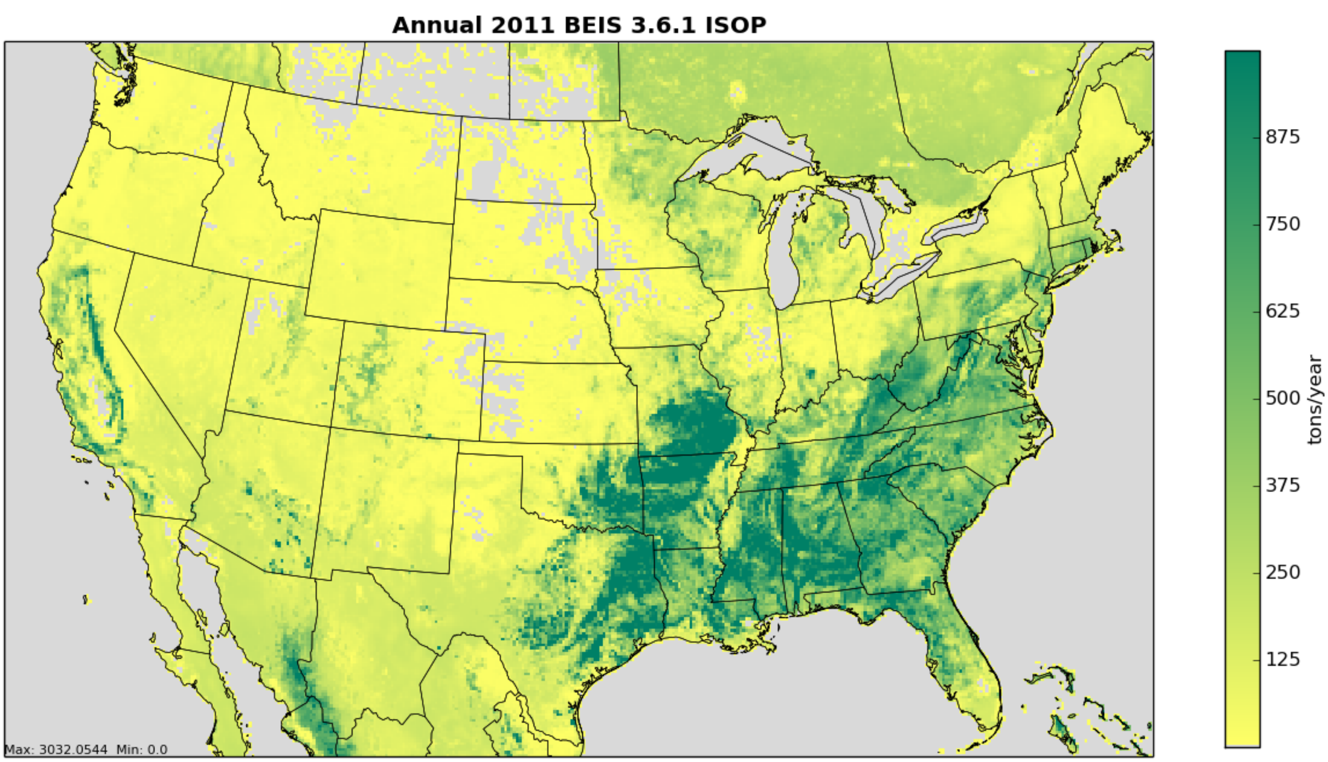


Table 2-16. Meteorological variables required by BEIS 3.61

Variable	Description
LAI	leaf-area index
PRSFC	surface pressure
Q2	mixing ratio at 2 m
RC	convective pcpn per met TSTEP
RGRND	solar rad reaching sfc
RN	nonconvec. pcpn per met TSTEP
RSTOMI	inverse of bulk stomatal resistance
SLYTP	soil texture type by USDA category
SOIM1	volumetric soil moisture in top cm
SOIT1	soil temperature in top cm
TEMPG	skin temperature at ground
USTAR	cell averaged friction velocity
RADYNI	inverse of aerodynamic resistance
TEMP2	temperature at 2 m

2.8 SMOKE-ready non-anthropogenic inventories for chlorine

The ocean chlorine gas emission estimates are based on the build-up of molecular chlorine (Cl_2) concentrations in oceanic air masses (Bullock and Brehme, 2002). Data at 36 km and 12 km resolution were available and were not modified other than the model-species name "CHLORINE" was changed to "CL2" to support CMAQ modeling.

3 Emissions Modeling Summary

Both the CMAQ and CAM_X models require hourly emissions of specific gas and particle species for the horizontal and vertical grid cells contained within the modeled region (i.e., modeling domain). To provide emissions in the form and format required by the model, it is necessary to "pre-process" the "raw" emissions (i.e., emissions input to SMOKE) for the sectors described above in Section 2. In brief, the process of emissions modeling transforms the emissions inventories from their original temporal resolution, pollutant resolution, and spatial resolution into the hourly, speciated, gridded resolution required by the air quality model. Emissions modeling includes temporal allocation, spatial allocation, and pollutant speciation. In some cases, emissions modeling also includes the vertical allocation of point sources, but many air quality models also perform this task because it greatly reduces the size of the input emissions files if the vertical layers of the sources are not included.

As seen in Section 2, the temporal resolutions of the emissions inventories input to SMOKE vary across sectors, and may be hourly, daily, monthly, or annual total emissions. The spatial resolution, may be individual point sources, county/province/municipio totals, or gridded emissions and varies by sector. This section provides some basic information about the tools and data files used for emissions modeling as part of the modeling platform. In Section 2, the emissions inventories and how they differ from the 2011NEIv2 were described. In Section 3, the descriptions of data are limited to the ancillary data SMOKE uses to perform the emissions modeling steps. Note that all SMOKE inputs for the 2011v6 platform are available from the CHIEF Emissions Modeling Clearinghouse website (see Section 1).

SMOKE version 3.6.5 was used to pre-process the raw emissions inventories into emissions inputs for CMAQ. For projects that used CAMx, the CMAQ emissions were converted into the CAMx formats using CAMx convertor programs. For sectors that have plume rise, the in-line emissions capability of the air quality models was used, which allows the creation of source-based and two-dimensional gridded emissions files that are much smaller than full three-dimensional gridded emissions files. For quality assurance of the emissions modeling steps, emissions totals by specie for the entire model domain are output as reports that are then compared to reports generated by SMOKE on the input inventories to ensure that mass is not lost or gained during the emissions modeling process.

3.1 Emissions modeling Overview

When preparing emissions for the air quality model, emissions for each sector are processed separately through SMOKE, and then the final merge program (Mrggrid) is run to combine the model-ready, sector-specific emissions across sectors. The SMOKE settings in the run scripts and the data in the SMOKE ancillary files control the approaches used by the individual SMOKE programs for each sector. Table 3-1 summarizes the major processing steps of each platform sector. The "Spatial" column shows the spatial approach used: here "point" indicates that SMOKE maps the source from a point location (i.e., latitude and longitude) to a grid cell; "surrogates" indicates that some or all of the sources use spatial surrogates to allocate county emissions to grid cells; and "area-to-point" indicates that some of the sources use the SMOKE area-to-point feature to grid the emissions (further described in Section 3.4.2). The "Speciation" column indicates that all sectors use the SMOKE speciation step, though biogenics speciation is done within the Tmpbeis3 program and not as a separate SMOKE step. The "Inventory resolution" column shows the inventory temporal resolution from which SMOKE needs to calculate hourly emissions. Note that for some sectors (e.g., onroad, beis), there is no input inventory; instead, activity data and emission factors are used in combination with meteorological data to compute hourly emissions.

Finally, the “plume rise” column indicates the sectors for which the “in-line” approach is used. These sectors are the only ones with emissions in aloft layers based on plume rise. The term “in-line” means that the plume rise calculations are done inside of the air quality model instead of being computed by SMOKE. The air quality model computes the plume rise using the stack data and the hourly air quality model inputs found in the SMOKE output files for each model-ready emissions sector. The height of the plume rise determines the model layer into which the emissions are placed. The othpt sector has only “in-line” emissions, meaning that all of the emissions are treated as elevated sources and there are no emissions for those sectors in the two-dimensional, layer-1 files created by SMOKE. Day-specific point fires are treated separately. For CMAQ modeling, fire plume rise is done within CMAQ itself, but for CAMx, the plume rise is done by running SMOKE to create a three-dimensional output file and then those emissions are postprocessed into a point source format that CAMx can read. In either case, after plume rise is applied, there will be emissions in every layer from the ground up to the top of the plume.

Table 3-1. Key emissions modeling steps by sector.

Platform sector	Spatial	Speciation	Inventory resolution	Plume rise
afdust	Surrogates	Yes	annual	
ag	Surrogates	Yes	annual	
agfire	Surrogates	Yes	monthly	
beis	Pre-gridded land use	in BEIS3.14	computed hourly	
c1c2rail	Surrogates	Yes	annual	
c3marine	Surrogates	Yes	annual	in-line
nonpt	Surrogates & area-to-point	Yes	annual	
nonroad	Surrogates & area-to-point	Yes	monthly	
np_oilgas	Surrogates	Yes	annual	
onroad	Surrogates	Yes	monthly activity, computed hourly	
othafdust	Surrogates	Yes	annual	
othar	Surrogates	Yes	annual	
othon	Surrogates	Yes	annual	
othpt	Point	Yes	annual	in-line
pt_oilgas	Point	Yes	annual	in-line
ptegu	Point	Yes	daily & hourly	in-line
ptprescfire	Point	Yes	daily	in-line
ptwildfire	Point	Yes	daily	in-line
ptnonipm	Point	Yes	annual	in-line
rwc	Surrogates	Yes	annual	

SMOKE has the option of grouping sources so that they are treated as a single stack when computing plume rise. For the 2011 platform, no grouping was performed because grouping combined with “in-line” processing will not give identical results as “offline” processing (i.e., when SMOKE creates 3-dimensional files). This occurs when stacks with different stack parameters or lat/lons are grouped, thereby changing the parameters of one or more sources. The most straightforward way to get the same results between in-line and offline is to avoid the use of grouping.

To prepare fires for CAMx using a plume rise algorithm that is consistent with the algorithms in SMOKE and CMAQ, the following steps are performed:

1) The ptfire inventories are run through SMOKE programs to read the inventories, speciate, temporalize, and grid the emissions.

2) The SMOKE program laypoint is used to estimate the plume height and layer fractions for each fire (see https://www.cmascenter.org/smoke/documentation/3.6.5/html/ch06s06.html#sect_programs_laypoint_plume_rise_fires).

3) The emissions are gridded and layered, and then written as three-dimensional netCDF CMAQ ready files.

4) Species in the CMAQ-formatted file are converted to CAMx species using the *spcmap* program.

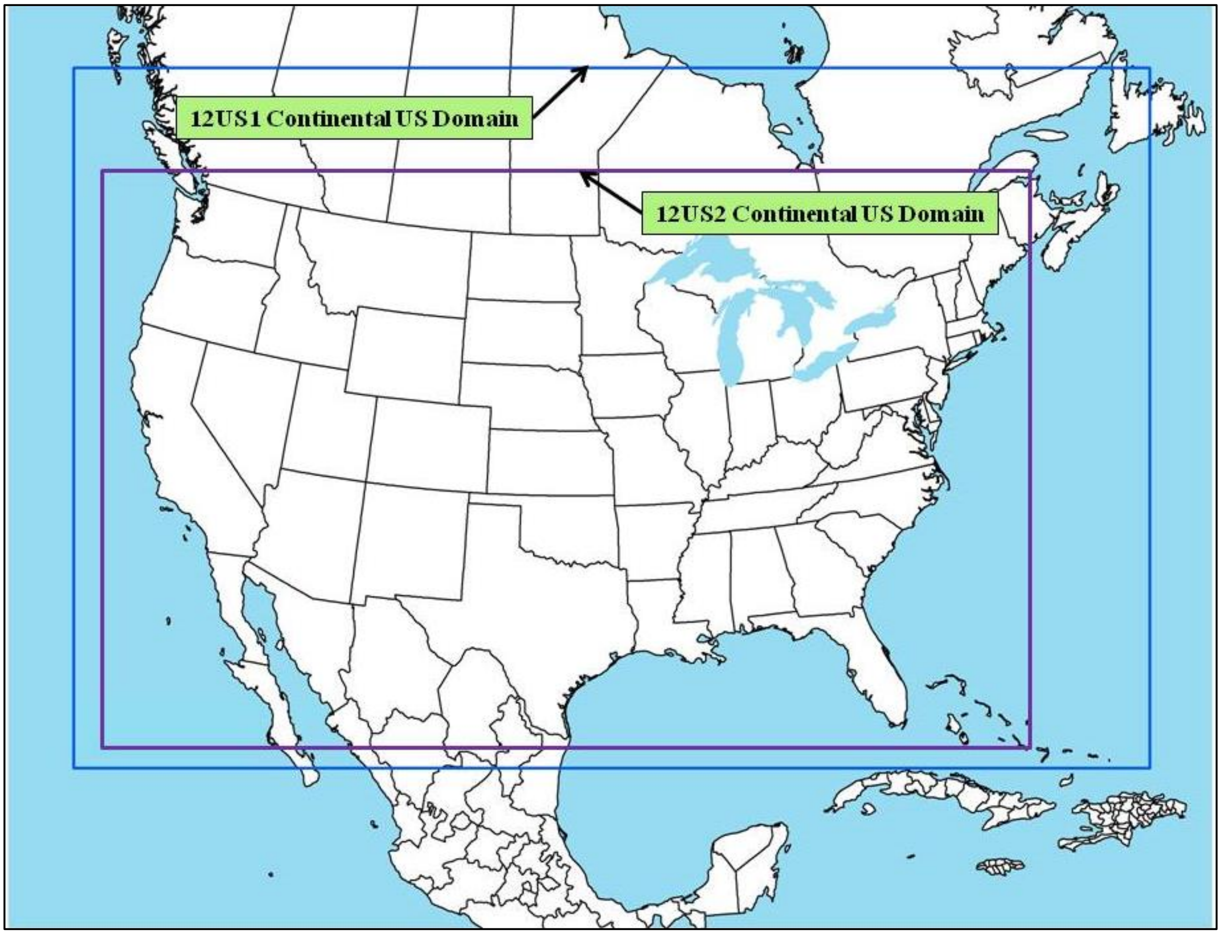
5) The netCDF fire files are converted to a CAMx "PTSOURCE" type file where each grid cell centroid represents one stack using the *cmaq2uam* program. Note: each virtual stack has default stack parameters of 1 m height, 1 m diameter, 273 K temperature, and 1 m/s velocity. Also, an individual virtual stack point (grid cell centroid) will have all of the emissions for the grid cell divided up into layers with an effective plume height at each layer. Only the layers that contain emissions are kept for each virtual stack.

6) The program *pthtq* is run to add an effective plume height based on the cell center height from the METCRO3D (ZH).

7) The resulting PTSOURCE files have emissions as a stack at (x,y) that to up to layer z that is derived from the CMAQ 3D file, and are merged with the PTSOURCE sector files from other sectors into a single PTSOURCE file with stacks for all point sources. This file, along with the 2D emissions file, is input into the CAMx model.

SMOKE was run for the smaller 12-km CONtinental United States "CONUS" modeling domain (12US2) shown in Figure 3-1 and boundary conditions were obtained from a 2011 run of GEOS-Chem.

Figure 3-1. Air quality modeling domains



Both grids use a Lambert-Conformal projection, with Alpha = 33º, Beta = 45º and Gamma = -97º, with a center of X = -97º and Y = 40º. Table 3-2 describes the grids for the two domains.

Table 3-2. Descriptions of the platform grids

Common Name	Grid Cell Size	Description (see Figure 3-1)	Grid name	Parameters listed in SMOKE grid description (GRIDDESC) file: projection name, xorig, yorig, xcell, ycell, ncols, nrows, nthik
Continental 12km grid	12 km	Entire conterminous US plus some of Mexico/Canada	12US1_459X299	'LAM_40N97W', -2556000, -1728000, 12.D3, 12.D3, 459, 299, 1
US 12 km or "smaller" CONUS-12	12 km	Smaller 12km CONUS plus some of Mexico/Canada	12US2	'LAM_40N97W', -2412000 , -1620000, 12.D3, 12.D3, 396, 246, 1

Section 3.4 provides the details on the spatial surrogates and area-to-point data used to accomplish spatial allocation with SMOKE.

3.2 Chemical Speciation

The emissions modeling step for chemical speciation creates the "model species" needed by the air quality model for a specific chemical mechanism. These model species are either individual chemical compounds or groups of species, called "model species." The chemical mechanism used for the 2011 platform is the CB6 mechanism (Yarwood, 2010). The 2011v6.2 platform is the first EPA modeling platform to use CB6; previous platforms used CB05 and earlier versions of the carbon bond mechanism. The key difference in CB6 from CB05 from an emissions modeling perspective is that is has additional lumped and explicit model species. The specific version of CAMx used in applications of this platform include secondary organic aerosol (SOA) and HONO enhancements. In addition, this platform generates the $PM_{2.5}$ model species associated with the CMAQ Aerosol Module, version 6 (AE6), though they are not used by CAM_X. Table 3-3 lists the model species produced by SMOKE in the 2011v6.2 platform and Table 3-4 provides the cmaq2camx mapping file used to convert the SMOKE generated model species to the appropriate inputs for CAM_X.

The TOG and $PM_{2.5}$ speciation factors that are the basis of the chemical speciation approach were developed from the SPECIATE 4.4 database (http://www.epa.gov/ttn/chief/software/speciate), which is EPA's repository of TOG and PM speciation profiles of air pollution sources. However, a few of the profiles used in the v6.2 platform will be published in later versions of the SPECIATE database after the release of this documentation. The SPECIATE database development and maintenance is a collaboration involving EPA's ORD, OTAQ, and the Office of Air Quality Planning and Standards (OAQPS), in cooperation with Environment Canada (EPA, 2006a). The SPECIATE database contains speciation profiles for TOG, speciated into individual chemical compounds, VOC-to-TOG conversion factors associated with the TOG profiles, and speciation profiles for $PM_{2.5}$.

Some updates to speciation made in the 2011v6.2 platform include the following (the subsections below contain more details on the specific changes):

- VOC speciation profile cross reference assignments for nonpoint oil and gas sources were updated based on comments;
- VOC and PM speciation for onroad mobile sources occurs within MOVES2014;
- the latest CB6 chemical mechanism was used;
- only AE6 PM species are included, where previously both AE5 and AE6 species were generated;
- the 2010 Canadian point source inventories in the othpt use CB05 speciation as it was provided from Environment Canada; and
- speciation for onroad mobile sources in Mexico was updated to be more consistent with that used in the United States.

Speciation profiles and cross-references for the 2011v6.2 platform are available in the SMOKE input files for the 2011v6.2 platform. Totals of each model species by state and sector can be found in the state-sector totals workbooks for the respective cases. In addition, the county-monthly reports for each case include EC and OC, and the 2011eh_county_SCC7_sector_CAP_PM.xlsx workbook contains speciated PM by county and the first seven digits of the SCC code.

Table 3-3. Emission model species produced for CB6 for CAM_X*

Inventory Pollutant	**Model Species**	**Model species description**
Cl_2	CL2	Atomic gas-phase chlorine
HCl	HCL	Hydrogen Chloride (hydrochloric acid) gas
CO	CO	Carbon monoxide
NO_X	NO	Nitrogen oxide
	NO2	Nitrogen dioxide
	HONO	Nitrous acid
SO_2	SO2	Sulfur dioxide
	SULF	Sulfuric acid vapor
NH_3	NH3	Ammonia
VOC	ACET	Acetone
	ALD2	Acetaldehyde
	ALDX	Propionaldehyde and higher aldehydes
	BENZ	Benzene
	CH4	Methane[8]
	ETH	Ethene
	ETHA	Ethane
	ETHY	Ethyne
	ETOH	Ethanol
	FORM	Formaldehyde
	KET	Ketone Groups
	IOLE	Internal olefin carbon bond (R-C=C-R)
	ISOP	Isoprene
	MEOH	Methanol
	OLE	Terminal olefin carbon bond (R-C=C)
	PAR	Paraffin carbon bond
	PRPA	Propane
	TOL	Toluene and other monoalkyl aromatics
	XYL	Xylene and other polyalkyl aromatics
VOC species from the biogenics model that do not map to model species above	SESQ	Sesquiterpenes
	TERP	Terpenes
PM_{10}	PMC	Coarse PM > 2.5 microns and ≤ 10 microns

[8] Technically, CH4 is not a VOC but part of TOG. Although emissions of CH4 are derived, the AQ models do not use these emissions because the anthropogenic emissions are dwarfed by the CH4 already in the atmosphere.

Inventory Pollutant	Model Species	Model species description
$PM_{2.5}$	PAL	Aluminum
	PCA	Calcium
	PCL	Chloride
	PEC	Particulate elemental carbon ≤ 2.5 microns
	PFE	Iron
	PK	Potassium
	PH2O	Water
	PMG	Magnesium
	PMN	Manganese
	PMOTHR	$PM_{2.5}$ not in other AE6 species
	PNA	Sodium
	PNCOM	Non-carbon organic matter
	PNO3	Particulate nitrate ≤ 2.5 microns
	PNH4	Ammonium
	POC	Particulate organic carbon (carbon only) ≤ 2.5 microns
	PSI	Silica
	PSO4	Particulate Sulfate ≤ 2.5 microns
	PTI	Titanium
Sea-salt species (non – anthropogenic) [9]	PCL	Particulate chloride
	PNA	Particulate sodium

*Notes:
1. CL2 is not used in CAM_X and is provided above because of its use in CMAQ
2. CAM_X particulate sodium is NA (in CMAQ it is PNA)
3. CAM_X uses different names for species that are both in CB6 and SOA for the following: TOLA=TOL, XYLA=XYL, ISP=ISOP, TRP=TERP. They are duplicate species in CAM_X that are used in the SOA chemistry. CMAQ uses the same names in CB05 and SOA for these species.
4. CAM_X uses a different name for sesquiterpenes: CMAQ SESQ = CAM_X SQT
5. CAM_X particulate species have different names for organic carbon, coarse particulate matter and other particulate mass: CAM_X uses POA, CPRM, FCRS, and FPRM, respectively.

[9] These emissions are created outside of SMOKE

Table 3-4. Cmaq2camx mapping file

CMAQ Species	CMAQ to CAMx Factor	CAMx Species	Units	CMAQ Species	CMAQ to CAMx Factor	CAMx Species	Units
SO2	1	SO2	moles/hr	UNR	1	NR	moles/hr
SULF	1	SULF	moles/hr	NR	1	NR	moles/hr
NH3	1	NH3	moles/hr	TOL	1	TOLA	moles/hr
CO	1	CO	moles/hr	XYL	1	XYLA	moles/hr
NO	1	NO	moles/hr	PSO4	1	PSO4	g/hr
NO2	1	NO2	moles/hr	PH2O	1	PH2O	g/hr
HONO	1	HONO	moles/hr	PNH4	1	PNH4	g/hr
CL2	1	CL2	moles/hr	PNO3	1	PNO3	g/hr
HCL	1	HCL	moles/hr	PEC	1	PEC	g/hr
CH4	1	CH4	moles/hr	POC	1	POC	g/hr
PAR	1	PAR	moles/hr	PMOTHR	1	PMOTHR	g/hr
ETHA	1	ETHA	moles/hr	PMC	1	CPRM	g/hr
MEOH	1	MEOH	moles/hr	ISOP	1	ISP	moles/s
ETOH	1	ETOH	moles/hr	TERP	1	TRP	moles/s
ETH	1	ETH	moles/hr	SESQ	1	SQT	moles/s
OLE	1	OLE	moles/hr	PCL	1	PCL	g/hr
IOLE	1	IOLE	moles/hr	PNCOM	1	PNCOM	g/hr
ISOP	1	ISOP	moles/hr	PAL	1	PAL	g/hr
TERP	1	TERP	moles/hr	PCA	1	PCA	g/hr
FORM	1	FORM	moles/hr	PFE	1	PFE	g/hr
ALD2	1	ALD2	moles/hr	PMG	1	PMG	g/hr
ALDX	1	ALDX	moles/hr	PK	1	PK	g/hr
TOL	1	TOL	moles/hr	PMN	1	PMN	g/hr
XYL	1	XYL	moles/hr	PSI	1	PSI	g/hr
PRPA	1	PRPA	moles/hr	PTI	1	PTI	g/hr
ETHY	1	ETHY	moles/hr	PNA	1	NA	g/hr
BENZ	1	BENZ	moles/hr	POC	1	POA	g/hr
ACET	1	ACET	moles/hr	PNCOM	1	POA	g/hr
KET	1	KET	moles/hr				

3.2.1 VOC speciation

The concept of VOC speciation is to use emission source-related speciation profiles to convert VOC to TOG, to speciate TOG into individual chemical compounds, and to use a chemical mechanism mapping file to aggregate the chemical compounds to the chemical mechanism model species. The chemical mechanism mapping file is typically developed by the developer of the chemical mechanism.

SMOKE uses profiles that convert inventory species and TOG directly to the model species. The SMOKE-ready profiles are generated from the Speciation Tool which uses the “raw” (TOG to chemical compounds) SPECIATE profiles and the chemical mechanism mapping file.

For the 2011v6.2 platform, Greg Yarwood (ENVIRON) provided the CB6 chemical mapping file based on the latest mechanism table for CB05 from Bill Carter. This CB6 mapping file included some corrections to the CB05 profiles used in the 2011v6.1 platform. Similarly to previous platforms, HAP VOC inventory species were used in the VOC speciation process for some sectors as described below.

3.2.1.1 The combination of HAP BAFM (benzene, acetaldehyde, formaldehyde and methanol) and VOC for VOC speciation

The VOC speciation includes HAP emissions from the 2011NEIv2 in the speciation process. Instead of speciating VOC to generate all of the species listed in Table 3-3, emissions of four specific HAPs: benzene, acetaldehyde, formaldehyde and methanol (collectively known as "BAFM") from the NEI were "integrated" with the NEI VOC. The integration combines these HAPs with the VOC in a way that does not double count emissions and uses the HAP inventory directly in the speciation process. The basic process is to subtract the specified HAPs emissions mass from the VOC emissions mass, and to then use a special "integrated" profile to speciate the remainder of VOC to the model species excluding the specific HAPs. EPA believes that the HAP emissions in the NEI are often more representative of emissions than HAP emissions generated via VOC speciation, although this varies by sector.

The BAFM HAPs (benzene, acetaldehyde, formaldehyde and methanol) were chosen for integration in previous platforms because, with the exception of BENZENE[10], they are the only explicit VOC HAPs in the base version of the CMAQ 5.0.2 (CAPs only with chlorine chemistry) model. These remain appropriate for the 2011v6.2 platform since they are all explicit in CAMx. Explicit means that they are not lumped chemical groups like PAR, IOLE and several other CB6 model species. These "explicit VOC HAPs" are model species that participate in the modeled chemistry using the CB6 chemical mechanism. The use of inventory HAP emissions along with VOC is called "HAP-CAP integration".

For specific sources, especially within the nonpt sector, the integration included ethanol. To differentiate when a source was integrating BAFM versus EBAFM (ethanol in addition to BAFM), the speciation profiles that do not include ethanol are referred to as an "E-profile" and should be used when ethanol comes from the inventory. For example, the E10 headspace gasoline evaporative speciation profile 8763 should be used when ethanol is speciated from VOC, but 8763E should be used when ethanol is obtained directly from the inventory.

The integration of HAP VOC with VOC is a feature available in SMOKE for all inventory formats other than PTDAY (the format used for the ptfire sector). SMOKE allows the user to specify both the particular HAPs to integrate via the INVTABLE and the particular sources to integrate via the NHAPEXCLUDE file (which actually provides the sources to be *excluded* from integration[11]). For the "integrated" sources, SMOKE subtracts the "integrated" HAPs from the VOC (at the source level) to compute emissions for the new pollutant "NONHAPVOC." The user provides NONHAPVOC-to-NONHAPTOG factors and NONHAPTOG speciation profiles[12]. SMOKE computes NONHAPTOG and then applies the speciation profiles to allocate the NONHAPTOG to the other air quality model VOC species not including the integrated HAPs. After determining if a sector is to be integrated, if all sources have the appropriate HAP emissions, then the sector is considered fully integrated and does not need a NHAPEXCLUDE file. If on the other hand, certain sources do not have the necessary HAPs, then an

[10] BENZENE was chosen to keep its emissions consistent between the multi-pollutant and base versions of CMAQ

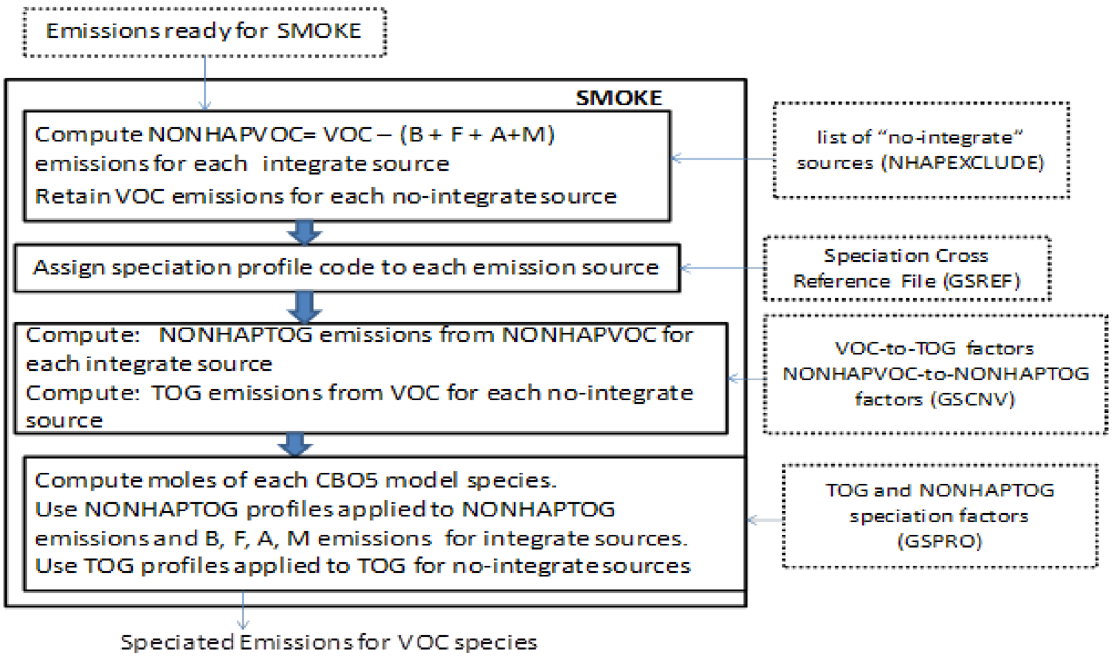
[11] In SMOKE version 3.6.5, the options to specify sources for integration are expanded so that a user can specify the particular sources to include or exclude from integration, and there are settings to include or exclude all sources within a sector. In addition, the error checking is significantly stricter for integrated sources. If a source is supposed to be integrated, but it is missing BAFM or VOC, SMOKE will now raise an error.

[12] These ratios and profiles are typically generated from the Speciation Tool when it is run with integration of a specified list of pollutants, for example BAFM.

NHAPEXCLUDE file must be provided based on the evaluation of each source's pollutant mix. EPA considered CAP-HAP integration for all sectors and developed "integration criteria" for some of them (see Section 3.2.1.3 for details).

The process of partial integration for BAFM is illustrated in Figure 3-2 that the BAFM records in the input inventories do not need to be removed from any sources in a partially integrated sector because SMOKE does this automatically using the INVTABLE configuration. For EBAFM integration, this process is identical to that shown in the figure except for the addition of ethanol (E) to the list of subtracted HAP pollutants. For full integration, the process would be very similar except that the NHAPEXCLUDE file would not be used and all sources in the sector would be integrated.

Figure 3-2. Process of integrating BAFM with VOC for use in VOC Speciation



In SMOKE, the INVTABLE allows the user to specify both the particular HAPs to integrate. Two different types of INVTABLE files are included for use with different sectors of the platform. For sectors that had no integration across the entire sector (see Table 3-5), EPA created a "no HAP use" INVTABLE in which the "KEEP" flag is set to "N" for BAFM pollutants. Thus, any BAFM pollutants in the inventory input into SMOKE are automatically dropped. This approach both avoids double-counting of these species and assumes that the VOC speciation is the best available approach for these species for sectors using this approach. The second INVTABLE, used for sectors in which one or more sources are integrated, causes SMOKE to keep the inventory BAFM pollutants and indicates that they are to be integrated with VOC. This is done by setting the "VOC or TOG component" field to "V" for all four HAP pollutants. This type of INVTABLE is further differentiated into a version for those sectors that integrate BAFM and another for those that integrate EBAFM.

Table 3-5. Integration approach for BAFM and EBAFM for each platform sector

Platform Sector	**Approach for Integrating NEI emissions of Benzene (B), Acetaldehyde (A), Formaldehyde (F), Methanol (M), and Ethanol (E)**
ptegu	No integration
ptnonipm	No integration
ptprescfire	No integration
ptwildfire	No integration
othafdust	No integration
othar	No integration
othon	No integration
ag	N/A – sector contains no VOC
afdust	N/A – sector contains no VOC
biog	N/A – sector contains no inventory pollutant "VOC"; but rather specific VOC species
agfire	Partial integration (BAFM)
c1c2rail	Partial integration (BAFM)
c3marine	Partial integration (BAFM)
nonpt	Partial integration (BAFM and EBAFM)
nonroad	Partial integration (BAFM)
np_oilgas	Partial integration (BAFM)
pt_oilgas	Partial integration (BAFM)
rwc	Partial integration (BAFM)
othpt	Partial integration (BAFM)
onroad	Full integration (internal to MOVES)

More details on the integration of specific sectors and additional details of the speciation are provided in Section 3.2.1.3.

3.2.1.2 County specific profile combinations (GSPRO_COMBO)

SMOKE can compute speciation profiles from mixtures of other profiles in user-specified proportions. The combinations are specified in the GSPRO_COMBO ancillary file by pollutant (including pollutant mode, e.g., EXH__VOC), state and county (i.e., state/county FIPS code) and time period (i.e., month).This feature was used to speciate nonroad mobile and gasoline-related related stationary sources that use fuels with varying ethanol content. In these cases, the speciation profiles require different combinations of gasoline profiles, e.g. E0 and E10 profiles. Since the ethanol content varies spatially (e.g., by state or county), temporally (e.g., by month) and by modeling year (future years have more ethanol) the GSPRO_COMBO feature allows combinations to be specified at various levels for different years. SMOKE computes the resultant profile using the fraction of each specific profile assigned by county, month and emission mode.

The GSREF file indicates that a specific source uses a combination file with the profile code "COMBO". Because the GSPRO_COMBO file does not differentiate by SCC and there are various levels of integration across sectors, sector-specific GSPRO_COMBO files are used. Different profile combinations are specified by the mode (e.g. exhaust, evaporative) and by changing the pollutant name (e.g. EXH__NONHAPTOG, EVP__NONHAPTOG). For the nonpt sector, a combination of BAFM and EBAFM integration is used. Due to the lack of SCC-specificity in the GSPRO_COMBO, the only way to differentiate the sources that should use BAFM integrated profiles versus E-profiles is by changing the pollutant name. For example, EPA changed the pollutant name for the PFC future year inventory so the integration would use EVP__NONHAPVOC to correctly select the E-profile combinations, while other sources used NONHAPVOC to select the typical BAFM profiles.

3.2.1.3 Additional sector specific details

The decision to integrate HAPs into the speciation was made on a sector by sector basis. For some sectors there is no integration and VOC is speciated directly; for some sectors there is full integration meaning all sources are integrated; and for other sectors there is partial integration meaning some sources are not integrated and other sources are integrated. The integrated HAPs are either BAFM (BAFM HAPs subtracted from VOC) or EBAFM (ethanol and BAFM HAPs subtracted from VOC). Table 3-5 above summarizes the integration method for each platform sector.

For the c1c2rail sector, EPA integrated BAFM for most sources from the 2011NEIv2. There were a few sources that had zero BAFM; therefore, they were not integrated. The MWRPO and CARB inventories (see Section 2.4.1) did not include HAPs; therefore, all non-NEI source emissions in the c1c2rail sector were not integrated. For California, the CARB inventory TOG was converted to VOC by dividing the inventory TOG by the available VOC-to-TOG speciation factor.

For the othpt sector, the C3 marine sources (see Section 2.4.2) are integrated. HAPs in this sector are derived identically to the U.S. c3marine sector. The rest of the sources in othpt are not integrated, thus the sector is partially integrated.

For the onroad sector, there are series of unique speciation issues. First, SMOKE-MOVES (see Section 2.3.1) is used to create emissions for these sectors and both the MEPROC and INVTABLE files are involved in controlling which pollutants are processed. Second, the speciation occurs within MOVES itself, not within SMOKE. The advantage of using MOVES to speciate VOC is that during the internal calculation of MOVES, the model has complete information on the characteristics of the fleet and fuels (e.g. model year, ethanol content, process, etc.), thereby allowing it to more accurately make use of specific speciation profiles. This means that MOVES produces EF tables that include inventory pollutants (e.g. TOG) and model-ready species (e.g. PAR, OLE, etc)[13]. SMOKE essentially calculates the model-ready species by using the appropriate emission factor without further speciation[14]. Third, MOVES' internal speciation uses full integration of an extended list of HAPs beyond EBAFM (called "M-profiles"). The M-profiles integration is very similar to BAFM integration explained above except that the integration calculation (see Figure 3-2) is performed on emissions factors instead of on emissions. The list of integrated HAPs is described in Table 3-6. An additional run of the speciation tool was necessary to create the M-profiles that were then loaded into the MOVES default database. Fourth, for California EPA applied adjustment factors to SMOKE-MOVES to produce California adjusted model-ready files (see Section 2.3.1 for details). By applying the ratios through SMOKE-MOVES, the CARB inventories are essentially speciated to match EPA estimated speciation.

[13] Because the EF table has the speciation "baked" into the factors, all counties that are in the county group (i.e. are mapped to that reference county) will have the same speciation.

[14] For more details on the use of model-ready EF, see the SMOKE 3.6.5 documentation: https://www.cmascenter.org/smoke/documentation/3.6.5/html/

Table 3-6. MOVES integrated species in M-profiles

MOVES ID	Pollutant Name
5	Methane (CH_4)
20	Benzene
21	Ethanol
22	MTBE
24	1,3-Butadiene
25	Formaldehyde
26	Acetaldehyde
27	Acrolein
40	2,2,4-Trimethylpentane
41	Ethyl Benzene
42	Hexane
43	Propionaldehyde
44	Styrene
45	Toluene
46	Xylene
185	Naphthalene gas

For the nonroad sector, CNG or LPG sources (SCCs beginning with 2268 or 2267) are not integrated because NMIM computed only VOC and not any HAPs for these SCCs. All other nonroad sources were integrated except in California. For California, the CARB inventory TOG was converted to VOC by dividing the inventory TOG by the available VOC-to-TOG speciation factor. SMOKE later applies the same VOC-to-TOG factor prior to computing speciated emissions. The CARB-based nonroad data includes exhaust and evaporative mode-specific data for VOC, but does not contain refueling. The CARB inventory does not include HAP estimates for all sources. Therefore, the sources which have VOC but not BAFM, or for which BAFM is greater than VOC, are not integrated and the remaining sources are integrated. The future year CARB inventories did not have BAFM so all sources for California were not integrated. The gasoline exhaust profiles were updated to 8750a and 8751a (this is true nation-wide).

For the ptnonipm sector, the 2011, 2017 and 2025 runs were not integrated. This was an oversight— it should have been partial integration because the 2011 ethanol inventory (SCC 30125010) provided by OTAQ includes BAFM. In the future years, ptnonipm should be partially integrated because both the ethanol and biodiesel inventories (SCC 30125010) provided by OTAQ include BAFM. Aircraft emissions use the profile 5565. In previous versions of the platform, a significant amount of VOC emissions associated with the pulp and paper and the chemical manufacturing industries did not have specific profiles assigned to them (i.e. they had the default VOC profile 0000). To address this, EPA and Environ developed industry wide average profiles to improve the speciation of these significant sources of VOC. The two new composite profiles are “Composite Profile – Chemical Manufacturing (95325)” and “Composite Profile – Pulp and Paper Mills” (95326)[15].

[15] These profiles are expected to be included in SPECIATE 4.5.

For most sources in the rwc sector, the VOC emissions were greater than or equal to BAFM, and BAFM was not zero, so those sources were integrated, although a few specific sources that did not meet these criteria could not be integrated.

For the oil and gas sources in the np_oilgas and pt_oilgas sectors, the basins studied in WRAP Phase III have basin-specific VOC speciation that takes into account the distinct composition of gas. ENVIRON developed these basin-specific profiles using gas composition analysis data obtained from operators through surveys. ENVIRON separated out emissions and speciation from conventional/tight sands/shale gas from coal-bed methane (CBM) gas sources. Table 3-7 lists the basin- and gas composition-specific profiles used for the sources in the WRAP Phase III basins. For oil and gas sources outside of the WRAP Phase III basins, the profiles did not vary by region or basin (see Table 3-8). Table 3-9 lists the WRAP Phase III counties.

Table 3-7. VOC profiles for WRAP Phase III basins

Profile Code	Description
DJFLA	D-J Basin Flashing Gas Composition for Condensate
DJVNT	D-J Basin Produced Gas Composition
PNC01	Piceance Basin Gas Composition at Conventional Wells
PNC02	Piceance Basin Gas Composition at Oil Wells
PNC03	Piceance Basin Flashing Gas Composition for Condensate
PRBCO	Powder River Basin Produced Gas Composition for Conventional Wells
PRM01	Permian Basin Produced Gas Composition
SSJCO	South San Juan Basin Produced Gas Composition for Conventional Wells
SWFLA	SW Wyoming Basin Flash Gas Composition
SWVNT	SW Wyoming Basin Vented Gas Composition
UNT02	Uinta Basin Gas Composition at Conventional Wells
UNT03	Uinta Basin Flashing Gas Composition for Oil
UNT04	Uinta Basin Flashing Gas Composition for Condensate
WRBCO	Wind River Basin Produced Gas Composition for Conventional Wells

Table 3-8. National VOC profiles for oil and gas

profile	Description
0000	Over All Average
0001	External Combustion Boiler - Residual Oil
0002	External Combustion Boiler - Distillate Oil
0003	External Combustion Boiler - Natural Gas
0004	External Combustion Boiler - Refinery Gas
0007	Natural Gas Turbine
0008	Reciprocating Diesel Engine
0051	Flares - Natural Gas
0296	Fixed Roof Tank - Crude Oil Production
1001	Internal Combustion Engine - Natural Gas
1010	Oil and Gas Production - Fugitives - Unclassified
1011	Oil and Gas Production - Fugitives - Valves and Fittings - Liquid Service

profile	Description
1012	Oil and Gas Production - Fugitives - Valves and Fittings - Gas Service
1207	Well Heads (Water Flood) Composite
2487	Composite of 7 Emission Profiles from Crude Oil Storage Tanks - 1993
2489	Composite of 15 Fugitive Emission Profiles from Petroleum Storage Facilities - 1993
8489	Natural Gas Production
8950	Natural Gas Transmission

Table 3-9. Counties included in the WRAP Dataset

FIPS	State	County
08001	CO	Adams
08005	CO	Arapahoe
08007	CO	Archuleta
08013	CO	Boulder
08014	CO	Broomfield
08029	CO	Delta
08031	CO	Denver
08039	CO	Elbert
08043	CO	Fremont
08045	CO	Garfield
08051	CO	Gunnison
08059	CO	Jefferson
08063	CO	Kit Carson
08067	CO	La Plata
08069	CO	Larimer
08073	CO	Lincoln
08075	CO	Logan
08077	CO	Mesa
08081	CO	Moffat
08087	CO	Morgan
08095	CO	Phillips
08097	CO	Pitkin
08103	CO	Rio Blanco
08107	CO	Routt
08115	CO	Sedgwick
08121	CO	Washington
08123	CO	Weld
08125	CO	Yuma
30003	MT	Big Horn
30075	MT	Powder River
35005	NM	Chaves
35015	NM	Eddy
35015	NM	Lea

FIPS	State	County
35031	NM	Mc Kinley
35039	NM	Rio Arriba
35041	NM	Roosevelt
35043	NM	Sandoval
35045	NM	San Juan
48003	TX	Andrews
48033	TX	Borden
48079	TX	Cochran
48081	TX	Coke
48103	TX	Crane
48105	TX	Crockett
48107	TX	Crosby
48109	TX	Culberson
48115	TX	Dawson
48125	TX	Dickens
48135	TX	Ector
48141	TX	El Paso
48151	TX	Fisher
48165	TX	Gaines
48169	TX	Garza
48173	TX	Glasscock
48219	TX	Hockley
48227	TX	Howard
48229	TX	Hudspeth
48235	TX	Irion
48263	TX	Kent
48269	TX	King
48301	TX	Loving
48303	TX	Lubbock
48305	TX	Lynn
48317	TX	Martin
48329	TX	Midland
48335	TX	Mitchell

FIPS	State	County
48353	TX	Nolan
48371	TX	Pecos
48383	TX	Reagan
48389	TX	Reeves
48413	TX	Schleicher
48415	TX	Scurry
48431	TX	Sterling
48435	TX	Sutton
48445	TX	Terry
48451	TX	Tom Green
48461	TX	Upton
48475	TX	Ward
48495	TX	Winkler
48501	TX	Yoakum
49007	UT	Carbon
49009	UT	Daggett
49013	UT	Duchesne
49015	UT	Emery
49019	UT	Grand
49043	UT	Summit
49047	UT	Uintah
56001	WY	Albany
56005	WY	Campbell
56007	WY	Carbon
56009	WY	Converse
56011	WY	Crook
56013	WY	Fremont
56019	WY	Johnson
56023	WY	Lincoln
56025	WY	Natrona
56027	WY	Niobrara
56033	WY	Sheridan
56035	WY	Sublette

FIPS	State	County
56037	WY	Sweetwater

FIPS	State	County
56041	WY	Uinta

FIPS	State	County
56045	WY	Weston

Although the intention was to apply WRAP speciation everywhere in the WRAP region (Table 3-9), a SMOKE processing error meant that for select sources in select counties the national VOC profiles for oil and gas were used[16]. For the biog sector, the speciation profiles used by BEIS are not included in SPECIATE. The 2011 platform uses BEIS3.61, which includes a new species (SESQ) that was mapped to the model species SESQT. The profile code associated with BEIS3.61 for use with CB05 is "B10C5", while the profile for use with CB6 is "B10C6". The main difference between the profiles is the explicit treatment of acetone emissions in B10C6.

For the nonpt sector, where VOC emissions were greater than or equal to BAFM and BAFM was not zero, the sources were integrated. For portable fuel containers (PFCs) and fuel distribution operations associated with the bulk-plant-to-pump (BTP) distribution, ethanol may be mixed into the fuels; therefore, county- and month-specific COMBO speciation was used (via the GSPRO_COMBO file). Refinery to bulk terminal (RBT) fuel distribution and bulk plant storage (BPS) speciation are considered upstream from the introduction of ethanol into the fuel; therefore a single profile is sufficient for these sources. No refined information on potential VOC speciation differences between cellulosic diesel and cellulosic ethanol sources was available, therefore cellulosic diesel and cellulosic ethanol sources used the same SCC (30125010: Industrial Chemical Manufacturing, Ethanol by Fermentation production) for VOC speciation as was used for corn ethanol plants. For the future year, PFC and the cellulosic sources were integrated EBAFM (i.e. used E-profiles) because ethanol was present in those inventories.

3.2.1.4 Future year speciation

The VOC speciation approach used for the future year case is customized to account for the impact of fuel changes. These changes affect the onroad, nonroad, and parts of the nonpt and ptnonipm sectors.

Speciation profiles for VOC in the nonroad sector account for the changes in ethanol content of fuels across years. A description of the actual fuel formulations for 2011 can be found in the 2011NEIv2 TSD, and for 2017 and 2025 see Section 4.3. For 2011, EPA used "COMBO" profiles to model combinations of profiles for E0 and E10 fuel use. For 2017 and 2025, EPA assumed E10 fuel use for all nonroad gasoline processes.

The speciation changes from fuels in the nonpt sector are for PFCs and fuel distribution operations associated with the BTP distribution. For these sources, ethanol may be mixed into the fuels, in which case speciation would change across years. The speciation changes from fuels in the ptnonipm sector include BTP distribution operations inventoried as point sources. RBT fuel distribution and BPS speciation does not change across the modeling cases because this is considered upstream from the introduction of ethanol into the fuel. For PFCs, ethanol was present in the future inventories and therefore

[16] The sources were accidentally not included in the list of no-integrated sources/counties. At the time of the modeling, EPA only had no-integrate WRAP profiles (VOC); therefore the incorrectly assigned integrated sources (NONHAPVOC) defaulted to the national integrated profiles for oil and gas. This impacted np_oilgas but not pt_oilgas.

EBAFM profiles were used to integrate ethanol in the future year speciation. The mapping of fuel distribution SCCs to PFC, BTP, BPS, and RBT emissions categories can be found in Appendix B.

Table 3-10 summarizes the different profiles utilized for the fuel-related sources in each of the sectors for 2011 and the future year cases. This table indicates when "E-profiles" were used instead of BAFM integrated profiles. The term "COMBO" indicates that a combination of the profiles listed was used to speciate that subcategory using the GSPRO_COMBO file. Although some of the component profiles are the same between 2017 and 2025, for example "nonpt, BTP", the proportion of each profile within the GSPRO_COMBO differs between the two future years.

Table 3-10. Select VOC profiles 2011 vs 2017 vs 2025

sector	Sub-category	2011		2017		2025	
nonroad	gasoline exhaust	COMBO 8750a 8751a	 Pre-Tier 2 E0 exhaust Pre-Tier 2 E10 exhaust	8751a	Pre-Tier 2 E10 exhaust	8751a	Pre-Tier 2 E10 exhaust
nonroad	gasoline evap-orative	COMBO 8753 8754	 E0 evap E10 evap	8754	E10 evap	8754	E10 evap
nonroad	gasoline refueling	COMBO 8869 8870	 E0 Headspace E10 Headspace	8870	E10 Headspace	8870	E10 Headspace
nonroad	diesel exhaust	8774	Pre-2007 MY HDD exhaust	8774	Pre-2007 MY HDD exhaust	8774	Pre-2007 MY HDD exhaust
nonroad	diesel evap-orative	4547	Diesel Headspace	4547	Diesel Headspace	4547	Diesel Headspace
nonroad	diesel refueling	4547	Diesel Headspace	4547	Diesel Headspace	4547	Diesel Headspace
nonpt/ ptnonipm	PFC	COMBO 8869 8870	 E0 Headspace E10 Headspace	8870E	E10 Headspace	8870E	E10 Headspace
nonpt/ ptnonipm	BTP	COMBO 8869 8870	 E0 Headspace E10 Headspace	COMBO 8870 8871 8934	 E10 Headspace E15 Headspace E85 Evap	COMBO 8870 8871 8934	 E10 Headspace E15 Headspace E85 Evap

sector	Sub-category	2011		2017		2025	
nonpt/ ptnonipm	BPS/RBT	8869	E0 Headspace	8869	E0 Headspace	8869	E0 Headspace

The speciation of onroad VOC occurs within MOVES. MOVES takes into account fuel type and properties, emission standards as they affect different vehicle types and model years, and specific emission processes. A description of the actual fuel formulations for 2011 can be found in the 2011NEIv2 TSD; for 2017 and 2025 see Section 4.3. Table 3-11 describes all of the M-profiles available to MOVES depending on the model year range, MOVES process (processID), fuel sub-type (fuelSubTypeID), and regulatory class (regClassID). Table 3-12 to Table 3-14 describe the meaning of these MOVES codes. For a specific representative county and future year, there will be a different mix of these profiles. For example, for HD diesel exhaust, the emissions will use a combination of profiles 8774M and 8775M depending on the proportion of HD vehicles that are pre-2007 model years (MY) in that particular county. As that county is projected farther into the future, the proportion of pre-2007 MY vehicles will decrease. A second example, for gasoline exhaust (not including E-85), the emissions will use a combination of profiles 8756M, 8757M, 8758M, 8750aM, and 8751aM. Each representative county has a different mix of these key properties and therefore has a unique combination of the specific M-profiles.

Table 3-11. Onroad M-profiles

Profile	Profile Description	Model Year range	processID	fuelSubTypeID	regClassID
1001M	CNG Exhaust	1940-2050	1,2,15,16	30	48
4547M	Diesel Headspace	1940-2050	11	20,21,22	0
4547M	Diesel Headspace	1940-2050	12,13,18,19	20,21,22	10,20,30,40,41, 42,46,47,48
8753M	E0 Evap	1940-2050	12,13,19	10	10,20,30,40,41,42, 46,47,48
8754M	E10 Evap	1940-2050	12,13,19	12,13,14	10,20,30,40,41, 42,46,47,48
8756M	Tier 2 E0 Exhaust	2001-2050	1,2,15,16	10	20,30
8757M	Tier 2 E10 Exhaust	2001-2050	1,2,15,16	12,13,14	20,30
8758M	Tier 2 E15 Exhaust	1940-2050	1,2,15,16	15,18	10,20,30,40,41, 42,46,47,48
8766M	E0 evap permeation	1940-2050	11	10	0
8769M	E10 evap permeation	1940-2050	11	12,13,14	0
8770M	E15 evap permeation	1940-2050	11	15,18	0
8774M	Pre-2007 MY HDD exhaust	1940-2006	1,2,15,16,17,9 0	20,21,22	40,41,42,46,47,48
8774M	Pre-2007 MY HDD exhaust	1940-2050	91	20,21,22	46,47
8774M	Pre-2007 MY HDD exhaust	1940-2006	1,2,15,16	20,21,22	20,30
8775M	2007+ MY HDD exhaust	2007-2050	1,2,15,16	20,21,22	20,30
8775M	2007+ MY HDD exhaust	2007-2050	1,2,15,16,17,9 0	20,21,22	40,41,42,46,47,48
8855M	Tier 2 E85 Exhaust	1940-2050	1,2,15,16	50,51,52	10,20,30,40,41, 42,46,47,48

Profile	Profile Description	Model Year range	processID	fuelSubTypeID	regClassID
8869M	E0 Headspace	1940-2050	18	10	10,20,30,40,41, 42,46,47,48
8870M	E10 Headspace	1940-2050	18	12,13,14	10,20,30,40,41, 42,46,47,48
8871M	E15 Headspace	1940-2050	18	15,18	10,20,30,40,41, 42,46,47,48
8872M	E15 Evap	1940-2050	12,13,19	15,18	10,20,30,40,41, 42,46,47,48
8934M	E85 Evap	1940-2050	11	50,51,52	0
8934M	E85 Evap	1940-2050	12,13,18,19	50,51,52	10,20,30,40,41, 42,46,47,48
8750aM	Pre-Tier 2 E0 exhaust	1940-2000	1,2,15,16	10	20,30
8750aM	Pre-Tier 2 E0 exhaust	1940-2050	1,2,15,16	10	10,40,41,42,46,47,48
8751aM	Pre-Tier 2 E10 exhaust	1940-2000	1,2,15,16	11,12,13,14	20,30
8751aM	Pre-Tier 2 E10 exhaust	1940-2050	1,2,15,16	11,12,13,14,15,1 8	10,40,41,42,46,47,48

Table 3-12. MOVES Process IDs

Process ID	Process Name
1	Running Exhaust
2	Start Exhaust
11	Evap Permeation
12	Evap Fuel Vapor Venting
13	Evap Fuel Leaks
15	Crankcase Running Exhaust
16	Crankcase Start Exhaust
17	Crankcase Extended Idle Exhaust
18	Refueling Displacement Vapor Loss
19	Refueling Spillage Loss
20	Evap Tank Permeation
21	Evap Hose Permeation
22	Evap RecMar Neck Hose Permeation
23	Evap RecMar Supply/Ret Hose Permeation
24	Evap RecMar Vent Hose Permeation
30	Diurnal Fuel Vapor Venting
31	HotSoak Fuel Vapor Venting
32	RunningLoss Fuel Vapor Venting
40	Nonroad
90	Extended Idle Exhaust
91	Auxiliary Power Exhaust

Table 3-13. MOVES Fuel subtype IDs

Fuel Subtype ID	Fuel Subtype Descriptions
10	Conventional Gasoline
11	Reformulated Gasoline (RFG)
12	Gasohol (E10)
13	Gasohol (E8)
14	Gasohol (E5)
15	Gasohol (E15)
18	Ethanol (E20)
20	Conventional Diesel Fuel
21	Biodiesel (BD20)
22	Fischer-Tropsch Diesel (FTD100)
30	Compressed Natural Gas (CNG)
50	Ethanol
51	Ethanol (E85)
52	Ethanol (E70)

Table 3-14. MOVES Regclass IDs

Reg. Class ID	Regulatory Class Description
0	Doesn't Matter
10	Motorcycles
20	Light Duty Vehicles
30	Light Duty Trucks
40	Class 2b Trucks with 2 Axles and 4 Tires (8,500 lbs < GVWR <= 10,000 lbs)
41	Class 2b Trucks with 2 Axles and at least 6 Tires or Class 3 Trucks (8,500 lbs < GVWR <= 14,000 lbs)
42	Class 4 and 5 Trucks (14,000 lbs < GVWR <= 19,500 lbs)
46	Class 6 and 7 Trucks (19,500 lbs < GVWR <= 33,000 lbs)
47	Class 8a and 8b Trucks (GVWR > 33,000 lbs)
48	Urban Bus (see CFR Sec 86.091_2)

3.2.2 PM speciation

In addition to VOC profiles, the SPECIATE database also contains the $PM_{2.5}$ speciated into both individual chemical compounds (e.g., zinc, potassium, manganese, lead), and into the "simplified" $PM_{2.5}$ components used in the air quality model. We speciated $PM_{2.5}$ into the AE6 species associated with CMAQ 5.0.1 and later versions. While provided in the platform, they are not used in CAM_X but rather converted to the $PM_{2.5}$ species based on the cmaq2camx file presented in Table 3-4.
Table 3-15 shows the mapping of AE5 and AE6 for historical reference. The majority of the 2011 platform PM profiles come from the 911XX series which include updated AE6 speciation[17]. The 2011eh_cb6v2, 2017eh_cb6v2, and 2025eh_cb6v2 state-sector totals workbooks include state totals of the PM emissions for each state for the sectors that include PM.

[17] The exceptions are 5674 (Marine Vessel – Marine Engine – Heavy Fuel Oil) used for c3marine and 92018 (Draft Cigarette Smoke – Simplified) used in nonpt.

Table 3-15. PM model species: AE5 versus AE6

Species name	Species description	AE5	AE6
POC	organic carbon	Y	Y
PEC	elemental carbon	Y	Y
PSO4	Sulfate	Y	Y
PNO3	Nitrate	Y	Y
PMFINE	unspeciated $PM_{2.5}$	Y	N
PNH4	Ammonium	N	Y
PNCOM	non-carbon organic matter	N	Y
PFE	Iron	N	Y
PAL	Aluminum	N	Y
PSI	Silica	N	Y
PTI	Titanium	N	Y
PCA	Calcium	N	Y
PMG	Magnesium	N	Y
PK	potassium	N	Y
PMN	Manganese	N	Y
PNA	Sodium	N	Y
PCL	Chloride	N	Y
PH2O	Water	N	Y
PMOTHR	$PM_{2.5}$ not in other AE6 species	N	Y

For the onroad sector, for all processes except brake and tire wear, PM speciation occurs within MOVES itself, not within SMOKE (similar to the VOC speciation described above). The advantage of using MOVES to speciate PM is that during the internal calculation of MOVES, the model has complete information on the characteristics of the fleet and fuels (e.g. model year, sulfur content, process, etc.) to accurately match to specific profiles. This means that MOVES produces EF tables that include total PM (e.g. PM_{10} and $PM_{2.5}$) and speciated PM (e.g. PEC, PFE, etc). SMOKE essentially calculates the PM components by using the appropriate EF without further speciation[18]. For onroad brake and tire wear, the PM is speciated in the *moves2smk* postprocessor that prepares the emission factors for processing in SMOKE. The formulas for this are based on the standard speciation factors that would otherwise be used in SMOKE via the profiles 91134 for brake wear and 91150 for tire wear:

```
POC = 0.4715 * PM25TIRE + 0.107 * PM25BRAKE
PEC = 0.22 * PM25TIRE + 0.0261 * PM25BRAKE
PNO3 = 0.0015 * PM25TIRE + 0.0016 * PM25BRAKE
PSO4 = 0.0311 * PM25TIRE + 0.0334 * PM25BRAKE
PNH4 = 0.00019 * PM25TIRE + 0.00003 * PM25BRAKE
PNCOM = 0.1886 * PM25TIRE + 0.0428 * PM25BRAKE
```

For California onroad emissions, adjustment factors were applied to SMOKE-MOVES to produce California adjusted model-ready files (see Section 2.3.1 for details). California did not supply speciated

[18] Unlike previous platforms, the PM components (e.g. POC) are now consistently defined between MOVES2014 and CMAQ. For more details on the use of model-ready EF, see the SMOKE 3.6.5 documentation: https://www.cmascenter.org/smoke/documentation/3.6.5/html/

PM, therefore the adjustment factors applied to PM2.5 were also applied to the speciated PM components. By applying the ratios through SMOKE-MOVES, the CARB inventories are essentially speciated to match EPA estimated speciation.

3.2.3 NO_X speciation

NO_X can be speciated into NO, NO2, and/or HONO. For the non-mobile sources, EPA used a single profile "NHONO" to split NO_X into NO and NO_2. For the mobile sources except for onroad (including nonroad, c1c2rail, c3marine, othon sectors) and for specific SCCs in othar and ptnonipm, the profile "HONO" splits NO_X into NO, NO_2, and HONO. Table 3-16 gives the split factor for these two profiles. The onroad sector does not use the "HONO" profile to speciate NO_X. MOVES2014 produces speciated NO, NO_2, and HONO by source, including emission factors for these species in the emission factor tables used by SMOKE-MOVES. Within MOVES, the HONO fraction is a constant 0.008 of NO_X. The NO fraction varies by heavy duty versus light duty, fuel type, and model year. The NO_2 fraction = 1 – NO – HONO. For more details on the NO_X fractions within MOVES, see http://www.epa.gov/otaq/models/moves/documents/420r12022.pdf.

Table 3-16. NO_X speciation profiles

Profile	pollutant	species	split factor
HONO	NOX	NO2	0.092
HONO	NOX	NO	0.9
HONO	NOX	HONO	0.008
NHONO	NOX	NO2	0.1
NHONO	NOX	NO	0.9

3.3 Temporal Allocation

Temporal allocation (i.e., temporalization) is the process of distributing aggregated emissions to a finer temporal resolution, thereby converting annual emissions to hourly emissions. While the total emissions are important, the timing of the occurrence of emissions is also essential for accurately simulating ozone, PM, and other pollutant concentrations in the atmosphere. Many emissions inventories are annual or monthly in nature. Temporalization takes these aggregated emissions and if needed distributes them to the month, and then distributes the monthly emissions to the day and the daily emissions to the hours of each day. This process is typically done by applying temporal profiles to the inventories in this order: monthly, day of the week, and diurnal. A summary of emissions by temporal profile and sector for the 2011eh case is available from ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/reports/2011eh_emissions_by_temporal_profile.xlsx.

In SMOKE 3.6.5 and in the 2011v6.2 platform, more readable and flexible files formats are used for temporal profiles and cross references. The profiles and cross references were initially created by converting the 2011v6.1 platform temporal profiles into the new formats, and then any specific adjustments for the 2011v6.2 platform were made. The temporal factors applied to the inventory are selected using some combination of country, state, county, SCC, and pollutant. Table 3-17 summarizes the temporal aspects of emissions modeling by comparing the key approaches used for temporal processing across the sectors. In the table, "Daily temporal approach" refers to the temporal approach for getting daily emissions from the inventory using the SMOKE Temporal program. The values given are the values of the SMOKE L_TYPE setting. The "Merge processing approach" refers to the days used to represent other days in the month for the merge step. If this is not "all", then the SMOKE merge step runs only for representative days, which could include holidays as indicated by the right-most column. The values given are those used for the SMOKE M_TYPE setting (see below for more information).

Table 3-17. Temporal settings used for the platform sectors in SMOKE

Platform sector short name	Inventory resolutions	Monthly profiles used?	Daily temporal approach	Merge processing approach	Process Holidays as separate days
afdust_adj	Annual	Yes	week	all	Yes
Ag	Annual	Yes	all	all	Yes
agfire	Monthly		week	week	Yes
beis	Hourly		n/a	all	Yes
c1c2rail	Annual	Yes	mwdss	mwdss	
c3marine	Annual	Yes	aveday	aveday	
nonpt	Annual	Yes	week	week	Yes
nonroad	Monthly		mwdss	mwdss	Yes
np_oilgas	Annual	yes	mwdss	mwdss	Yes
onroad	Annual & monthly[1]		all	all	Yes
onroad_ca_adj	Annual & monthly[1]		all	all	Yes
othar	Annual	yes	week	week	
othon	Annual	yes	week	week	
othpt	Annual	yes	mwdss	mwdss	
pt_oilgas	Annual	yes	mwdss	mwdss	Yes
ptegu	Daily & hourly		all	all	Yes
ptnonipm	Annual	yes	mwdss	mwdss	Yes
ptprescfire	Daily		all	all	Yes
ptwildfire	Daily		all	all	Yes
rwc	Annual	no	met-based	all	Yes

1. Note the annual and monthly "inventory" actually refers to the activity data (VMT and VPOP) for onroad. The actual emissions are computed on an hourly basis.

The following values are used in the table: The value "all" means that hourly emissions are computed for every day of the year and that emissions potentially have day-of-year variation. The value "week" means that hourly emissions computed for all days in one "representative" week, representing all weeks for each month. This means emissions have day-of-week variation, but not week-to-week variation within the month. The value "mwdss" means hourly emissions for one representative Monday, representative weekday (Tuesday through Friday), representative Saturday, and representative Sunday for each month. This means emissions have variation between Mondays, other weekdays, Saturdays and Sundays within the month, but not week-to-week variation within the month. The value "aveday" means hourly emissions computed for one representative day of each month, meaning emissions for all days within a month are the same. Special situations with respect to temporalization are described in the following subsections.

In addition to the resolution, temporal processing includes a ramp-up period for several days prior to January 1, 2011, which is intended to mitigate the effects of initial condition concentrations. The ramp-up period was 10 days (December 22-31, 2010). For most sectors, emissions from December 2011 were used to fill in surrogate emissions for the end of December 2010. In particular, December 2011 emissions (representative days) were used for December 2010. For biogenic emissions, December 2010 emissions were processed using 2010 meteorology.

3.3.1 Use of FF10 format for finer than annual emissions

The Flat File 2010 format (FF10) inventory format for SMOKE provides a more consolidated format for monthly, daily, and hourly emissions inventories than prior formats supported. Previously, processing monthly inventory data required the use of 12 separate inventory files. With the FF10 format, a single inventory file can contain emissions for all 12 months and the annual emissions in a single record. This helps simplify the management of numerous inventories. Similarly, daily and hourly FF10 inventories contain individual records with data for all days in a month and all hours in a day, respectively.

SMOKE prevents the application of temporal profiles on top of the "native" resolution of the inventory. For example, a monthly inventory should not have annual-to-month temporalization applied to it; rather, it should only have month-to-day and diurnal temporalization. This becomes particularly important when specific sectors have a mix of annual, monthly, daily, and/or hourly inventories. The flags that control temporalization for a mixed set of inventories are discussed in the SMOKE documentation. The modeling platform sectors that make use of monthly values in the FF10 files are agfire, nonroad, onroad, and ptegu.

3.3.2 Electric Generating Utility temporalization (ptegu)

3.3.2.1 Base year temporal allocation of EGUs

The 2011NEIv2 annual EGU emissions are allocated to hourly emissions using the following 3-step methodology: annual value to month, month to day, and day to hour. Several updates were made to EGU temporalization in the 2011v6.2 platform. First, the CEMS data were processed using a tool that reviewed the data quality flags that indicate the data were not measured. Unmeasured data can cause erroneously high values in the CEMS data. If the data were not measured at specific hours, and those values were found to be more the 3 times the annual mean for that unit, the data for those hours were replaced with annual mean values (Adelman, et al., 2012). These adjusted CEMS data were then used for the remainder of the temporalization process described below (see Figure 3-3 for an example). Another update in the 2011v6.2 platform was the incorporation of winter and summer seasons into the development of the diurnal profiles as opposed to using data for the entire year. Analysis of the hourly CEMS data revealed that there were different diurnal patterns in winter versus summer in many areas. Typically a single mid-day peak is visible in the summer, while there are morning and evening peaks in the winter as shown in Figure 3-4.

The temporal allocation procedure is differentiated by whether or not the source could be directly matched to a CEMS unit via ORIS facility code and boiler ID. Prior to temporal allocation, as many sources as possible were matched to CEMS data via ORIS facility code and boiler ID. Units were considered matches if the FIPS state/county code matched, the facility name was similar, and the NOx and SO_2 emissions were similar. EIS stores a base set of previously matched units via alternate facility and unit IDs. Additions to these matches were made for the 2011v6.2 platform. For any units that are matched, the ORIS facility and boiler ID columns of the point FF10 inventory files are filled with the information on the rows for the corresponding NEI unit. Note that for units matched to CEMS data, annual totals of their emissions may be different than the annual values in 2011NEIv2 because the CEMS data actually replaces the inventory data for the seasons in which the CEMS are operating. If a CEMS-matched unit is determined to be a partial year reporter, as can happen for sources that run CEMS only in the summer, emissions totaling the difference between the annual emissions and the total CEMS emissions are allocated to the non-summer months.

Figure 3-3. Eliminating unmeasured spikes in CEMS data

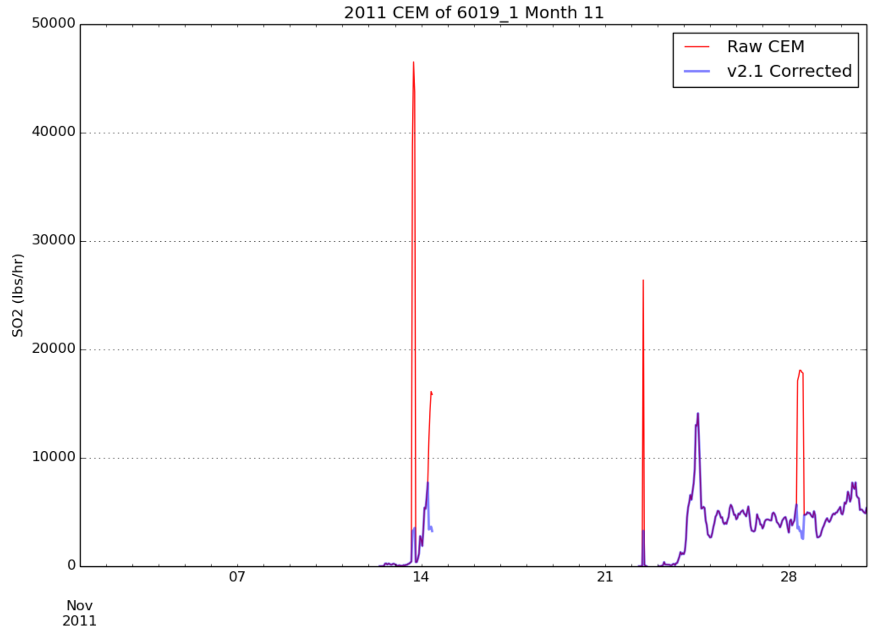
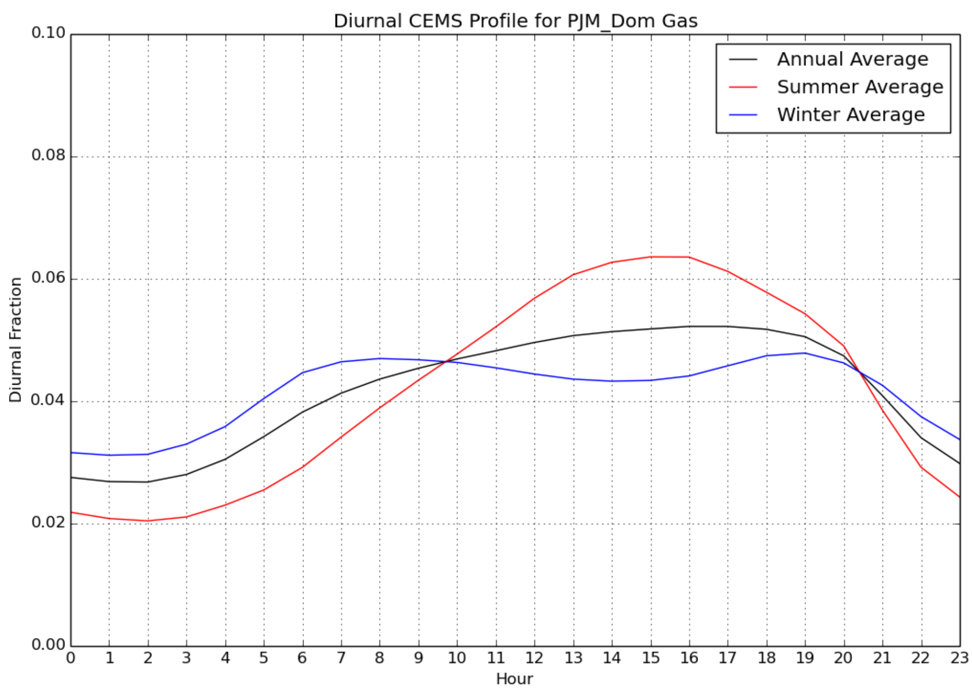
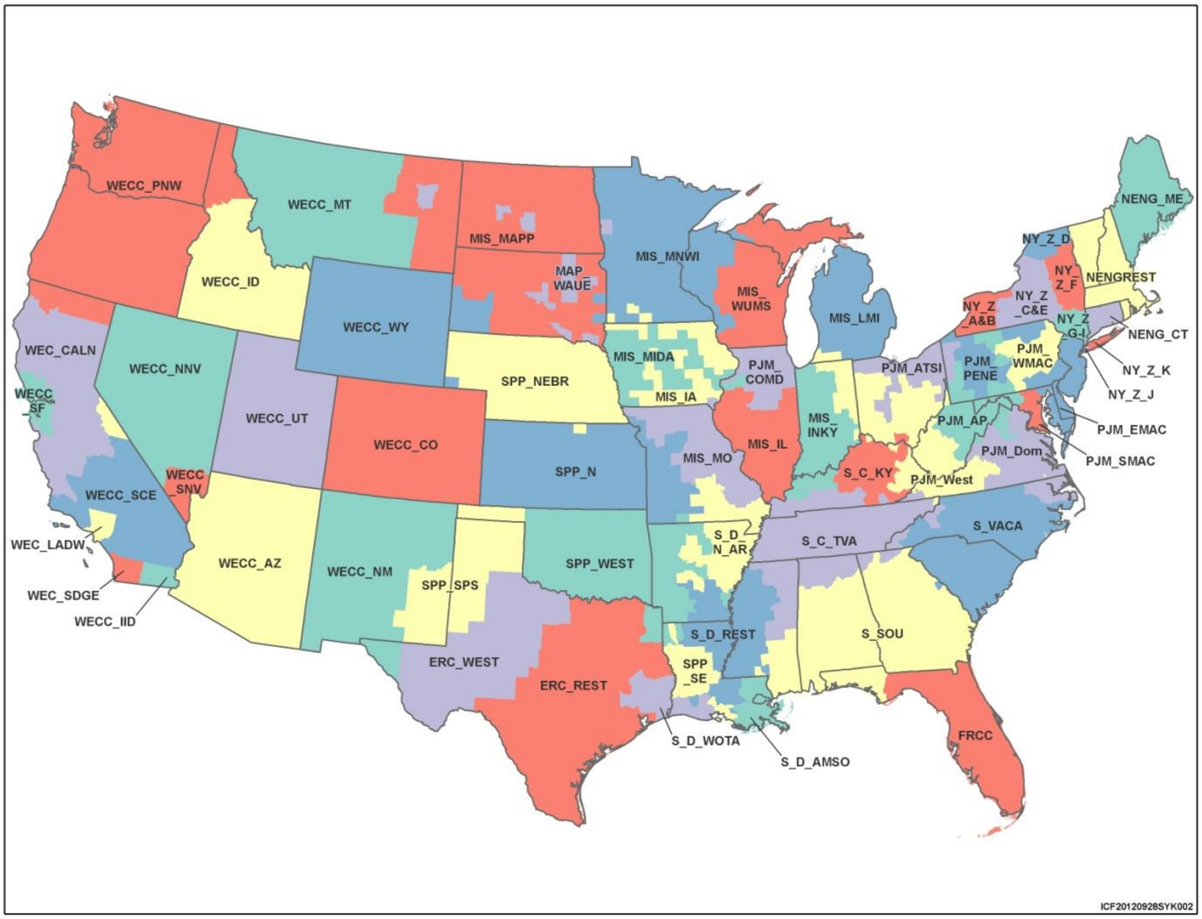


Figure 3-4. Seasonal diurnal profiles for EGU emissions in a Virginia Region



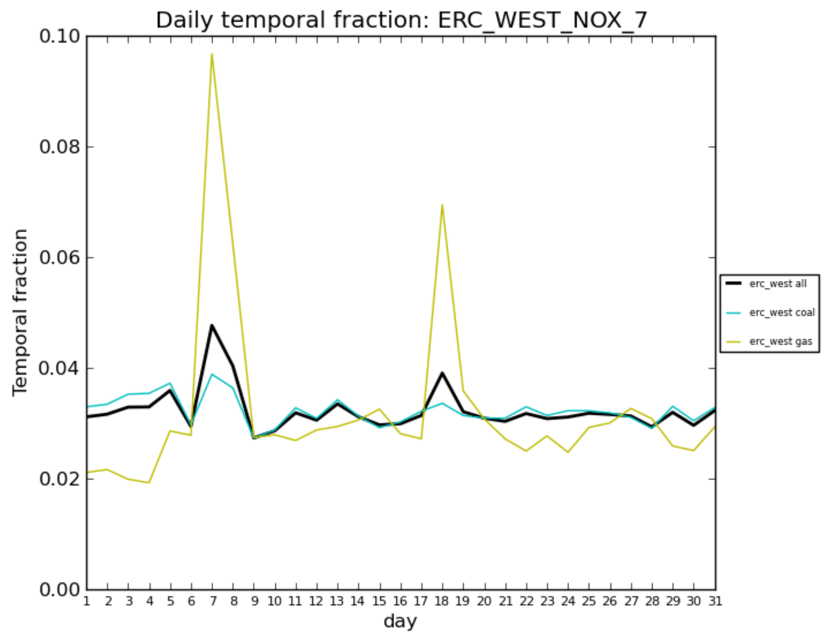
For sources not matched to CEMS units, the allocation of annual emissions to months and then days are done outside of SMOKE and then daily emissions are output to day-specific inventory files. For these units, the allocation of the inventory annual emissions to months is done using average fuel-specific season-to-month factors generated for each of the 64 IPM regions shown in Figure 3-5. These factors are based 2011 CEMS data only. In each region, separate factors were developed for the fuels: coal, natural gas, and “other”, where the types of fuels included in “other” vary by region. Separate profiles were computed for NO_x, SO_2, and heat input. An overall composite profile was also computed and was used when there were no CEMS units with the specified fuel in the region containing the unit. For both CEMS-matched units and units not matched to CEMS, NO_x and SO_2 CEMS data are used to allocate NO_x and SO_2 emissions to daily emissions, respectively, while heat input data are used to allocate emissions of all other pollutants.

Figure 3-5. IPM Regions for EPA Base Case v5.14



Daily temporal allocation of units matched to CEMS was performed using a procedure similar to the approach to allocate emissions to months in that the CEMS data replaces the inventory data for each pollutant. For units without CEMS data, emissions were allocated from month to day using IPM-region and fuel-specific average month-to-day factors based on the 2011 CEMS data. Separate month-to-day allocation factors were computed for each month of the year using heat input for the fuels coal, natural gas, and “other” in each region. For both CEMS and non-CEMS matched units, NO_x and SO_2 CEMS data are used to allocate NO_x and SO_2 emissions, while CEMS heat input data are used to allocate all other pollutants. An example of month-to-day profiles for gas, coal, and an overall composite for a region in western Texas is shown in Figure 3-6.

Figure 3-6. Month-to-day profiles for different fuels in a West Texas Region



For units matched to CEMS data, hourly emissions use the hourly CEMS values for NOx and SO2, while other pollutants are allocated according to heat input values. For units not matched to CEMS data, temporal profiles from days to hours are computed based on the season-, region- and fuel-specific average day-to-hour factors derived from the CEMS data for those fuels and regions using the appropriate subset of data. For the unmatched units, CEMS heat input data are used to allocate *all* pollutants (including NO_x and SO_2) because the heat input data was generally found to be more complete than the pollutant-specific data. SMOKE then allocates the daily emissions data to hours using the temporal profiles obtained from the CEMS data for the analysis base year (i.e., 2011 in this case).

3.3.2.2 Future year temporal allocation of EGUs

IPM provides unit-level emission projections of average winter (representing October through April) and average summer (representing May through September) values. To use these data in an air quality model, the unit-level data must first be converted to into hourly values through the temporal allocation process. These annualized emissions are allocated to hourly emissions using a 3-step methodology: annualized summer/winter value to month, month to day, and day to hour. The first two steps are done outside of SMOKE and the third step is done by SMOKE using daily emissions files created from the first two steps. The approach in the 2011v6.2 platform maximizes the use of the CEMS data from the air quality analysis year (e.g., 2011).

The goal of the temporal allocation process is to reflect the variability in the unit-level emissions that can impact air quality over seasonal, daily, or hourly time scales, in a manner compatible with incorporating future-year emission projections into future-year air quality modeling. The temporal allocation process is applied to the seasonal emission projections obtained from an IPM modeling scenario. IPM represents two seasons: summer (May through September) and winter (October through April). IPM unit-level parsed files contain seasonal and annual totals of SO_2, NO_X, CO_2, Hg, and HCl emissions (computed directly within IPM), while $PM_{2.5}$, PM_{10}, VOC, NH_3, and CO emissions are calculated using a postprocessing tool[19] based on each unit's projected fuel use and configuration, coupled with pollutant-specific emission factors.[20] When calculating PM emissions, the post-processing tool utilizes specific data assumptions such as the ash and sulfur content of the coal projected to be used at the unit. The tool creates a Flat File (in a comma-separated value or .csv file format) that provides the starting point for developing emission inputs to an air quality model.

The resulting Flat File contains all of the endogenously-determined and post-calculated unit-level emissions combined with stack parameters (i.e., stack location and other characteristics consistent with information found in the National Emissions Inventory (NEI)). A cross reference is used to map the units in NEEDS to the stack parameter and facility, unit, release point, and process identifiers used in the National Emissions Inventory (NEI). The cross reference also maps sources to the hourly Continuous Emissions Monitoring System (CEMS) data used to temporally allocate the emissions in the base year air quality modeling. This cross reference has been updated for the v5.14 platform through collaboration with EPA, regional planning organizations, and states and is also used to determine which emissions sources in the NEI sources have future year emissions predicted by IPM, and is available at ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/reports/ipm_to_flat_file_xref_2011NEIv2_IPM5.14_20150113.xlsx.

Emissions from point sources for which emissions are not predicted by IPM are carried forward into the future year modeling platform using other projection methods. Therefore, if the NEI and IPM sources are not properly matched, double-counting could result because the future year emissions output from IPM in the future year are treated as a full replacement for the base year emissions, although only for the emissions processes estimated by IPM. Note: any feedback to EPA on future updates to the cross reference should be provided based on this updated version that will be used with later versions of IPM: ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/reports/ipm_to_flat_file_xref_2011NEIv2_Updated_20150710.xlsx.

In order to support the temporal allocation process and other requirements of modeling point sources, the Flat File output from the IPM postprocessor specifies annual and monthly emissions for each stack; however, since IPM projections are only modeled for two seasons comprising multiple months each, monthly emissions cannot be precisely specified in the Flat File. Instead, the monthly values in the Flat File output from the postprocessor are computed by multiplying the average summer day and average winter day emissions predicted by IPM by the number of days in the respective month. In summary, the monthly emission values shown in the Flat File are not intended to represent an actual month-to-month emission pattern; instead, they are interim values that have translated IPM's seasonal projections into month-level data that serve as a starting point for the temporal allocation process.

The monthly emissions within the Flat File undergo a multi-step temporal allocation process to yield the hourly emission values at each unit, as is needed for air quality modeling: summer/winter value to month, month to day, and day to hour. For sources not matched to unit-specific CEMS data, the first two steps are done outside of SMOKE and the third step to get to hourly values is done by SMOKE using daily the emissions files created from the first two steps. For each of these three temporal allocation steps, NO_x and SO_2 CEMS data are used to allocate NO_x and SO_2 emissions, while CEMS heat input data are used to allocate all other pollutants. The approach defined here gives priority to temporalization based on the base year CEMS data to the maximum extent possible.

[19] Documentation of this tool can be found at www.epa.gov/powersectormodeling

[20] For more information on EPA emission factors see http://www.epa.gov/ttnchie1/ap42/

Prior to using the 2011 CEMS data to develop monthly, daily, and hourly profiles, the CEMS data were processed through a tool that found data quality flags that indicated the data were measured (see Section 3.3.2.1). These adjusted CEMS data were used to compute the monthly, daily, and hourly profiles described below.

For units in NEEDS that are matched to units in the National Emission Inventory (NEI), and for which CEMS data are available, the emissions are temporalized based on the CEMS data for that unit and pollutant. For units that are not matched to the NEI or for which CEMS data are not available, the allocation of the IPM seasonal emissions to months is done using average fuel-specific season-to-month factors generated for each of the 64 IPM regions shown in Figure 3-5. These factors are based on a single year of CEMS data for the modeling base year associated with the air quality modeling analysis being performed, such as 2011. Note that IPM uses load data (reflecting the shape of demand) corresponding to the load in each IPM region that occurred in the base year of the air quality modeling analysis, such as 2011. The fuels used for creating the profiles for a region are coal, natural gas, and other, where the other fuels used include oil and wood and vary by region. Separate profiles are computed for NO_x, SO_2, and heat input. An overall composite profile across all fuels is also computed and can be used in the event that a region has too few units of a fuel type to make a reasonable average profile, or in the case when a unit changes fuels between the base and future year and there were previously no units with that fuel in the region containing the unit.

The monthly emission values in the Flat File are first reallocated across the months in that season to align the month-to-month emission pattern at each stack with historic seasonal emission patterns.[21] While this reallocation affects the monthly pattern of each unit's future-year seasonal emissions, the seasonal totals are held equal to the IPM projection for that unit and season. Second, the reallocated monthly emission values at each stack are disaggregated down to the daily level consistent with historic daily emission patterns in the given month at the given stack using separate profiles for NO_x, SO_2, and heat input. This process helps to capture the influence of meteorological episodes that cause electricity demand to vary from day-to-day, as well as weekday-weekend effects that change demand during the course of a given week. Third, this data set of emission values for each day of the year at each unit is input into SMOKE, which uses temporal profiles to disaggregate the daily values into specific values for each hour of the year.

For units without or not matched to CEMS data, or for which the CEMS data are found to be unsuitable for use in the future year, emissions are allocated from month to day using IPM-region and fuel-specific average month-to-day factors based on CEMS data from the base year of the air quality modeling analysis. These instances include units that did not operate in the base year or for which it may not have been possible to match the unit in NEEDS with a specific unit in the NEI. EPA uses average emission profiles for some units with CEMS data in the base year when one of the following cases is true: (1) units are projected to have substantially increased emissions in the future year compared to its emissions in the base (historic) year[22]; (2) CEMS data are only available for a limited number of hours in that base year; (3) units change fuels in the future year; (4) the unit is new in the future year; or (5) units experienced atypical conditions during the base year, such as lengthy downtimes for maintenance or installation of

[21] For example, the total emissions for a unit in May would not typically be the same as the total emissions for the same unit in July, even though May and July are both in the summer season and the number of days in those months is the same. This is because the weather changes over the course of each season, and thus the operating behavior of a specific unit can also vary throughout each season. Therefore, part of the temporal allocation process is intended to create month-specific emissions totals that reflect this intra-seasonal variation in unit operation and associated emissions.

[22] In such instances, EPA does not use that unit's CEMS data for temporal allocation in order to avoid assigning large increases in emissions over short time periods in the unit's hourly emission profile.

controls. The temporal profiles that map emissions from days to hours are computed based on the region and fuel-specific seasonal (i.e., winter and summer) average day-to-hour factors derived from the CEMS data for those fuels and regions using only heat input data for that season. Only heat input is used because it is the variable that is the most complete in the CEMS data. SMOKE uses these profiles to allocate the daily emissions data to hours.

The emissions from units for which unit-specific profiles are not deemed appropriate, and for units in the IPM outputs that are not specifically matched to units in the base year, are temporally allocated to hours reflecting patterns typical of the region in which the unit is located. Analysis of CEMS data for units in each of the 64 IPM regions revealed that there were differences in the temporal patterns of historic emission data that correlate with fuel type (e.g., coal, gas, and other), time of year, pollutant, season (i.e. winter versus summer) and region of the country. The correlation of the temporal pattern with fuel type is explained by the relationship of units' operating practices with the fuel burned. For example, coal units take longer to ramp up and ramp down than natural gas units, and some oil units are used only when electricity demand cannot otherwise be met. Geographically, the patterns were less dependent on state location than they were on IPM regional location. For temporal allocation of emissions at these units, Figure 3-6 provides an example of daily coal, gas, and composite profiles in one IPM region. EPA developed seasonal average emission profiles, each derived from base year CEMS data for each season across all units sharing both IPM region and fuel type.[23] Figure 3-4 provides an example of seasonal profiles that allocate daily emissions to hours in one IPM region. These average day-to-hour temporal profiles were also used for sources during seasons of the year for which there were no CEMS data available, but for which IPM predicted emissions in that season. This situation can occur for multiple reasons, including how the CEMS was run at each source in the base year.

For units that do have CEMS data in the base year and are matched to units in the IPM output, the base year CEMS data are scaled so that their seasonal emissions match the IPM-projected totals. In particular, the fraction of the unit's seasonal emissions in the base year is computed for each hour of the season, and then applied to the seasonal emissions in the future year. This is accomplished outside of SMOKE by creating data in the same format as CEMS data for NOx, SO2, and heat input. Any pollutants other than NOX and SO2 are temporalized within SMOKE using heat input as a surrogate. Distinct factors are used for the fuels coal, natural gas, and "other". This procedure yields future-year hourly data that have the same temporal pattern as the base year CEMS data while matching future-year seasonal total emissions for each stack to IPM's future-year projections (see example in Figure 3-7).

In cases when the emissions for a particular unit are projected to be substantially higher in the future year than in the base year, the proportional scaling method to match the emission patterns in the base year described above can yield emissions for a unit that are much higher than the historic maximum emissions for that unit. To address this issue for the 2017 case, the maximum measured emissions of NO_x and SO_2 in the period of 2011-2014 were computed. The temporalized emissions were then evaluated at each hour to determine whether they were above this cumulative maximum. The amount of "excess emissions" over the maximum was then computed. For units for which the "excess emissions" could be reallocated to other hours, those emissions were distributed evenly to hours that were below the maximum. Those hourly emissions were then reevaluated against the maximum, and the procedure of reallocating the excess emissions to other hours was repeated until all of the hours had emissions below the maximum, whenever possible (see example in Figure 3-8). Note: this reallocation technique is new in the 2011v6.2

[23] EPA also uses an overall composite profile across all fuels for each IPM region in instances where a unit is projected to burn a fuel for which EPA cannot construct an average emission profile (because there were no other units in that IPM region whose historic CEMS data represent emissions from burning that fuel).

platform and was only used in the 2017eh case, not in the 2025eh case, as it was developed after modeling for the 2025eh case was completed.

Figure 3-7. Future year emissions follow pattern of base year emissions

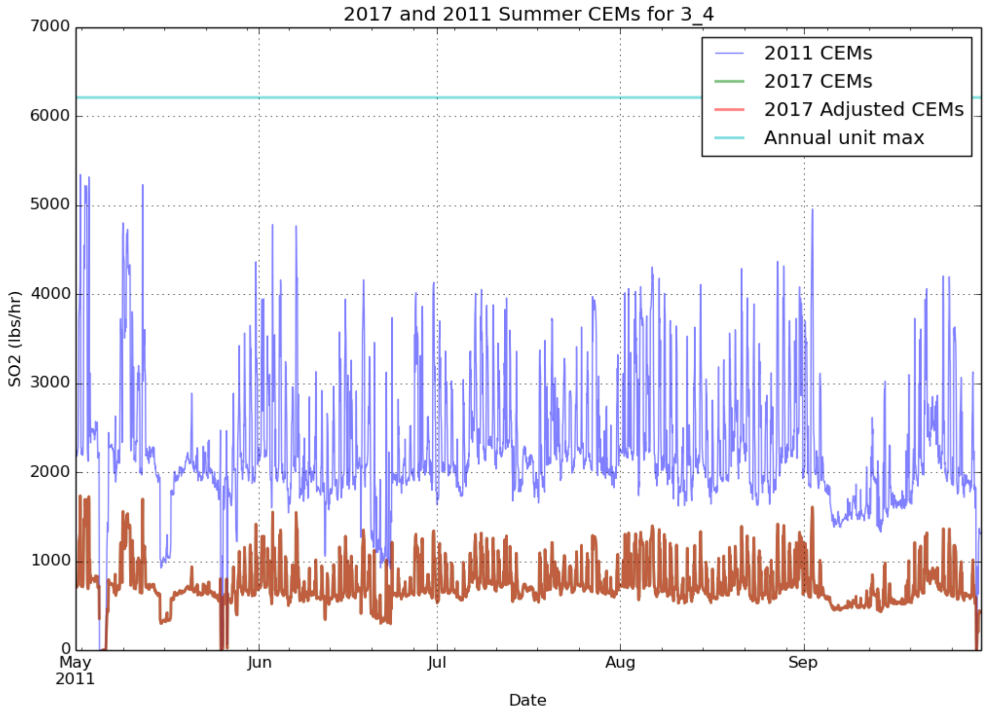
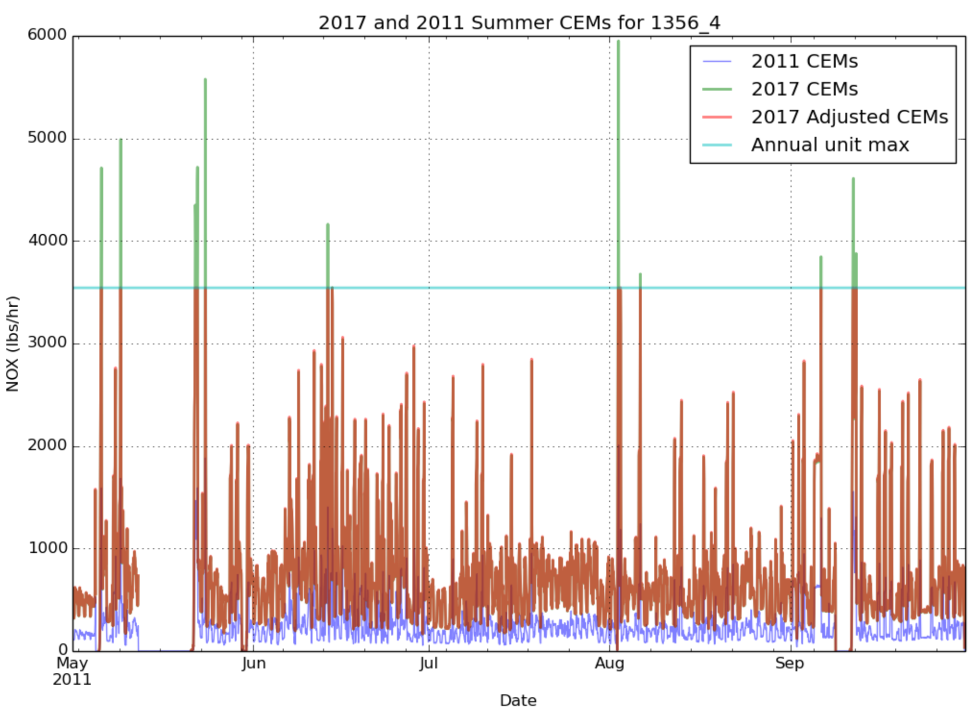


Figure 3-8. Excess emissions apportioned to hours less than maximum



Using the above approach, it was not always possible to reallocate excess emissions to hours below the historic maximum, such as when the total seasonal emissions of NOx or SO2 for a unit divided by the number of hours of operation are greater than the 2011-2014 maximum emissions level. For these units, the *regional* fuel-specific average profile was applied to all pollutants, including heat input, for that season (see example in Figure 3-9). An exception to this is if the fuel for that unit is not gas or coal. In that case, the composite (non-fuel-specific) profile was used for that unit. This is because many sources that used "other" fuel profiles had very irregular shapes due to a small number of sources in the region, and the allocated emissions frequently still exceeded the 2011-2014 maximum. Note that it was not possible for SMOKE to use regional profiles for some pollutants and adjusted CEMS data for other pollutants for the same unit / season, therefore all pollutants are assigned to regional profiles when regional profiles are needed. Also note that for some units, some hours still exceed the 2011-2014 annual maximum for the unit even after regional profiles were applied (see example in Figure 3-10).

For more information on the development of IPM emission estimates and the temporalization of those, see http://www.epa.gov/powersectormodeling/psmodel514.html, in particular the Air Quality Modeling Flat File Documentation and accompanying inputs.

Figure 3-9. Adjustment to Hours Less than Maximum not Possible, Regional Profile Applied

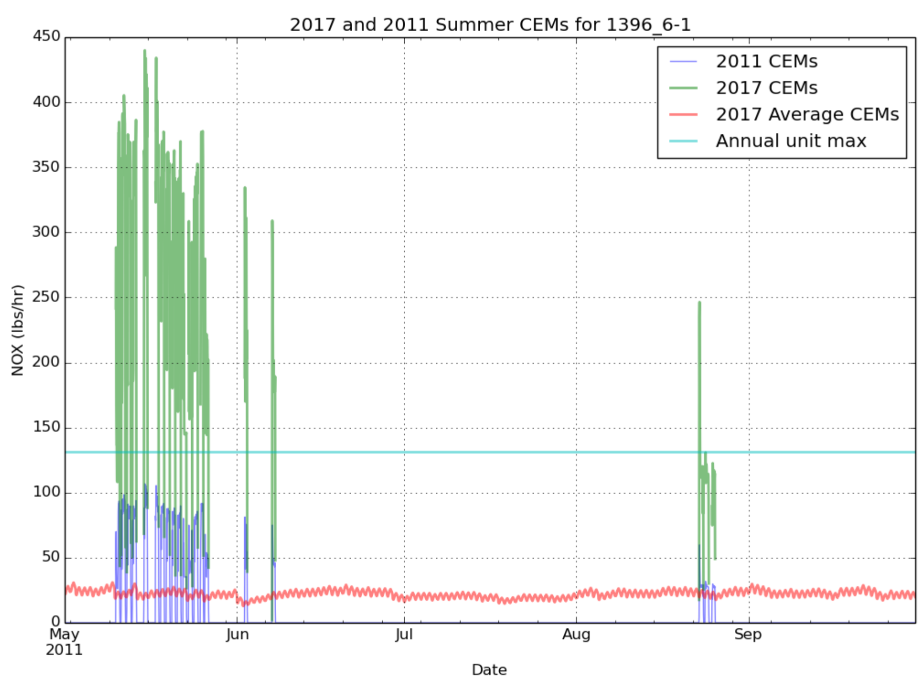
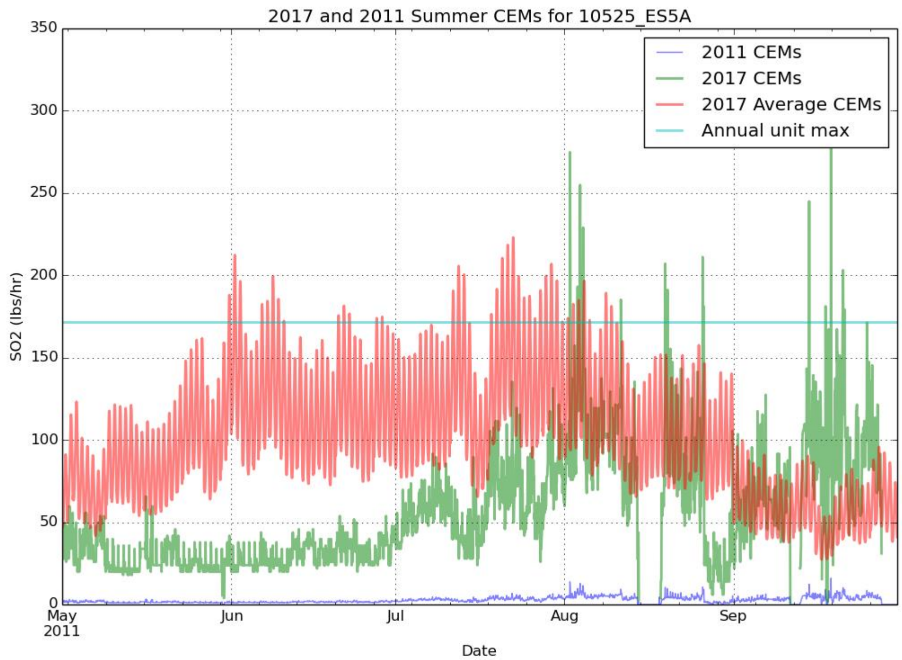


Figure 3-10. Regional Profile Applied, but Exceeds Maximum in Some Hours



3.3.3 Residential Wood Combustion Temporalization (rwc)

There are many factors that impact the timing of when emissions occur, and for some sectors this includes meteorology. The benefits of utilizing meteorology as method for temporalization are: (1) a meteorological dataset consistent with that used by the AQ model is available (e.g., outputs from WRF); (2) the meteorological model data are highly resolved in terms of spatial resolution; and (3) the meteorological variables vary at hourly resolution and can therefore be translated into hour-specific temporalization.

The SMOKE program GenTPRO provides a method for developing meteorology-based temporalization. Currently, the program can utilize three types of temporal algorithms: annual-to-day temporalization for residential wood combustion (RWC), month-to-hour temporalization for agricultural livestock ammonia, and a generic meteorology-based algorithm for other situations. For the 2011 platform, meteorological-based temporalization was used for portions of the rwc sector and for livestock within the ag sector.

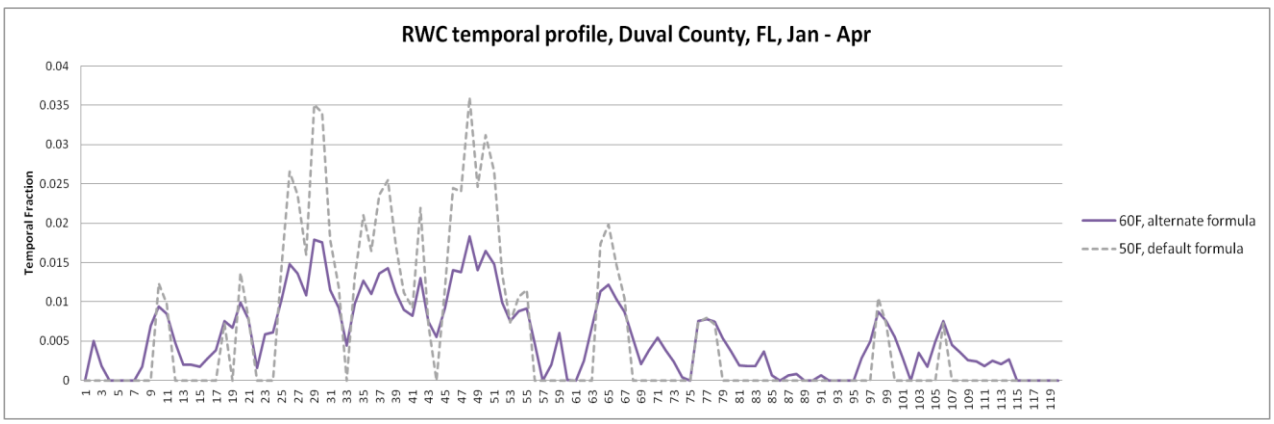
GenTPRO reads in gridded meteorological data (output from MCIP) along with spatial surrogates, and uses the specified algorithm to produce a new temporal profile that can be input into SMOKE. The meteorological variables and the resolution of the generated temporal profile (hourly, daily, etc.) depend on the selected algorithm and the run parameters. For more details on the development of these algorithms and running GenTPRO, see the GenTPRO documentation and the SMOKE documentation at http://www.cmascenter.org/smoke/documentation/3.1/GenTPRO_TechnicalSummary_Aug2012_Final.pdf and http://www.cmascenter.org/smoke/documentation/3.5.1/html/ch05s03s07.html, respectively.

In the 2011v6.2 platform and in SMOKE 3.6.5, the temporal profile format has been updated. GenTPRO now produces separate files including the monthly temporal profiles (ATPRO_MONTHLY) and day-of-month temporal profiles (ATPRO_DAILY), instead of a single ATPRO_DAILY with day-of-year temporal profiles as it did in SMOKE 3.5. The results are the same either way, so the temporal profiles themselves are effectively the same in 2011v6.2 as they were in 2011v6.0 since the meteorology is the same, but they are formatted differently.

For the RWC algorithm, GenTPRO uses the daily minimum temperature to determine the temporal allocation of emissions to days. GenTPRO was used to create an annual-to-day temporal profile for the RWC sources. These generated profiles distribute annual RWC emissions to the coldest days of the year. On days where the minimum temperature does not drop below a user-defined threshold, RWC emissions for most sources in the sector are zero. Conversely, the program temporally allocates the largest percentage of emissions to the coldest days. Similar to other temporal allocation profiles, the total annual emissions do not change, only the distribution of the emissions within the year is affected. The temperature threshold for rwc emissions was 50 ˚F for most of the country, and 60 ˚F for the following states: Alabama, Arizona, California, Florida, Georgia, Louisiana, Mississippi, South Carolina, and Texas.

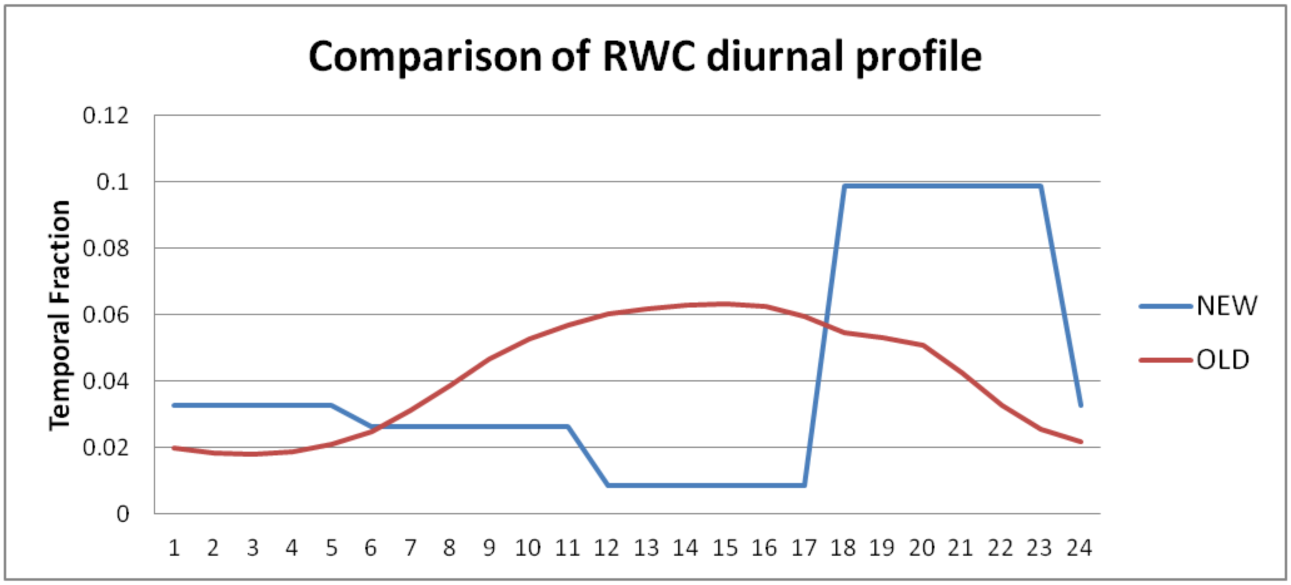
Figure 3-11 illustrates the impact of changing the temperature threshold for a warm climate county. The plot shows the temporal fraction by day for Duval County, Florida for the first four months of 2007. The default 50 ˚F threshold creates large spikes on a few days, while the 60 ˚F threshold dampens these spikes and distributes a small amount of emissions to the days that have a minimum temperature between 50 and 60 ˚F.

Figure 3-11. Example of RWC temporalization in 2007 using a 50 versus 60 ˚F threshold



The diurnal profile for used for most RWC sources (see Figure 3-12) places more of the RWC emissions in the morning and the evening when people are typically using these sources. This profile is based on a 2004 MANE-VU survey based temporal profiles (see http://www.marama.org/publications_folder/ResWoodCombustion/Final_report.pdf). This profile was created by averaging three indoor and three RWC outdoor temporal profiles from counties in Delaware and aggregating them into a single RWC diurnal profile. This new profile was compared to a concentration based analysis of aethalometer measurements in Rochester, NY (Wang *et al.* 2011) for various seasons and day of the week and found that the new RWC profile generally tracked the concentration based temporal patterns.

Figure 3-12. RWC diurnal temporal profile



The temporalization for "Outdoor Hydronic Heaters" (i.e.,"OHH", SCC=2104008610) and "Outdoor wood burning device, NEC (fire-pits, chimneas, etc.)" (i.e., "recreational RWC", SCC=21040087000) were updated because the meteorological-based temporalization used for the rest of the rwc sector did not agree with observations for how these appliances are used.

For OHH, the annual-to-month, day-of-week and diurnal profiles were modified based on information in the New York State Energy Research and Development Authority (NYSERDA) "Environmental, Energy Market, and Health Characterization of Wood-Fired Hydronic Heater Technologies, Final Report" (NYSERDA, 2012) as well as a Northeast States for Coordinated Air Use Management (NESCAUM) report "Assessment of Outdoor Wood-fired Boilers" (NESCAUM, 2006). A Minnesota 2008 Residential Fuelwood Assessment Survey of individual household responses (MDNR, 2008) provided additional annual-to-month, day-of-week and diurnal activity information for OHH as well as recreational RWC usage.

The diurnal profile for OHH, shown in Figure 3-13 is based on a conventional single-stage heat load unit burning red oak in Syracuse, New York. As shown in
Figure 3-14, the NESCAUM report describes how for individual units, OHH are highly variable day-to-day but that in the aggregate, these emissions have no day-of-week variation. In contrast, the day-of-week profile for recreational RWC follows a typical "recreational" profile with emissions peaked on weekends.

Annual-to-month temporalization for OHH as well as recreational RWC were computed from the MN DNR survey (MDNR, 2008) and are illustrated in Figure 3-15. OHH emissions still exhibit strong seasonal variability, but do not drop to zero because many units operate year round for water and pool heating. In contrast to all other RWC appliances, recreational RWC emissions are used far more frequently during the warm season.

Figure 3-13. Diurnal profile for OHH, based on heat load (BTU/hr)

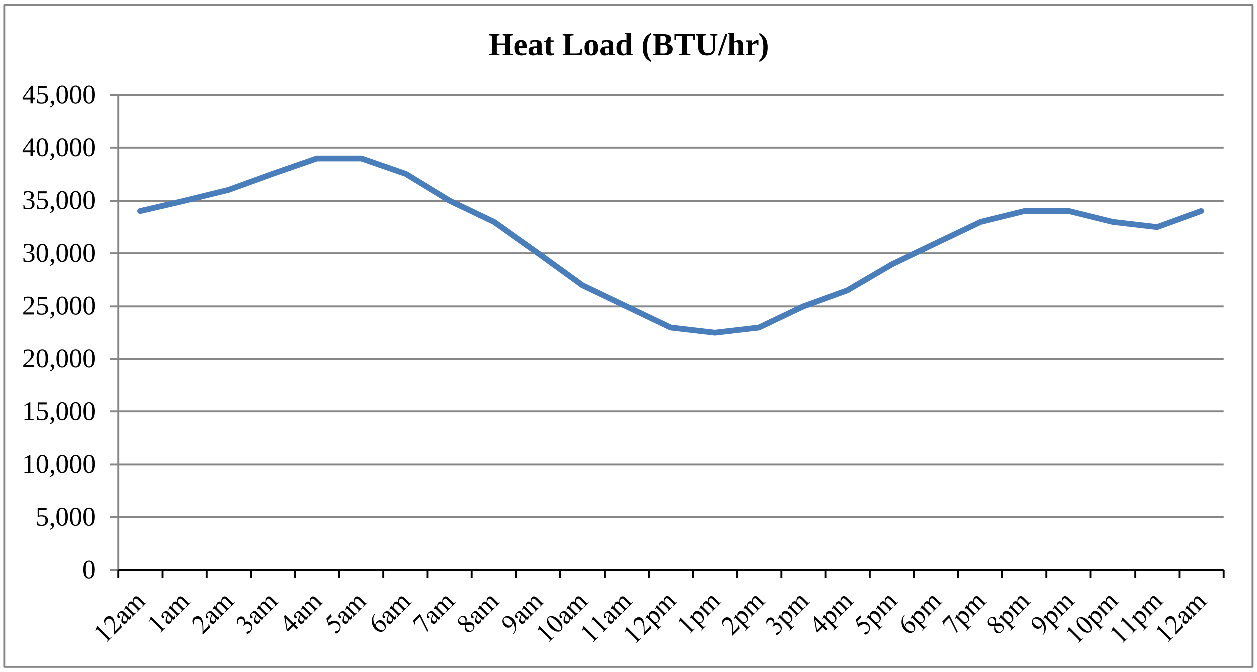


Figure 3-14. Day-of-week temporal profiles for OHH and Recreational RWC

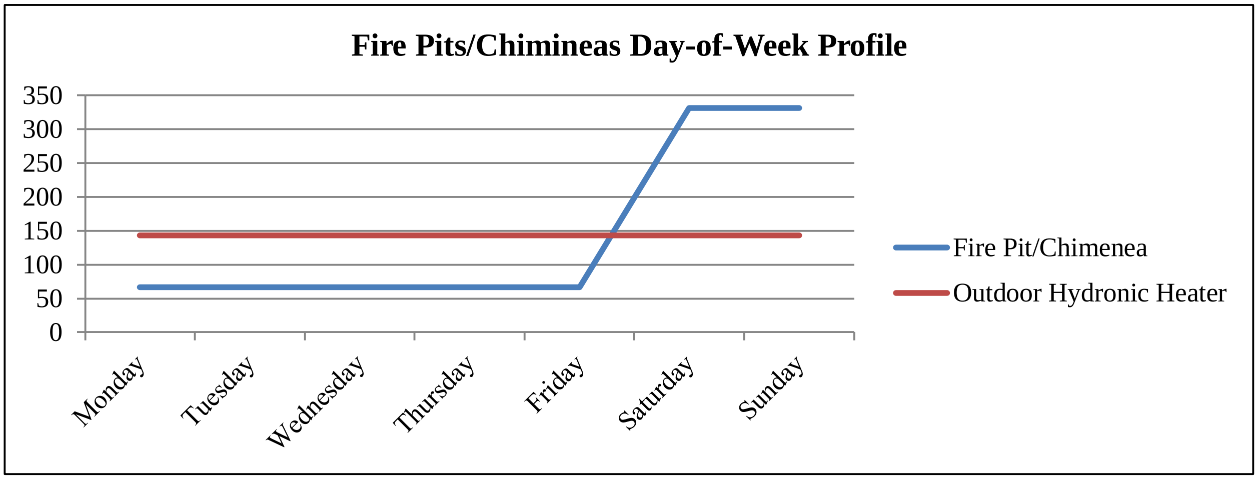
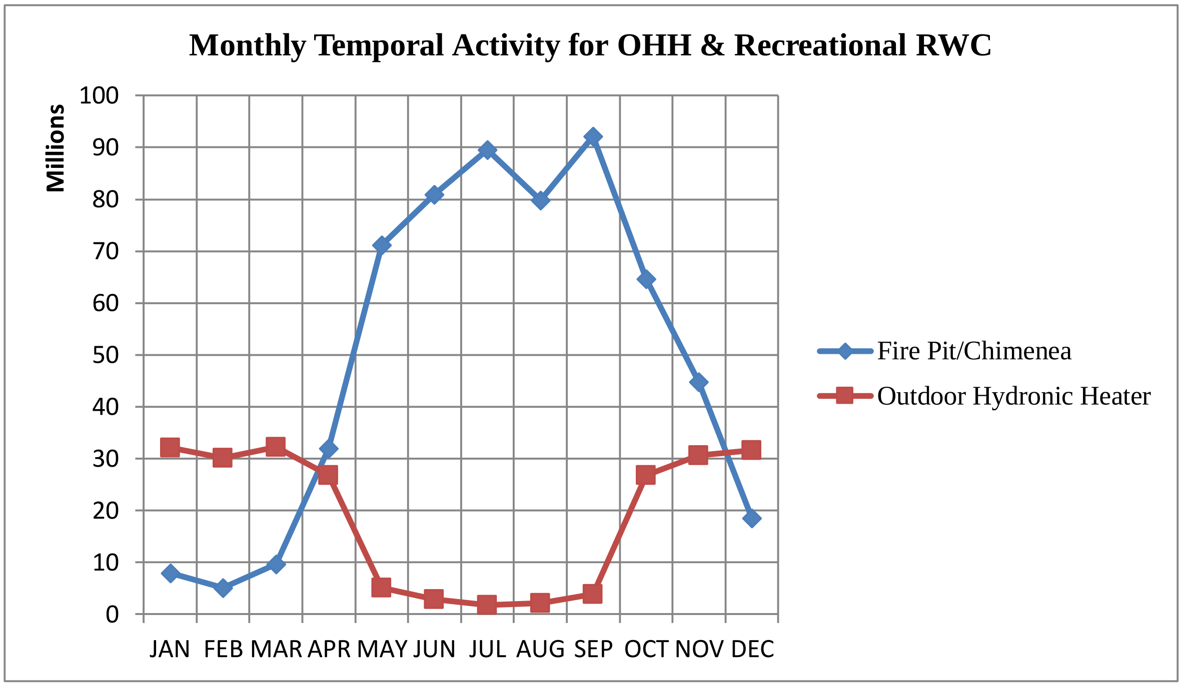


Figure 3-15. Annual-to-month temporal profiles for OHH and recreational RWC



3.3.4 Agricultural Ammonia Temporal Profiles (ag)

For the agricultural livestock NH_3 algorithm, the GenTPRO algorithm is based on an equation derived by Jesse Bash of EPA ORD based on the Zhu, Henze, et al. (2013) empirical equation. This equation is based on observations from the TES satellite instrument with the GEOS-Chem model and its adjoint to estimate diurnal NH3 emission variations from livestock as a function of ambient temperature, aerodynamic resistance, and wind speed. The equations are:

$$E_{i,h} = [161500/T_{i,h} \text{ x } e^{(-1380/T_{i,h})}] \text{ x } AR_{i,h}$$

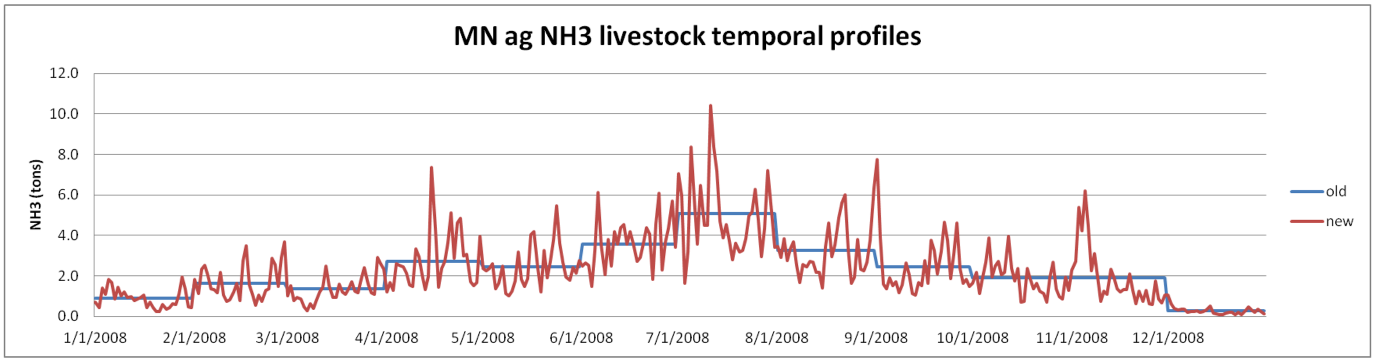
$$PE_{i,h} = E_{i,h} / \text{Sum}(E_{i,h})$$

where

- $PE_{i,h}$ = Percentage of emissions in county *i* on hour *h*
- $E_{i,h}$ = Emission rate in county *i* on hour *h*
- $T_{i,h}$ = Ambient temperature (Kelvin) in county *i* on hour *h*
- $V_{i,h}$ = Wind speed (meter/sec) in county *i* (minimum wind speed is 0.1 meter/sec)
- $AR_{i,h}$ = Aerodynamic resistance in county *i*

GenTPRO was run using the "BASH_NH3" profile method to create month-to-hour temporal profiles for these sources. Because these profiles distribute to the hour based on monthly emissions, the monthly emissions are obtained from a monthly inventory, or from an annual inventory that has been temporalized to the month. Figure 3-16 compares the daily emissions for Minnesota from the "old" approach (uniform monthly profile) with the "new" approach (GenTPRO generated month-to-hour profiles). Although the GenTPRO profiles show daily (and hourly variability), the monthly total emissions are the same between the two approaches.

Figure 3-16. Example of animal NH_3 emissions temporalization approach, summed to daily emissions



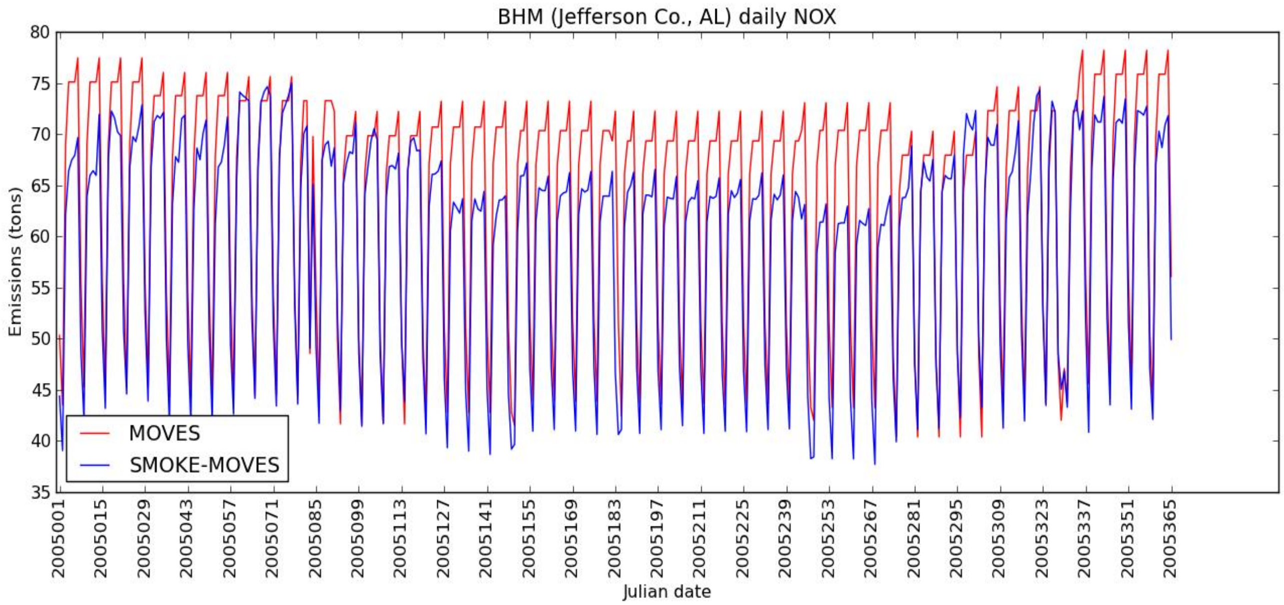
3.3.5 Onroad mobile temporalization (onroad)

For the onroad sector, the temporal distribution of emissions is a combination of more traditional temporal profiles and the influence of meteorology. This section will discuss both the meteorological influences and the updates to the diurnal temporal profiles for the 2011v6.2 platform.

Meteorology is not used in the development of the temporal profiles, but rather it impacts the calculation of the hourly emissions through the program Movesmrg. The result is that the emissions vary at the hourly level by grid cell. More specifically, the on-network (RPD) and the off-network parked vehicle (RPV, RPH, and RPP) processes use the gridded meteorology (MCIP) directly. Movesmrg determines the temperature for each hour and grid cell and uses that information to select the appropriate emission factor (EF) for the specified SCC/pollutant/mode combination. In the 2011 platform (and the 2011NEIv2), RPP was updated to use the gridded minimum and maximum temperature for the day. This more spatially resolved temperature range produces more accurate emissions for each grid cell. The combination of these four processes (RPD, RPV, RPH, and RPP) is the total onroad sector emissions. The onroad sector show a strong meteorological influence on their temporal patterns (see the 2011NEIv2 TSD for more details).

Figure 3-17 illustrates the difference between temporalization of the onroad sector used in the 2005 and earlier platforms and the meteorological influence via SMOKE-MOVES. In the plot, the "MOVES" inventory is a monthly inventory that is temporalized by SCC to day-of-week and hour. Similar temporalization is done for the VMT in SMOKE-MOVES, but the meteorologically varying EFs add an additional variation on top of the temporalization. Note, the SMOKE-MOVES run is based on the 2005 platform and previous temporalization of VMT to facilitate the comparison of the results. In the figure, the MOVES emissions have a repeating pattern within the month, while the SMOKE-MOVES shows day-to-day (and hour-to-hour) variability. In addition, the MOVES emissions have an artificial jump between months which is due to the inventory providing new emissions for each month that are then temporalized within the month but not between months. The SMOKE-MOVES emissions have a smoother transition between the months.

Figure 3-17. Example of SMOKE-MOVES temporal variability of NO_X emissions

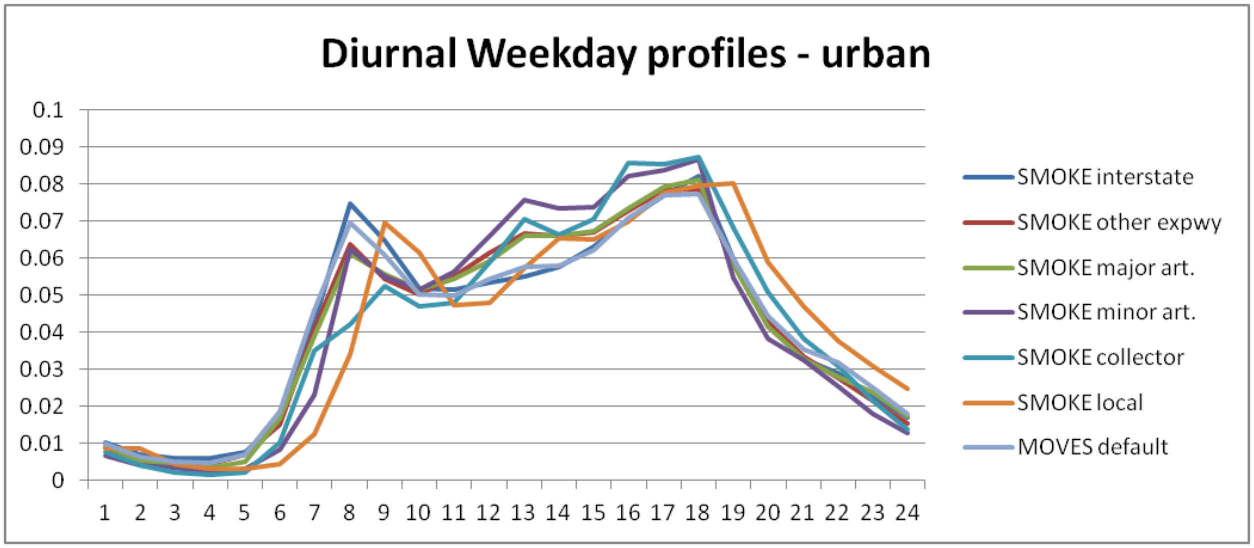


For the onroad sector, the "inventories" referred to in Table 3-17 actually consist of activity data, not emissions. For RPP and RPV processes, the VPOP inventory is annual and does not need temporalization. For RPD, the VMT inventory is monthly and was temporalized to days of the week and then to hourly VMT through temporal profiles. The RPD processes require a speed profile (SPDPRO) that consists of vehicle speed by hour for a typical weekday and weekend day. Unlike other sectors, the temporal profiles and SPDPRO will impact not only the distribution of emissions through time but also the total emissions. Because SMOKE-MOVES (for RPD) calculates emissions from VMT, speed and meteorology, if one shifted the VMT or speed to different hours, it would align with different temperatures and hence different EF. In other words, two SMOKE-MOVES runs with identical annual VMT, meteorology, and MOVES EF, will have different total emissions if the temporalization of VMT changes. For RPH, the HOTELING inventory is monthly and was temporalized to days of the week and to hour of the day through temporal profiles. This is an analogous process to RPD except that speed is not included in the calculation of RPH.

In previous platforms, the diurnal profile for VMT[24] varied by road type but not by vehicle type (see Figure 3-18). These profiles were used throughout the nation.

[24] These profiles were used in the 2007 platform and proceeding platforms.

Figure 3-18. Previous onroad diurnal weekday profiles for urban roads



Diurnal profiles that could differentiate by vehicle type as well as by road type and would potentially vary over geography were desired. In the development of the 2011v6.0[25] platform, the EPA updated these profiles to include information submitted by states in their MOVES county databases (CDBs). The 2011NEIv2 process provided an opportunity to update these diurnal profile with new information submitted by states, to supplement the data with additional sources, and to refine the methodology.

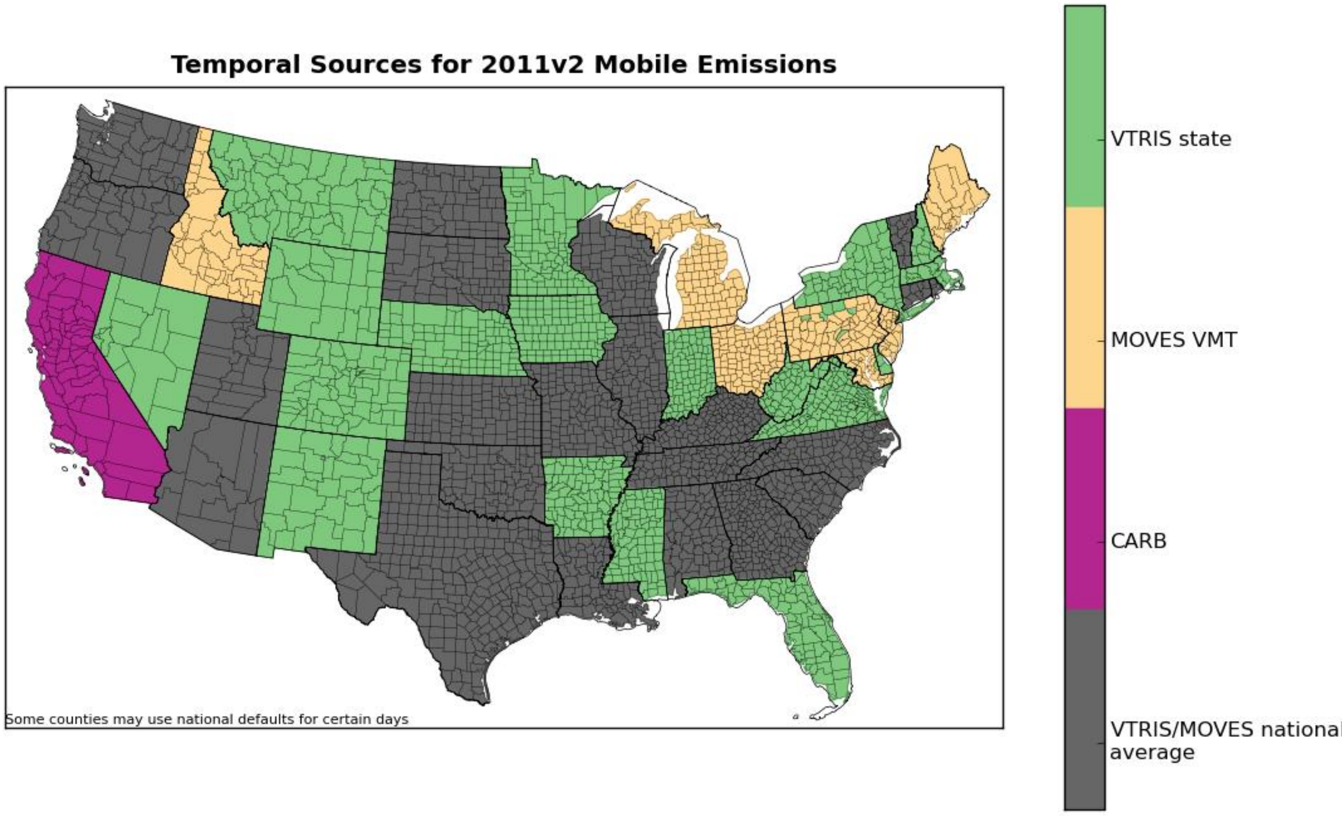
States submitted MOVES county databases (CDBs) that included information on the distribution of VMT by hour of day and by day of week[26] (see the 2011NEIv2 TSD for details on the submittal process for onroad). EPA mined the state submitted MOVES CDBs for non-default diurnal profiles[27]. The list of potential diurnal profiles was then analyzed to see whether the profiles varied by vehicle type, road type, weekday vs. weekend, and by county within a state. For the MOVES diurnal profiles, EPA only considered the state profiles that varied significantly by both vehicle and road types. Only those profiles that passed this criteria were used in that state or used in developing default temporal profiles. The Vehicle Travel Information System (VTRIS) is a repository for reported traffic count data to the Federal Highway Administration (FHWA). EPA used 2012 VTRIS data to create additional temporal profiles for states that did not submit temporal information in their CDBs or where those profiles did not pass the variance criteria. The VTRIS data were used to create state specific diurnal profiles by HPMS vehicle and road type. EPA created distinct diurnal profiles for weekdays, Saturday and Sunday along with day of the week profiles[28].

EPA attempted to maximize the use of state and/or county specific diurnal profiles (either from MOVES or VTRIS). Where there was no MOVES or VTRIS data, then a new default profile would be used (see below for description of new profiles). This analysis was done separately for weekdays and for weekends, therefore some areas had submitted profiles for weekdays but defaults for weekends. The

[25] These profiles that were generated from MOVES submittals only were used for the v6 and v6.1 platforms. See their respective TSDs for more details.
[26] The MOVES tables are the hourvmtfraction and the dayvmtfraction.
[27] Further QA was done to remove duplicates and profiles that were missing two or more hours. If they were missing a single hour, the missing hour could be calculated by subtracting all other hours fractions from 1.
[28] Note, the day of the week profiles (ie. Monday vs Tuesday vs etc) are only from the VTRIS data. The MOVES CDBs only have weekday vs weekend profiles so they were not included in calculating a new national default day of the week profile.

result was a set of profiles that varied geographically depending on the source of the profile and the characteristics of the profiles (see Figure 3-19).

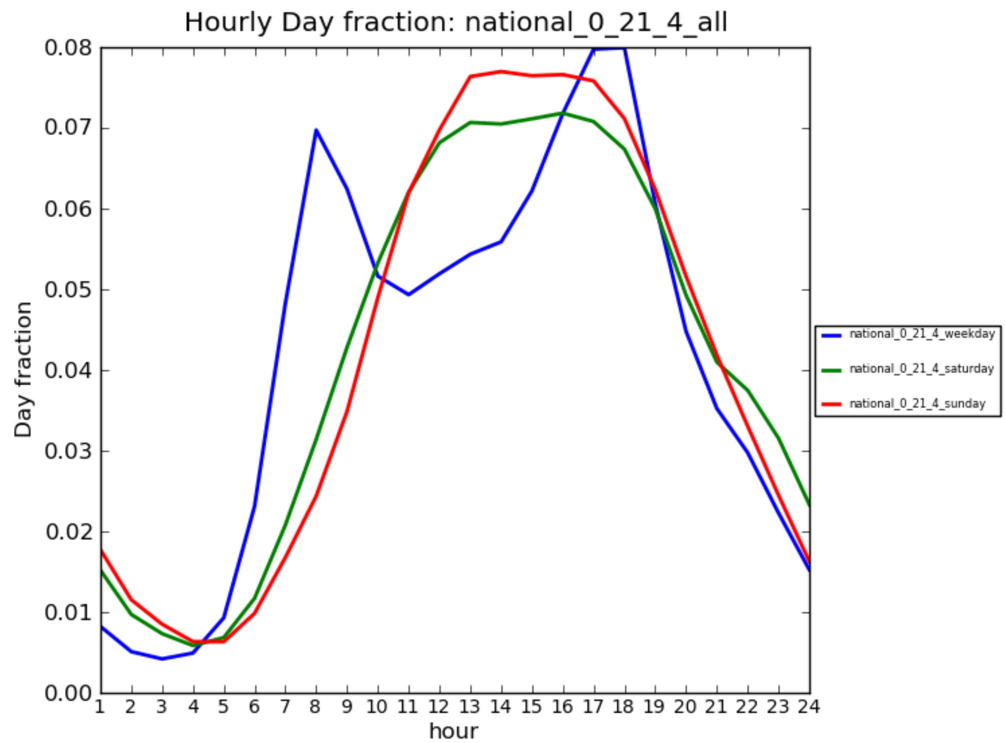
Figure 3-19. Use of submitted versus new national default profiles

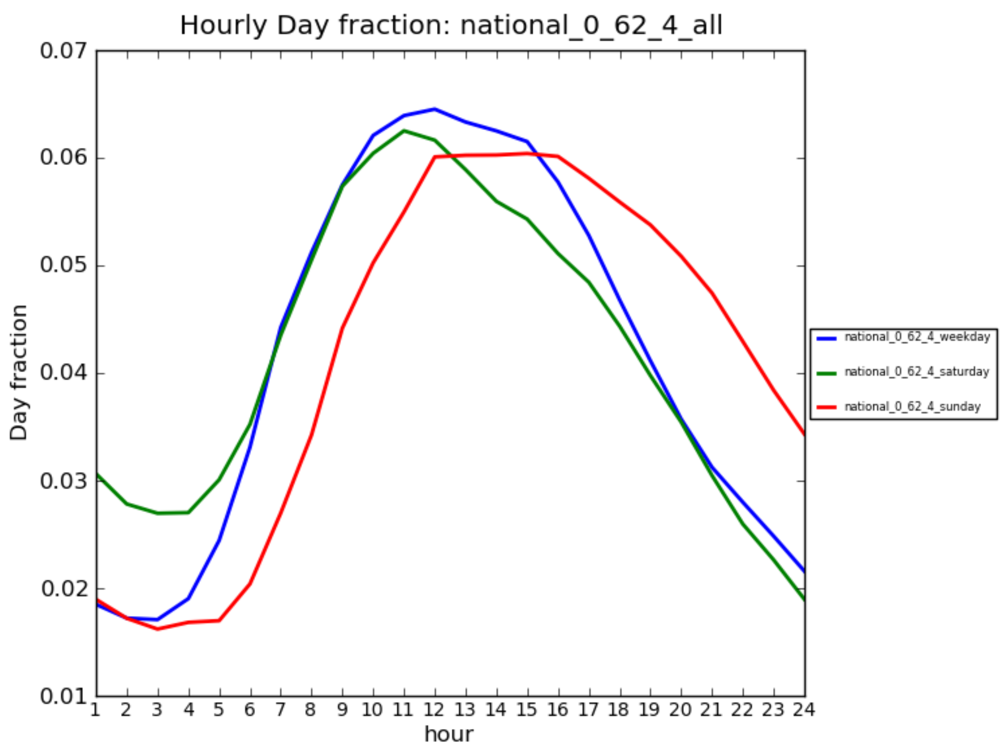


A new set of diurnal profiles was developed from the submitted profiles that varied by both vehicle type and road type. For the purposes of constructing the national default diurnal profiles, EPA created individual profiles for each state (averaging over the counties within) to create a single profile by state, vehicle type, road type, and the day (i.e. weekday vs Saturday vs Sunday). The source of the underlying profiles was either MOVES or VTRIS data (see Figure 3-19). The states individual profiles were averaged together to create a new default profile[29]. Figure 3-20 shows two new national default profiles for light duty gas vehicles (LDGV, SCC6 220121) and combination long-haul diesel trucks (HHDDV, SCC6 220262) on restricted urban roadways (interstates and freeways). The blue lines indicate the weekday profile, the green the Saturday profile, and the red the Sunday profile. In comparison, the new default profiles for weekdays places more LDGV VMT (upper plot) in the rush hours while placing HHDDV VMT (lower plot) predominately in the middle of the day with a longer tail into the evening hours and early morning.

[29] Note that the states were weighted equally in the average independent of the size of the state or the variation in submitted county data.

Figure 3-20. Updated national default profiles for LDGV vs. HHDDV, urban restricted

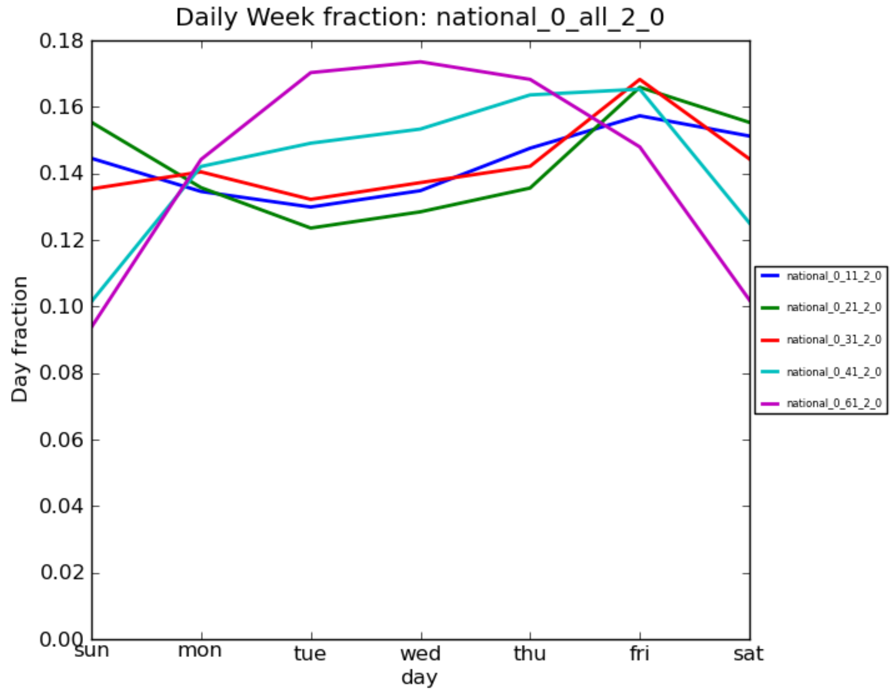


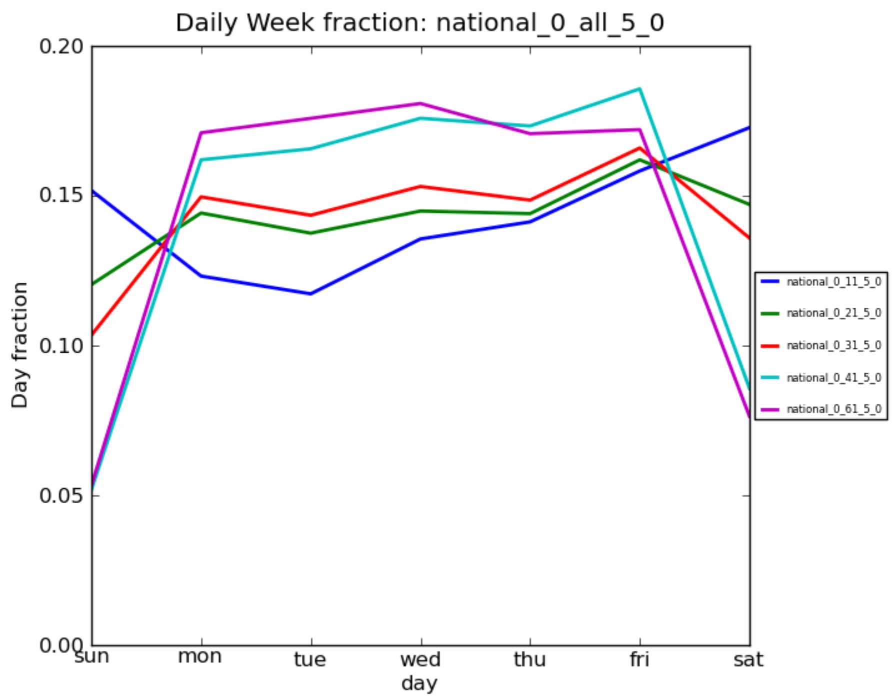


In addition to creating diurnal profiles, EPA developed day of week profiles using the VTRIS data. The creation of the state and national profiles was similar to the diurnal profiles (described above). Figure

3-21 shows a set of national default profiles for rural restricted roads (top plot) and urban unrestricted roads (lower plot). Each vehicle type is a different color on the plots.

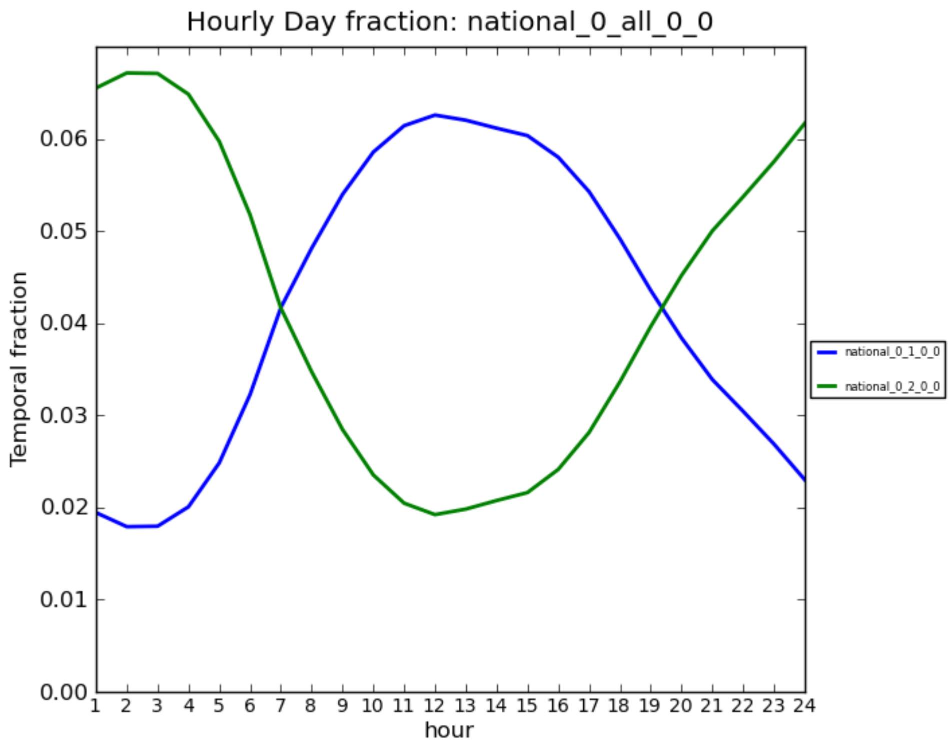
Figure 3-21. Updated national default profiles for day of week





In addition to creating diurnal profiles for VMT, EPA developed a national profile for hoteling. EPA averaged all the combination long-haul truck profiles on restricted roads (urban and rural) for weekdays to create a single national restricted profile (blue line in **Figure 3-22**). This was then inverted to create a profile for hoteling (green line in **Figure 3-22**). This single national profile was used for hoteling irrespective of location.

Figure 3-22. Combination long-haul truck restricted and hoteling profile



For California, CARB supplied diurnal profiles that varied by vehicle type, day of the week[30], and air basin. These CARB specific profiles were used in developing EPA estimates for California. Although EPA adjusted the total emissions to match California's submittal to the 2011NEIv2, the temporalization of these emissions took into account both the state-specific VMT profiles and the SMOKE-MOVES process of incorporating meteorology. For more details on the adjustments to California's onroad emissions, see Section 2.3.1 and the 2011NEIv2 TSD.

3.3.6 Additional sector specific details (afdust, beis, c1c2rail, c3marine, nonpt, ptnonipm, ptfire, np_oilgas)

For the afdust sector, meteorology is not used in the development of the temporal profiles, but it is used to reduce the total emissions based on meteorological conditions. These adjustments are applied through sector-specific scripts, beginning with the application of land use-based gridded transport fractions and then subsequent zero-outs for hours during which precipitation occurs or there is snow cover on the ground. The land use data used to reduce the NEI emissions explains the amount of emissions that are subject to transport. This methodology is discussed in (Pouliot, et al., 2010, http://www.epa.gov/ttn/chief/conference/ei19/session9/pouliot_pres.pdf, and in "Fugitive Dust Modeling for the 2008 Emissions Modeling Platform" (Adelman, 2012). The precipitation adjustment is applied to remove all emissions for days where measureable rain occurs. Therefore, the afdust emissions vary day-to-day based on the precipitation and/or snow cover for that grid cell and day. Both the transport fraction and meteorological adjustments are based on the gridded resolution of the platform; therefore, somewhat

[30] California's diurnal profiles varied within the week. Monday, Friday, Saturday, and Sunday had unique profiles and Tuesday, Wednesday, Thursday had the same profile.

different emissions will result from different grid resolutions. Application of the transport fraction and meteorological adjustments prevents the overestimation of fugitive dust impacts in the grid modeling as compared to ambient samples.

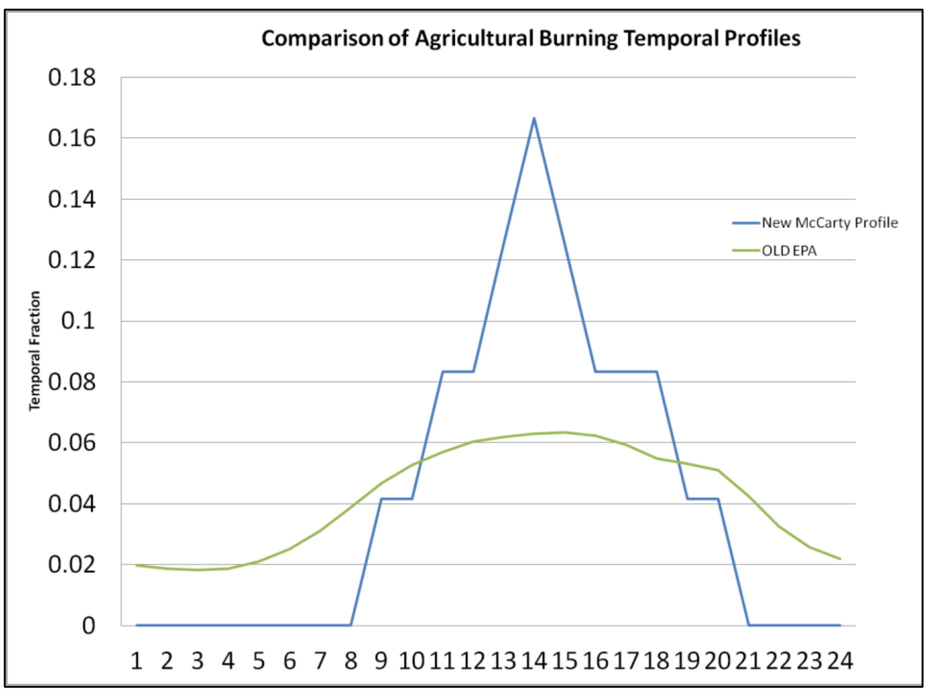
Biogenic emissions in the beis sector vary by every day of the year because they are developed using meteorological data including temperature, surface pressure, and radiation/cloud data. The emissions are computed using appropriate emission factors according to the vegetation in each model grid cell, while taking the meteorological data into account.

For the c1c2rail and c3marine sectors, emissions are allocated with flat monthly and day of week profiles, and most emissions are also allocated with flat hourly profiles.

For the agfire sector, the emissions were allocated to months by adding up the available values for each day of the month. For all agricultural burning, the diurnal temporal profile used reflected the fact that burning occurs during the daylight hours - see Figure 3-23 (McCarty et al., 2009). This puts most of the emissions during the work day and suppresses the emissions during the middle of the night. A uniform profile for each day of the week was used for all agricultural burning emissions in all states, except for the following states that for which EPA used state-specific day of week profiles: Arkansas, Kansas, Louisiana, Minnesota, Missouri, Nebraska, Oklahoma, and Texas.

Updates were made to temporal profiles for the ptnonipm sector in the 2011v6.2 platform based on comments and data review by EPA staff. Temporal profiles for small airports (i.e., non-commercial) were updated to eliminate emissions between 10pm and 6am due to a lack of tower operations. Industrial process that are not likely to shut down on Sundays such as those at cement plants were assigned to other more realistic profiles that included emissions on Sundays. This also affected emissions on holidays because Sunday emissions are also used on holidays.

Figure 3-23. Agricultural burning diurnal temporal profile



For the ptwildfire and ptprescfire sectors, the inventories are in the daily point fire format ORL PTDAY. The ptfire sector is used in the model evaluation case (2011eh and in the future base case (2017eh). The 2007 and earlier platforms had additional regulatory cases that used averaged fires and temporally averaged EGU emissions, but the 2011 platform uses base year-specific (i.e., 2011) data for both cases.

For the nonroad sector, while the NEI only stores the annual totals, the modeling platform uses monthly inventories from output from NMIM. For California, a monthly inventory was created from CARB's annual inventory using EPA-estimated NMIM monthly results to compute monthly ratios by pollutant and SCC7 and these ratios were applied to the CARB inventory to create a monthly inventory.

Some cross reference updates for temporalization of the np_oilgas sector were made in the 2011v6.2 platform to assign np_oilgas sources to 24 hour per day, 7 days a week based on comments received.

3.4 Spatial Allocation

The methods used to perform spatial allocation are summarized in this section. For the modeling platform, spatial factors are typically applied by county and SCC. As described in Section 3.1, spatial allocation was performed for a national 12-km domain. To accomplish this, SMOKE used national 12-km spatial surrogates and a SMOKE area-to-point data file. For the U.S., EPA updated surrogates to use circa 2010-2011 data wherever possible. For Mexico, updated spatial surrogates were used as described below. For Canada surrogates provided by Environment Canada were used and are unchanged from the 2007 platform. The U.S., Mexican, and Canadian 12-km surrogates cover the entire CONUS domain 12US1 shown in Figure 3-1. Additional documentation on the 2011 spatial surrogates is available at ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/spatial_surrogates/ in the files US_SpatialSurrogate_Documentation_v070115.pdf and US_SpatialSurrogate_Workbook_v072115.xlsx. The remainder of this subsection provides further detail on the origin of the data used for the spatial surrogates and the area-to-point data.

3.4.1 Spatial Surrogates for U.S. emissions

There are more than 70 spatial surrogates available for spatially allocating U.S. county-level emissions to the 12-km grid cells used by the air quality model. As described in Section 3.4.2, an area-to-point approach overrides the use of surrogates for a limited set of sources. Table 3-18 lists the codes and descriptions of the surrogates. Many surrogates use circa 2010-based data, including 2010 census data at the block group level, 2010 American Community Survey Data for heating fuels, 2010 TIGER/Line data for railroads and roads, the 2006 National Land Cover Database, 2011 gas station and dry cleaner data, and the 2012 National Transportation Atlas Data for rail-lines, ports and navigable waterways. Surrogates for ports (801) and shipping lanes (802) were developed based on the 2011NEIv2 shapefiles: Ports_032310_wrf and ShippingLanes_111309FINAL_wrf, but also included shipping lane data in the Great Lakes and support vessel activity data in the Gulf of Mexico.

The creation of surrogates and shapefiles for the U.S. was generated via the Surrogate Tool. The tool and documentation for it is available at http://www.ie.unc.edu/cempd/projects/mims/spatial/ and https://www.cmascenter.org/sa-tools/documentation/4.2/html/srgtool/SurrogateToolUserGuide_4_2.htm.

Table 3-18. U.S. Surrogates available for the 2011 modeling platform.

Code	Surrogate Description	Code	Surrogate Description
N/A	Area-to-point approach (see 3.3.1.2)	520	Commercial plus Industrial plus Institutional
100	Population	525	Golf Courses + Institutional +Industrial + Commercial
110	Housing	527	Single Family Residential
120	Urban Population	530	Residential - High Density
130	Rural Population	535	Residential + Commercial + Industrial + Institutional + Government
137	Housing Change	540	Retail Trade
140	Housing Change and Population	545	Personal Repair
150	Residential Heating - Natural Gas	550	Retail Trade plus Personal Repair
160	Residential Heating – Wood	555	Professional/Technical plus General Government
165	0.5 Residential Heating - Wood plus 0.5 Low Intensity Residential	560	Hospital
170	Residential Heating - Distillate Oil	565	Medical Office/Clinic
180	Residential Heating – Coal	570	Heavy and High Tech Industrial
190	Residential Heating - LP Gas	575	Light and High Tech Industrial
200	Urban Primary Road Miles	580	Food, Drug, Chemical Industrial
210	Rural Primary Road Miles	585	Metals and Minerals Industrial
220	Urban Secondary Road Miles	590	Heavy Industrial
230	Rural Secondary Road Miles	595	Light Industrial
240	Total Road Miles	596	Industrial plus Institutional plus Hospitals
250	Urban Primary plus Rural Primary	600	Gas Stations
255	0.75 Total Roadway Miles plus 0.25 Population	650	Refineries and Tank Farms
260	Total Railroad Miles	675	Refineries and Tank Farms and Gas Stations
270	Class 1 Railroad Miles	680	Oil & Gas Wells, IHS Energy, Inc. and USGS
261	NTAD Total Railroad Density	700	Airport Areas
271	NTAD Class 1, 2, 3 Railroad Density	710	Airport Points
280	Class 2 and 3 Railroad Miles	720	Military Airports
300	Low Intensity Residential	800	Marine Ports
310	Total Agriculture	801	NEI Ports
312	Orchards/Vineyards	802	NEI Shipping Lanes
320	Forest Land	807	Navigable Waterway Miles
330	Strip Mines/Quarries	808	Gulf Tug Zone Area
340	Land	810	Navigable Waterway Activity
350	Water	812	Midwest Shipping Lanes
400	Rural Land Area	850	Golf Courses
500	Commercial Land	860	Mines
505	Industrial Land	870	Wastewater Treatment Facilities
510	Commercial plus Industrial	880	Drycleaners
515	Commercial plus Institutional Land	890	Commercial Timber

For the onroad sector, the on-network (RPD) emissions were spatially allocated to roadways, and the off-network (RPP and RPV) emissions were allocated to population. The refueling emissions were spatially allocated to gas station locations (surrogate 600). On-network (i.e., on-roadway) mobile source emissions were assigned to the following surrogates: rural restricted access to rural primary road miles (210), rural unrestricted access to 231, urban restricted access to urban primary road miles (200), and urban unrestricted access to 221. Off-network emissions were spatially allocated according to the mapping in

Table 3-19. In the 2011v6.2 platform, emissions from the extended (i.e., overnight) idling of trucks were assigned to a new surrogate 205 that is based on locations of overnight truck parking spaces.

Table 3-19. Off-Network Mobile Source Surrogates

Source type	Source Type name	**Surrogate ID**
11	Motorcycle	535
21	Passenger Car	535
31	Passenger Truck	535
32	Light Commercial Truck	510
41	Intercity Bus	258
42	Transit Bus	259
43	School Bus	506
51	Refuse Truck	507
52	Single Unit Short-haul Truck	256
53	Single Unit Long-haul Truck	257
54	Motor Home	526
61	Combination Short-haul Truck	256
62	Combination Long-haul Truck	257

For the oil and gas sources in the np_oilgas sector, the spatial surrogates were updated to those shown in Table 3-20 using 2011 data consistent with what was used to develop the 2011NEI nonpoint oil and gas emissions. Note that the "Oil & Gas Wells, IHS Energy, Inc. and USGS" (680) is older and based on circa-2005 data. These surrogates were based on the same GIS data of well locations and related attributes as was used to develop the 2011NEIv2 data for the oil and gas sector. The data sources included Drilling Info (DI) Desktop's HPDI database (Drilling Info, 2012) aggregated to grid cell levels, along with data from Oil and Gas Commission (OGC) websites. Well completion data from HPDI was supplemented by implementing the methodology for counting oil and gas well completions developed for the U.S. National Greenhouse Gas Inventory. Under that methodology, both completion date and date of first production from HPDI were used to identify wells completed during 2011. In total, over 1.08 million unique well locations were compiled from the various data sources. The well locations cover 33 states and 1,193 counties (ERG, 2014b). Although basically the same surrogates were used, some minor updates to the oil and gas surrogates were made in the 2011v6.2 platform to correct some mis-located emissions.

Table 3-20. Spatial Surrogates for Oil and Gas Sources

Surrogate Code	Surrogate Description
681	Spud count - Oil Wells
682	Spud count - Horizontally-drilled wells
683	Produced Water at all wells
684	Completions at Gas and CBM Wells
685	Completions at Oil Wells
686	Completions at all wells
687	Feet drilled at all wells
688	Spud count - Gas and CBM Wells
689	Gas production at all wells
692	Spud count - All Wells

693	Well count - all wells
694	Oil production at oil wells
695	Well count - oil wells
697	Oil production at Gas and CBM Wells
698	Well counts - Gas and CBM Wells

Some spatial surrogate cross reference updates were made between the 2011v6.1 platform and the 2011v6.2 platform aside from the reworking of the onroad mobile source surrogates described above. These updates included the following:

- Nonroad SCCs using spatial surrogate 525 (50% commercial + industrial + institutional, 50% golf courses) were changed to 520 (100% commercial + industrial + institutional). The golf course surrogate 850, upon which 525 is partially based, is incomplete and subject to hot spots;
- Some nonroad SCCs for commercial equipment in New York County had assignments updated to surrogate 340;
- Commercial lawn and garden equipment was updated to use surrogate 520; and
- Some county-specific assignments for RWC were updated to use surrogate 300.

Not all of the available surrogates are used to spatially allocate sources in the modeling platform; that is, some surrogates shown in Table 3-18 were not assigned to any SCCs, although many of the “unused” surrogates are actually used to “gap fill” other surrogates that are used. When the source data for a surrogate has no values for a particular county, gap filling is used to provide values for the surrogate in those counties to ensure that no emissions are dropped when the spatial surrogates are applied to the emission inventories. Table 3-21 shows the CAP emissions (i.e., NH_3, NOx, $PM_{2.5}$, SO_2, and VOC) by sector, with rows for each sector listed in order of most emissions to least CAP emissions.

Table 3-21. Selected 2011 CAP emissions by sector for U.S. Surrogates*

Sector	ID	Description	NH3	NOX	PM2_5	SO2	VOC
afdust	130	Rural Population	0	0	1,089,422	0	0
afdust	310	T0otal Agriculture	0	0	895,786	0	0
afdust	240	Total Road Miles	0	0	286,188	0	0
afdust	140	Housing Change and Population	0	0	159,485	0	0
afdust	330	Strip Mines/Quarries	0	0	58,959	0	0
afdust	400	Rural Land Area	0	0	1	0	0
ag	310	Total Agriculture	3,502,246	0	0	0	0
agfire	310	Total Agriculture	3,287	42,326	92,754	15,470	73,858
agfire	312	Orchards/Vineyards	27	432	1,082	753	799
agfire	320	Forest Land	7	8	121	0	124
c1c2rail	271	NTAD Class 1 2 3 Railroad Density	332	734,683	22,636	7,390	38,304
c1c2rail	806	Offshore Shipping NEI2011 NOx	329	504,779	16,146	7,272	12,151
c1c2rail	820	Ports NEI2011 NOx	19	56,363	1,866	834	1,666
c1c2rail	280	Class 2 and 3 Railroad Miles	13	41,963	948	287	1,622
c1c2rail	261	NTAD Total Railroad Density	2	16,636	379	260	925

Sector	ID	Description	NH3	NOX	PM2_5	SO2	VOC
c3marine	806	Offshore Shipping NEI2011 NOx	27	77,281	5,143	50,309	3,150
c3marine	820	Ports NEI2011 NOx	41	54,101	3,900	36,064	1,998
nonpt	100	Population	4,137	0	0	0	1,196,465
nonpt	505	Industrial Land	35,360	195,282	124,150	111,849	114,391
nonpt	600	Gas Stations	0	0	0	0	416,448
nonpt	310	Total Agriculture	0	0	614	0	363,385
nonpt	535	Residential + Commercial + Industrial + Institutional + Government	23	366	1,283	0	327,986
nonpt	515	Commercial plus Institutional Land	1,408	177,903	18,637	58,287	21,915
nonpt	150	Residential Heating - Natural Gas	40,775	217,560	4,785	1,443	13,031
nonpt	510	Commercial plus Industrial	4	178	27	109	224,110
nonpt	140	Housing Change and Population	3	23,423	65,897	29	134,887
nonpt	300	Low Intensity Residential	3,847	18,334	90,706	3,048	40,003
nonpt	527	Single Family Residential	0	0	0	0	153,528
nonpt	590	Heavy Industrial (IND1)	10	4,373	5,419	1,131	138,575
nonpt	170	Residential Heating - Distillate Oil	2,045	40,842	4,523	88,432	1,394
nonpt	650	Refineries and Tank Farms	0	0	0	0	129,572
nonpt	500	Commercial Land	2,367	2	85,404	585	26,183
nonpt	250	Urban Primary plus Rural Primary	0	0	0	0	102,207
nonpt	595	Light Industrial (IND2)	0	1	244	0	79,169
nonpt	545	Personal Repair (COM3)	0	0	93	0	60,289
nonpt	190	Residential Heating - LP Gas	136	38,705	224	705	1,432
nonpt	240	Total Road Miles	0	27	602	0	32,152
nonpt	520	Commercial plus Industrial plus Institutional	0	0	0	0	14,965
nonpt	801	Port Areas	0	0	0	0	12,469
nonpt	580	Food, Drug, Chemical Industrial (IND3)	0	610	313	171	10,535
nonpt	180	Residential Heating – Coal	247	1,033	605	7,931	1,233
nonpt	880	Drycleaners	0	0	0	0	7,053
nonpt	870	Wastewater Treatment Facilities	1,003	0	0	0	4,671
nonpt	555	Professional/Technical (COM4) plus General Government (GOV1)	0	0	0	0	2,865
nonpt	400	Rural Land Area	2,855	0	0	0	0
nonpt	312	Orchards/Vineyards	0	441	117	1,806	262
nonpt	575	Light and High Tech Industrial (IND2 + IND5)	0	0	0	0	2,538
nonpt	260	Total Railroad Miles	0	0	0	0	2,195
nonpt	700	Airport area	0	0	0	0	1,956
nonpt	540	Retail Trade (COM1)	0	0	0	0	1,371
nonpt	675	Refineries and Tank Farms and Gas Stations	0	0	0	0	1,203

Sector	ID	Description	NH3	NOX	PM2_5	SO2	VOC
nonpt	585	Metals and Minerals Industrial (IND4)	0	23	140	8	443
nonpt	320	Forest Land	0	85	287	0	97
nonpt	330	Strip Mines/Quarries	0	4	0	0	48
nonpt	560	Hospital (COM6)	0	0	0	0	10
nonroad	350	Water	213	143,096	12,395	337	614,637
nonroad	400	Rural Land Area	157	25,658	16,711	194	620,786
nonroad	140	Housing Change and Population	554	537,250	45,058	1,255	78,526
nonroad	310	Total Agriculture	481	488,224	39,037	910	57,473
nonroad	520	Commercial plus Industrial plus Institutional	205	70,541	16,361	288	255,836
nonroad	510	Commercial plus Industrial	382	131,572	9,888	348	139,291
nonroad	300	Low Intensity Residential	106	26,637	4,324	138	202,928
nonroad	505	Industrial Land	452	146,871	5,809	411	32,978
nonroad	100	Population	40	39,475	2,824	85	5,030
nonroad	890	Commercial Timber	19	12,979	1,486	38	8,680
nonroad	850	Golf Courses	12	2,394	112	17	7,092
nonroad	860	Mines	2	2,931	341	5	594
nonroad	261	NTAD Total Railroad Density	2	2,673	310	5	568
np_oilgas	698	Well count - gas and CBM wells	0	378,342	6,608	2,636	566,281
np_oilgas	694	Oil production at oil wells	0	1,847	0	12,602	729,489
np_oilgas	695	Well count - oil wells	0	103,585	3,299	96	452,404
np_oilgas	697	Oil production at gas and CBM wells	0	3,275	203	35	465,498
np_oilgas	686	Completions at all wells	0	8,926	333	44	106,170
np_oilgas	689	Gas production at all wells	0	39,256	2,323	225	62,716
np_oilgas	693	Well count - all wells	0	29,867	436	141	51,389
np_oilgas	687	Feet drilled at all wells	0	44,820	1,449	119	9,714
np_oilgas	683	Produced Water at all wells	0	0	0	0	45,033
np_oilgas	692	Spud count - all wells	0	29,816	417	520	4,686
np_oilgas	685	Completions at Oil Wells	0	360	11	381	28,194
np_oilgas	688	Spud count - Gas and CBM Wells	0	0	0	0	16,115
np_oilgas	684	Completions at Gas and CBM Wells	0	1,532	46	1,497	11,706
np_oilgas	681	Spud count - Oil Wells	0	0	0	0	6,700
np_oilgas	682	Spud count - Horizontally-drilled wells	0	5,526	208	9	349
np_oilgas	680	Oil and Gas Wells	0	10	0	0	55
np_oilgas	400	Rural Land Area	0	0	0	0	50
onroad	221	Urban Unrestricted Roads	49,896	1,580,588	66,861	12,781	407,127
onroad	535	Residential + Commercial + Industrial + Institutional + Government		675,029	13,884	982	1,349,381
onroad	231	Rural Unrestricted Roads	30,644	1,245,765	42,117	6,945	224,361
onroad	200	Urban Primary Road Miles	26,961	938,015	37,845	5,855	150,425
onroad	210	Rural Primary Road Miles	12,396	799,645	24,520	2,811	76,295

Sector	ID	Description	NH3	NOX	PM2_5	SO2	VOC
onroad	205	Extended Idle Locations	908	336,235	6,874	119	75,323
onroad	510	Commercial plus Industrial		132,109	2,225	156	213,658
onroad	600	Gas Stations					190,698
onroad	256	Off-Network Short-Haul Trucks		11,019	271	10	17,088
onroad	526	Residential - Non-Institutional		741	19	1	2,415
onroad	257	Off-Network Long-Haul Trucks		431	38	2	1,423
onroad	506	Education		346	28	1	1,050
onroad	507	Heavy Light Construction Industrial Land		33	2	0	98
onroad	259	Transit Bus Terminals		8	4	0	101
onroad	258	Intercity Bus Terminals		18	1	0	27
rwc	165	0.5 Residential Heating - Wood plus 0.5 Low Intensity Residential	19,260	33,660	374,085	8,838	433,797
rwc	300	Low Intensity Residential	412	745	6,742	107	8,301

3.4.2 Allocation method for airport-related sources in the U.S.

There are numerous airport-related emission sources in the NEI, such as aircraft, airport ground support equipment, and jet refueling. The modeling platform includes the aircraft and airport ground support equipment emissions as point sources. For the modeling platform, EPA used the SMOKE "area-to-point" approach for only jet refueling in the nonpt sector. The following SCCs use this approach: 2501080050 and 2501080100 (petroleum storage at airports), and 2810040000 (aircraft/rocket engine firing and testing). The ARTOPNT approach is described in detail in the 2002 platform documentation: http://www.epa.gov/scram001/reports/Emissions%20TSD%20Vol1_02-28-08.pdf. The ARTOPNT file that lists the nonpoint sources to locate using point data were unchanged from the 2005-based platform.

3.4.3 Surrogates for Canada and Mexico emission inventories

The surrogates for Canada to spatially allocate the 2010 Canadian emissions have been updated in the 2011v6.2 platform. The spatial surrogate data came from Environment Canada, along with cross references. The surrogates they provided were outputs from the Surrogate Tool (previously referenced). The Canadian surrogates used for this platform are listed in Table 3-22. The leading "9" was added to the surrogate codes to avoid duplicate surrogate numbers with U.S. surrogates. Surrogates for Mexico are circa 1999 and 2000 and were based on data obtained from the Sistema Municpal de Bases de Datos (SIMBAD) de INEGI and the Bases de datos del Censo Economico 1999. Most of the CAPs allocated to the Mexico and Canada surrogates are shown in Table 3-23. The entries in this table are for the othar sector except for the "MEX Total Road Miles" and the "CAN traffic" rows, which are for the othon sector.

Table 3-22. Canadian Spatial Surrogates

Code	Canadian Surrogate Description	Code	Description
9100	Population	92424	BARLEY
9101	total dwelling	92425	BUCWHT
9103	rural dwelling	92426	CANARY
9106	ALL_INDUST	92427	CANOLA
9111	Farms	92428	CHICPEA
9113	Forestry and logging	92429	CORNGR
9211	Oil and Gas Extraction	92425	BUCWHT

Code	**Canadian Surrogate Description**	**Code**	**Description**
9212	Mining except oil and gas	92430	CORNSI
9221	Total Mining	92431	DFPEAS
9222	Utilities	92432	FLAXSD
9233	Total Land Development	92433	FORAGE
9308	Food manufacturing	92434	LENTIL
9321	Wood product manufacturing	92435	MUSTSD
9323	Printing and related support activities	92436	MXDGRN
9324	Petroleum and coal products manufacturing	92437	OATS
9327	Non-metallic mineral product manufacturing	92438	ODFBNS
9331	Primary Metal Manufacturing	92439	OTTAME
9412	Petroleum product wholesaler-distributors	92440	POTATS
9416	Building material and supplies wholesaler-distributors	92441	RYEFAL
9447	Gasoline stations	92442	RYESPG
9448	clothing and clothing accessories stores	92443	SOYBNS
9481	Air transportation	92444	SUGARB
9482	Rail transportation	92445	SUNFLS
9562	Waste management and remediation services	92446	TOBACO
9921	Commercial Fuel Combustion	92447	TRITCL
9924	Primary Industry	92448	WHITBN
9925	Manufacturing and Assembly	92449	WHTDUR
9932	CANRAIL	92450	WHTSPG
9941	PAVED ROADS	92451	WHTWIN
9942	UNPAVED ROADS	92452	BEANS
9945	Commercial Marine Vessels	92453	CARROT
9946	Construction and mining	92454	GRPEAS
9948	Forest	92455	OTHVEG
9950	Combination of Forest and Dwelling	92456	SWCORN
9955	UNPAVED_ROADS_AND_TRAILS	92457	TOMATO
9960	TOTBEEF	92430	CORNSI
9970	TOTPOUL	92431	DFPEAS
9980	TOTSWIN	92432	FLAXSD
9990	TOTFERT	92433	FORAGE
9996	urban_area	92434	LENTIL
9997	CHBOISQC	92435	MUSTSD
91201	traffic_bcw	92436	MXDGRN
92401	BULLS	92437	OATS
92402	BFCOWS	92438	ODFBNS
92403	BFHEIF	92439	OTTAME
92404	CALFU1	92440	POTATS
92405	FDHEIF	92441	RYEFAL
92406	STEERS	92442	RYESPG
92407	MLKCOW	92443	SOYBNS
92408	MLKHEIF	92444	SUGARB

Code	Canadian Surrogate Description	Code	Description
92409	MBULLS	92445	SUNFLS
92410	MCALFU1	92446	TOBACO
92412	BROILER	92447	TRITCL
92413	LAYHEN	92448	WHITBN
92414	TURKEY	92449	WHTDUR
92416	BOARS	92450	WHTSPG
92417	GRWPIG	92451	WHTWIN
92418	NURPIG	92452	BEANS
92419	SOWS	92453	CARROT
92421	IMPAST	92454	GRPEAS
92422	UNIMPAST	92455	OTHVEG
92423	ALFALFA	92456	SWCORN
		92457	TOMATO

Table 3-23. CAPs Allocated to Mexican and Canadian Spatial Surrogates

Code	Mexican or Canadian Surrogate Description	NH_3	NO_X	PM_{2_5}	SO_2	VOC
22	MEX Total Road Miles	15,965	370,867	34,396	13,713	375,276
10	MEX Population	0	0	0	0	431,231
12	MEX Housing	0	161,013	17,483	2,123	452,685
14	MEX Residential Heating - Wood	0	20,093	211,525	2,859	380,572
16	MEX Residential Heating - Distillate Oil	0	38	0	11	2
20	MEX Residential Heating - LP Gas	0	25,303	787	63	614
22	MEX Total Road Miles	0	0	0	0	3,513
24	MEX Total Railroads Miles	0	74,969	1,669	663	2,824
26	MEX Total Agriculture	679,212	164,144	72,372	2,127	43,958
28	MEX Forest Land	0	16,224	67,683	660	79,018
32	MEX Commercial Land	0	125,211	7,726	0	286,982
34	MEX Industrial Land	0	45,831	5,684	59,201	133,440
36	MEX Commercial plus Industrial Land	0	0	0	0	332,495
38	MEX Commercial plus Institutional Land	0	6,400	216	84	28,293
40	Residential (RES1-4)+Commercial+Industrial+ Institutional+ Government	0	8	20	0	241,710
42	MEX Personal Repair (COM3)	0	0	0	0	33,616
44	MEX Airports Area	0	14,639	0	1,149	6,857
46	MEX Marine Ports	0	124,951	2,991	1,482	1,099
48	Brick Kilns - Mexico	0	776	6,691	0	10,244
50	Mobile sources - Border Crossing - Mexico	0	454	0	0	2,668
9100	CAN Population	603	0	276	0	304
9101	CAN total dwelling	643	46,256	12,783	14,698	32,944
9106	CAN ALL_INDUST	133	21,526	381	3,921	2
9113	CAN Forestry and logging	1,582	8,561	28,622	1,809	36,114
9115	CAN Agriculture and forestry activities	160	239,553	25,318	9,092	26,526
9116	CAN Total Resources	0	17	0	0	5

Code	Mexican or Canadian Surrogate Description	NH_3	NO_X	PM_{2_5}	SO_2	VOC
9212	CAN Mining except oil and gas	0	0	5,391	0	0
9221	CAN Total Mining	42	2,292	45,374	728	26
9222	CAN Utilities	189	14,882	369	1,124	255
9233	CAN Total Land Development	17	20,789	1,928	981	2,551
9308	CAN Food manufacturing	0	0	0	0	4,535
9323	CAN Printing and related support activities	0	0	0	0	25,203
9324	CAN Petroleum and coal products manufacturing	0	0	2,402	0	0
9327	CAN Non-metallic mineral product manufacturing	0	238	7,708	2,941	1,218
9331	CAN Primary Metal Manufacturing	0	98	5,062	12	6
9412	CAN Petroleum product wholesaler-distributors	0	0	0	0	70,125
9416	CAN Building material and supplies wholesaler-distributors	2	0	1,461	3,259	560
9448	CAN clothing and clothing accessories stores	0	0	0	0	328
9562	CAN Waste management and remediation services	165	893	1,596	1,998	16,551
9921	CAN Commercial Fuel Combustion	494	33,816	2,750	35,471	850
9924	CAN Primary Industry	0	0	0	0	219,282
9925	CAN Manufacturing and Assembly	0	0	0	0	139,227
9931	CAN OTHERJET	9	14,388	548	1,139	7,629
9932	CAN CANRAIL	109	122,694	4,093	5,737	3,304
9942	CAN UNPAVED ROADS	40	3,462	3,499	48	152,674
9945	CAN Commercial Marine Vessels	28	45,454	6,404	14,325	61,139
9946	CAN Construction and mining	247	156,770	10,070	5,667	17,180
9947	CAN Agriculture Construction and mining	19	37,452	536	26	32,683
9950	CAN Intersection of Forest and Housing	1,053	11,700	120,045	1,671	173,130
9960	CAN TOTBEEF	176,156	0	7,420	0	317,394
9970	CAN TOTPOUL	74,204	0	2	0	264
9980	CAN TOTSWIN	122,094	0	996	0	3,186
9990	CAN TOTFERT	178,791	0	9,279	0	0
9991	CAN traffic	22,294	550,896	10,888	5,548	285,104
9994	CAN ALLROADS	0	0	55,468	0	0
9995	CAN 30UNPAVED_70trail	0	0	106,707	0	0
9996	CAN urban_area	0	0	284	0	0

4 Development of 2017 and 2025 Base-Case Emissions

The emission inventories for the future years of 2017 and 2025 have been developed using projection methods that are specific to the type of emission source. Future emissions are projected from the 2011 base case either by running models to estimate future year emissions from specific types of emission sources (e.g., EGUs, and onroad and nonroad mobile sources), or for other types of sources by adjusting the base year emissions according to the best estimate of changes expected to occur in the intervening years (e.g., non-EGU point and nonpoint sources). For some sectors, the same emissions are used in the base and future years, such as biogenic, fire, and Canadian emissions. For the remaining sectors, rules and specific legal obligations that go into effect in the intervening years, along with changes in activity for the sector, are considered when possible. The 2017 and 2025 base case emission inventories represent predicted emissions that account for Federal and State measures promulgated or under reconsideration by December, 2014.

Emissions inventories for neighboring countries used in our modeling are included in the 2011v6.2 platform, specifically 2008, 2018, and 2025 emissions inventories for Mexico, and 2010 emissions inventories for Canada. The meteorological data used to create and temporalize emissions for the future year cases is held constant and represents the year 2011. With the exception of speciation profiles for mobile sources and temporal profiles for EGUs, the same ancillary data files are used to prepare the future year emissions inventories for air quality modeling as were used to prepare the 2011 base year inventories.

Emission projections for EGUs were developed using IPM version 5.14 and are reflected in an air quality modeling-ready flat file taken from the EPA Base Case v.5.14. The NEEDS database is an important input to IPM in that contains the generation unit records used for the model plants that represent existing and planned/committed units in EPA modeling applications of IPM. NEEDS includes basic geographic, operating, air emissions, and other data on these generating units and has been updated for the EPA's version 5.14 power sector modeling platform based on comments received on the notices of data availability for the 2011 and 2018 emissions modeling platforms and through other sources of data. The EGU emission projections in the flat file format, the corresponding NEEDS database, and user guides and documentation are available with the information for the EPA's Power Sector Modeling Platform v.5.14 at http://www.epa.gov/powersectormodeling Note: after October 1, 2015, the new site will be http://www.epa.gov/airmarkets/powersectormodeling.html. The projected EGU emissions include the Final Mercury and Air Toxics (MATS) rule announced on December 21, 2011 and the Cross-State Air Pollution Rule (CSAPR) issued July 6, 2011. Note that the Clean Power Plan is not included in the 2017 or 2025 base cases.

To project future emissions for onroad and nonroad mobile sources, the EPA used MOVES2014 and NMIM, respectively. The EPA obtained future year projected emissions for these sectors by running the MOVES and NMIM models using year-specific information about fuel mixtures, activity data, and the impacts of national and state-level rules and control programs. Development of the future year onroad and nonroad emissions requires a substantial amount of lead time and resources. EPA had already prepared the emissions projections for 2018 when EPA revised the attainment deadline for Moderate nonattainment areas to July 2018 in the 2008 Ozone SIP Requirements Rule, as discussed above, which effectively required the agency to adjust its projection year for this rulemaking to 2017. Thus, for purposes of the 2011v6.2 platform, the EPA calculated the 2017 emissions from mobile sources by adjusting the 2018 emissions to represent 2017 using factors derived from national scale runs of MOVES and NMIM, respectively. The agency anticipates that for the final rule to address interstate transport for the 2008 ozone standard, the mobile source emissions for 2017 that will be used in the air quality modeling will be generated by running these for models the year 2017.

For non-EGU point and nonpoint sources, projections of 2017 emissions were developed by starting with the 2011 emissions inventories and applying adjustments that represent the impact of national, state, and local rules coming into effect in the years 2012 through 2017, along with the impacts of planned shutdowns, the construction of new plants, specific information provided by states, and specific legal obligations resolving alleged environmental violations, such as consent decrees. Changes in activity are considered for sectors such as oil and gas, residential wood combustion, cement kilns, livestock, aircraft, commercial marine vessels and locomotives. Efforts were made to include some regional haze and state-reported local controls as part of a larger effort to include more local control information on stationary non-EGU sources are described further in Section 4.2.

The following bullets summarize the projection methods used for sources in the various sectors, while additional details and data sources are given in the following subsections and in Table 4-1.

- EGU sector (ptegu): Unit-specific estimates from IPM version 5.14, including CASPR, Final MATS, Regional Haze rule, and Cooling Water Intakes Rule.
- Non-IPM sector (ptnonipm): Closures, projection factors and percent reductions reflect comments received from the notices of data availability for the 2011 and 2018 emissions modeling platforms, along with emission reductions due to national and local rules, control programs, plant closures, consent decrees and settlements. Projection for corn ethanol and biodiesel plants, refineries and upstream impacts take into account Annual Energy Outlook (AEO) fuel volume projections. Airport-specific terminal area forecast (TAF) data were used for aircraft to account for projected changes in landing/takeoff activity. For year 2017, due to the late change of modeling years from 2018 to 2017, most projection information was obtained for year 2018 but projections were processed for the year 2017, meaning that controls with known compliance dates in year 2018 were not applied.
- Point and nonpoint oil and gas sectors (pt_oilgas and np_oilgas): Regional projection factors by product and consumption indicators using information from AEO 2014 projections to years 2018 and 2025, as well as comments received on the notices of data availability for the 2011 and 2018 emissions modeling platforms. Cobenefits of stationary engines CAP-cobenefit reductions (RICE NESHAP) and controls from New Source Performance Standards (NSPS) are reflected for select source categories.
- Biogenic (beis): 2011 emissions are used for all future-year scenarios and are computed with the same “11g” meteorology as is used for the air quality modeling.
- Fires sectors (ptwildfire, ptprescfire, agfire): No growth or control – 2011 estimates are used directly.
- Agricultural sector (ag): Year 2017 and 2025 projection factors for livestock estimates based on expected changes in animal population from 2005 Department of Agriculture data, updated according to EPA experts in July 2012.
- Area fugitive dust sector (afdust): For livestock PM emissions, projection factors for dust categories related to livestock estimates based on expected changes in animal population. For unpaved and paved road dust, county-level VMT projections to 2017 and 2025 were considered.
- Remaining Nonpoint sector (nonpt): Projection factors and percent reductions reflect comments received from the notices of data availability for the 2011 and 2018 emissions modeling platforms, along with emission reductions due to national and local rules/control programs. PFC projection factors reflecting impact of the final Mobile Source Air Toxics (MSAT2) rule. Upstream impacts from AEO fuel volume, including cellulosic ethanol plants, are reflected. For year 2017, due to the late change of modeling years from 2018 to 2017, most projection information was obtained for year 2018 and used as-is without interpolation to 2017.
- Residential Wood Combustion (rwc): Year 2017 and 2025 projection factors reflect assumed growth of wood burning appliances based on sales data, equipment replacement rates and change outs. These

changes include the 2-stage NSPS for Residential Wood Heaters, resulting in growth in lower-emitting stoves and a reduction in higher emitting stoves.

- Locomotive, and non-Category 3 commercial marine sector (c1c2rail): Year 2017 and 2025 projection factors for Category 1 and Category 2 commercial marine and locomotives reflect final locomotive-marine controls.
- Category 3 commercial marine vessel (c3marine): Base-year 2011 emissions grown and controlled to 2017 and 2025, incorporating controls based on Emissions Control Area (ECA) and International Marine Organization (IMO) global NO_X and SO_2 controls.
- Nonroad mobile sector (nonroad): Other than for California and Texas, this sector uses data from a run of NMIM that utilized NONROAD2008a, using future-year equipment population estimates and control programs to years 2018 and 2025. The year 2018 data were adjusted to 2017 using national adjustment factors. The inputs were either state-supplied as part of the 2011NEIv2 process or using national level inputs, with only minor updates for 2011NEIv2. Final controls from the final locomotive-marine and small spark ignition rules are included. California and Texas-specific data were provided by CARB and TCEQ, respectively.
- Onroad mobile (onroad): MOVES2014-based emissions factors for years 2018 and 2025 were developed using the same representative counties, state-supplied data, meteorology, and procedures that were used to produce the 2011 emission factors described in Section 2.3.1.The 2018 emissions were adjusted to 2017 using national adjustment factors. Data for California were provided by the California Air Resources Board.
- Other point (othpt), nonpoint/nonroad (othar), onroad (othon): For Canada, year 2010 inventories were used for 2017 and 2025 because no future year projected inventories were available. Mexico inventory data were projected from year 2008 to 2018 (used for 2017) and 2025. C3 CMV data projected using the same methodology as the c3marine sector. Offshore oil platforms emission held constant at 2011 levels.

Table 4-1 summarizes the growth and control assumptions by source type that were used to create the U.S. 2017 and 2025 base-case emissions from the 2011v6.2 base year inventories. The control, closures and projection packets (i.e., data sets) used to create the 2017 and 2025 future year base-case scenario inventories from the 2011 base case are provided on the EMCH web site and are discussed in more detail in the sections listed in Table 4-1. These packets were processed through EPA's Control Strategy Tool (CoST) to create future year emission inventories. CoST is described here: http://www.epa.gov/ttnecas1/cost.htm and discussed in context to this emissions modeling platform in Section 4.2.1. The last column in Table 4-1 indicates the order of the CoST strategy used for the source/packet type. For some sectors (e.g., ptnonipm), multiple CoST strategies are needed to produce the future year inventory because the same source category may be subject to multiple projection or control packets. For example, the "Loco-marine" projection factors are applied in a second control strategy for the ptnonipm sector, while for the c1c2rail sector, these same projection factors can be applied in the first (and only) control strategy. Thus, in Table 4-1, packets with a "1" in the CoST strategy column are applied in the first strategy, while packets with a "2" in the CoST strategy column are applied in a second strategy that is run on an intermediate inventory output from the first strategy.

The remainder of this section is organized by broad NEI sectors with further stratification by the types of packets (e.g., projection, control, closure packets) and whether emissions are projected via a stand-alone model (e.g., EGUs use the IPM model and onroad mobile uses MOVES), using CoST, or by other mechanisms. EGU projections are discussed in Section 4.1. All NEI non-EGU Point and Nonpoint sector projections (including all commercial marine vessels, locomotives and aircraft) are described in Section 4.2, along with some background on CoST. Onroad and nonroad mobile projections are discussed in Sections 4.3 and 4.4, respectively. Finally, projections for all "other" sources, primarily outside the U.S., are described in Section 4.5.

Table 4-1. Control strategies and growth assumptions for creating the 2017 and 2025 base-case emissions inventories from the 2011 base case

Description of growth, control, closure data, or, new inventory	**Sector(s)**	**Packet Type**	**CAPs impacted**	**Section(s)**	**CoST Strategy**
Non-EGU Point (ptnonipm and pt_oilgas sectors) Controls and Growth Assumptions					
Facility, unit and stack closures, primarily from the Emissions Inventory System (EIS)	ptnonipm, pt_oilgas	CLOSURE	All	4.2.2	1
"Loco-marine rule": Growth and control to years 2017 and 2025 from Locomotives and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder: March, 2008	ptnonipm, c1c2rail	PROJECTION	All	4.2.3.3	2, 1
Upstream RFS2/EISA/LDGHG impacts on gas distribution, pipelines and refineries to years 2018 and 2025	ptnonipm, pt_oilgas, nonpt	PROJECTION	All	4.2.3.5	2
AEO growth to 2018 and 2025: industrial sources, including oil and gas play-level projections	ptnonipm, pt_oilgas, nonpt, np_oilgas	PROJECTION	All	4.2.3.6	1
Aircraft growth via Itinerant (ITN) operations at airports to 2017 and 2025	ptnonipm	PROJECTION	All	4.2.3.8	1
Corn Ethanol plants adjusted via AEO volume projections to 2017 and 2025	ptnonipm	PROJECTION	All	4.2.3.10	1
NESHAP: Portland Cement census-division level based on Industrial Sector Integrated Solutions (ISIS) policy emissions to years 2018 and 2025. The ISIS results are from the ISIS-Cement model runs for the NESHAP and NSPS analysis of August 2013 and include closures and growth.	ptnonipm, nonpt	PROJECTION & new inventories for new kilns	All	4.2.3.9 & 4.2.5.4	1 & n/a
NESHAP: RICE (reciprocating internal combustion engines) with reconsideration amendments	ptnonipm, pt_oilgas, nonpt, np_oilgas	CONTROL	CO, NO_X, PM, SO_2, VOC	4.2.4.2	1
NSPS: oil and gas	pt_oilgas, np_oilgas	CONTROL	VOC	4.2.4.1	1
NSPS: RICE	ptnonipm, pt_oilgas, nonpt, np_oilgas	CONTROL	CO, NO_X, VOC	4.2.4.3	2
NSPS: Gas turbines	ptnonipm, pt_oilgas	CONTROL	NO_X	4.2.4.6	1
NSPS: Process heaters	ptnonipm, pt_oilgas	CONTROL	NO_X	4.2.4.7	1
Industrial/Commercial/Institutional Boiler MACT with Reconsideration Amendments + local programs	nonpt, ptnonipm, pt_oilgas	CONTROL	CO, NO_X, PM, SO_2, VOC	4.2.4.4	1
State fuel sulfur content rules for fuel oil – via 2018 NODA comments, effective only in most northeast states	nonpt, ptnonipm, pt_oilgas	CONTROL	SO_2	4.2.4.5	1
State comments: from previous platforms (including consent decrees) and 2018 NODA (search for 'EPA-HQ-OAR-2013-0809' at regulations.gov)	nonpt, ptnonipm, pt_oilgas	PROJECTION & CONTROL	All	4.2.3.6, 4.2.3.7, 4.2.4.10	1
Commercial and Industrial Solid Waste Incineration (CISWI) revised NSPS	ptnonipm	CONTROL	SO2	4.2.4.9	1
Arizona Regional haze controls	ptnonipm	CONTROL	NO_X,SO_2	4.2.4.8	1
New biodiesel plants in year 2018	ptnonipm	new inventory	All	4.2.5.2	n/a
Nonpoint (afdust, ag, nonpt, np_oilgas and rwc sectors) Controls and Growth Assumptions					
AEO-based VMT growth for paved and unpaved roads	afdust	PROJECTION	PM	4.2.3.1	1

Description of growth, control, closure data, or, new inventory	Sector(s)	Packet Type	CAPs impacted	Section(s)	CoST Strategy
Livestock emissions growth from year 2011 to years 2017 and 2025	ag	PROJECTION	NH_3	4.2.3.2	1
Upstream RFS2/EISA/LDGHG impacts on gas distribution, pipelines and refineries to years 2018 and 2025	ptnonipm, pt_oilgas, nonpt	PROJECTION	All	4.2.3.5	2
AEO growth to 2018 and 2025: industrial sources, including oil and gas play-level projections	ptnonipm, pt_oilgas, nonpt, np_oilgas	PROJECTION	All	4.2.3.6	1
NESHAP: RICE (reciprocating internal combustion engines) with reconsideration amendments	ptnonipm, pt_oilgas, nonpt, np_oilgas	CONTROL	CO, NO_X, PM, SO_2, VOC	4.2.4.2	1
NSPS: oil and gas	pt_oilgas, np_oilgas	CONTROL	VOC	4.2.4.1	1
NSPS: RICE	ptnonipm, pt_oilgas, nonpt, np_oilgas	CONTROL	CO, NO_X, VOC	4.2.4.3	2
Residential wood combustion growth and change-outs from year 2011 to years 2018 and 2025	rwc	PROJECTION	All	4.2.3.11	1
Industrial/Commercial/Institutional Boiler MACT with Reconsideration Amendments + local programs	nonpt, ptnonipm, pt_oilgas	CONTROL	CO, NO_X, PM, SO_2, VOC	4.2.4.4	1
State fuel sulfur content rules for fuel oil – via 2018 NODA comments, effective only in most northeast states	nonpt, ptnonipm, pt_oilgas	CONTROL	SO_2	4.2.4.5	1
State comments: from previous platforms (including consent decrees) and 2018 NODA (search for 'EPA-HQ-OAR-2013-0809' at regulations.gov)	nonpt, ptnonipm, pt_oilgas	PROJECTION & CONTROL	All	4.2.3.6, 4.2.3.7, 4.2.4.10	1
MSAT2 and RFS2 impacts with state comments on PFC (portable fuel container) growth and control from 2011 to years 2018 and 2025	nonpt	new inventory	All	4.2.5.1	n/a
New cellulosic plants in year 2018	nonpt	new inventory	All	4.2.5.3	n/a
Onroad Mobile (onroad sector) Controls and Growth Assumptions **All national in-force regulations are modeled. The list includes recent key mobile source regulations but is not exhaustive.**					
National Onroad Rules:					
All onroad control programs finalized as of the date of the model run, including most recently:	onroad	n/a	All	4.3	n/a
Tier-3 Vehicle Emissions and Fuel Standards Program: March, 2014					
2017 and Later Model Year Light-Duty Vehicle Greenhouse Gas Emissions and Corporate Average Fuel Economy Standards: October, 2012					
Greenhouse Gas Emissions Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles: September, 2011					
Regulation of Fuels and Fuel Additives: Modifications to Renewable Fuel Standard Program (RFS2): December, 2010					
Light-Duty Vehicle Greenhouse Gas Emission Standards and Corporate Average Fuel Economy Standards; Final Rule for Model-Year 2012-2016: May, 2010					
Final Mobile Source Air Toxics Rule (MSAT2): February, 2007					

Description of growth, control, closure data, or, new inventory	Sector(s)	Packet Type	CAPs impacted	Section(s)	CoST Strategy
Local Onroad Programs:					
California LEVIII Program	onroad	n/a	All	4.3	n/a
Ozone Transport Commission (OTC) LEV Program: January,1995					
Inspection and Maintenance programs					
Fuel programs (also affect gasoline nonroad equipment)					
Stage II refueling control programs					
Nonroad Mobile (c1c2rail, c3marine, nonroad sectors) Controls and Growth Assumptions All national in-force regulations are modeled. The list includes recent key mobile source regulations but is not exhaustive.					
National Nonroad Controls:					
All nonroad control programs finalized as of the date of the model run, including most recently:	nonroad	n/a	All	4.4	n/a
Emissions Standards for New Nonroad Spark-Ignition Engines, Equipment, and Vessels: October, 2008					
Growth and control to years 2017 and 2025 from Locomotives and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder: March, 2008					
Clean Air Nonroad Diesel Final Rule – Tier 4: May, 2004					
Locomotives:					
Growth and control to years 2017 and 2025 from Locomotives and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder: March, 2008	c1c2rail, ptnonipm	PROJECTION	All	4.2.3.3	1, 2
Clean Air Nonroad Diesel Final Rule – Tier 4: May, 2004	c1c2rail	n/a	All	4.4	n/a
Commercial Marine:					
Category 3 marine diesel engines Clean Air Act and International Maritime Organization standards: April, 2010	c3marine	PROJECTION	All	4.2.3.4	1
Growth and control to years 2017 and 2025 from Locomotives and Marine Compression-Ignition Engines Less than 30 Liters per Cylinder: March, 2008	c1c2rail, ptnonipm	PROJECTION	All	4.2.3.3	1, 2
Clean Air Nonroad Diesel Final Rule – Tier 4: May, 2004	nonroad	n/a	All	4.4	n/a

4.1 EGU sector projections: ptegu

The future-year data for the ptegu sector used in the air quality modeling were created by the Integrated Planning Model (IPM) version 5.14 (v5.14). The IPM is a multiregional, dynamic, deterministic linear programming model of the U.S. electric power sector. IPM version 5.14 reflects state rules, consent decrees and announced shutdowns through December, 2014, in addition the NEEDS database was updated based on comments received on the notices of data availability for the 2011 and 2018 emissions modeling platforms. IPM 5.14 was updated from the previous version 5.13 and represents electricity demand projections for the Annual Energy Outlook (AEO) 2014. The scenario used for this modeling represents the implementation of the Cross-State Air Pollution Rule (CSAPR), the Mercury and Air Toxics Standards (MATS), the final actions EPA has taken to implement the Regional Haze Rule, and the Cooling Water Intakes Rule and Combustion Residuals from Electric Utilities (CCR). More details on the IPM v5.14 base case scenarios can be found at http://epa.gov/powersectormodeling/psmodel514.html.

Directly emitted PM emissions (i.e., $PM_{2.5}$ and PM_{10}) from the EGU sector are computed via a post processing routine that applies emission factors to the IPM-estimated fuel throughput based on fuel, configuration and controls to compute the filterable and condensable components of PM. This postprocessing step also apportions

the regional emissions down to the unit-level emissions used for air quality modeling. A single IPM run was postprocessed once for each output year to get results for 2018 and 2025. For information on how the 2018 emissions were adjusted to represent 2017, see:
http://www.epa.gov/airmarkets/documents/ipm/Adjusted2017.pdf.

From the unit-level parsed file, a flat file is created that is used as the input to SMOKE and processed into the format needed by the air quality model. As part of the development of the flat file, a cross reference between the 2011NEIv2 and IPM is used to populate stack parameters and other related information for matched sources. The flat file creation methodology is documented in the air quality modeling flat file documentation available here: http://www.epa.gov/airmarkets/documents/ipm/FlatFile_Methodology.pdf. The cross reference is available from http://www.epa.gov/airmarkets/documents/ipm/FlatFile_Inputs.xls, with additional information available in ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/reports/ipm_to_flat_file_xref_2011NEIv2_IPM5.14_20150113.xlsx. The emissions in the flat file created based on the IPM outputs are temporalized into the hourly emissions needed by the air quality model as described in Section 3.3.2.

4.2 Non-EGU Point and NEI Nonpoint sector projections: afdust, ag, c1c2rail, c3marine, nonpt, np_oilgas, ptnonipm, pt_oilgas, rwc

To project all U.S. non-EGU stationary sources, facility/unit closures information, and growth (PROJECTION) factors and/or controls were applied to certain categories within the afdust, ag, c1c2rail, c3marine, nonpt, np_oilgas, ptnonipm, pt_oilgas and rwc platform sectors. Some facility or sub-facility-level closure information was also applied to the point sources. There are also a handful of situations where new inventories were generated for sources that did not exist in the 2011 NEI (e.g., biodiesel and cellulosic plants, yet-to-be constructed cement kilns). This subsection provides details on the data and projection methods used for these sectors.

In recent platforms, EPA has assumed that emissions growth for most industrial sources did not track with economic growth for most stationary non-IPM sources (EPA, 2006b). This “no-growth” assumption was based on an examination of historical emissions and economic data. Recently however, EPA has received growth (and control) data from numerous states and regional planning organizations for many industrial sources, including the rapidly-changing oil and gas sector. EPA provided a Notice of Data Availability for the 2011v6.0 emissions modeling platform and projected 2018 inventory in January, 2014 (docket EPA-HQ-OAR-2013-0809). EPA requested comment on the future year growth and control assumptions used to develop the 2018 inventories. One of the most frequent comments EPA received was to use the growth factors information that numerous states either provided or deferred to growth factors provided by broader region-level efforts. In an attempt to make the projections approach as consistent as possible across all states, EPA decided to expand this effort to all states for some of the most-significant industrial sources (see Section 4.2.3.6).

Because much of the projections and controls data are developed independently from how EPA defines its emissions modeling sectors, this section is organized primarily by the type of projections data, with secondary consideration given to the emissions modeling sector. For example, industrial source growth factors are applicable to 4 emissions modeling sectors. The rest of this section is organized in the order that the EPA uses CoST in combination with other methods to produce future year inventories: 1) for point sources, apply plant (facility or sub-facility-level) closure information via CoST, 2) apply all PROJECTION packets via CoST (multiplicative factors that could cause increases or decreases), 3) apply all percent reduction-based CONTROL packets via CoST, and 4) append all other future-year inventories not generated via CoST. This organization allows consolidation of the discussion of the emissions categories that are contained in multiple sectors, because the data and approaches used across the sectors are consistent and do not need to be repeated. Sector names associated with the CoST packets are provided in parentheses.

4.2.1 CoST Background: Used for NEI non-EGU Point and Nonpoint sectors

CoST is used to apply most non-EGU projection/growth factors, controls and facility/unit/stack-level closures to the 2011 NEI-based emissions modeling inventories to create inventories for years 2017 and 2025 for the following sectors: afdust, ag, c1c2rail, c3marine, nonpt, np_oilgas, ptnonipm, pt_oilgas and rwc. The CoST training manual is available at: http://www.cmascenter.org/help/model_docs/cost/2.5/CoST_UsersGuide_2012-08-01_Final.pdf. The CoST development document, which is a more thorough albeit dated document of how to build and format CoST input files (packets) is available at: http://www.epa.gov/ttnecas1/models/CoST_Development%20Document_2010-06-09.pdf.

CoST allows the user to apply projection (growth) factors, controls and closures at various geographic and inventory key field resolutions. Each of these CoST datasets, also called "packets" or "programs", provides the user with the ability to perform numerous quality assurance assessments as well as create SMOKE-ready future year inventories. Future year inventories are created for each emissions modeling sector via a CoST "strategy" and each strategy includes all 2011 inventories and applicable CoST packets. For reasons discussed later, some emissions modeling sectors require multiple CoST strategies to account for the compounding of control programs that impact the same type of sources. There are also available linkages to existing and user-defined control measures databases and it is up to the user to determine how control strategies are developed and applied. EPA typically creates individual CoST packets that represent specific intended purposes. For example, aircraft projections for airports are in a separate PROJECTION packet from residential wood combustion sales/appliance turnover-based projections. CoST uses three packet types as described below:

1. CLOSURE: Applied first in CoST. This packet can be used to zero-out (close) point source emissions at resolutions as broad as a facility to as specific as a stack. EPA uses these types of packets for known post-2011 controls as well as information on closures provided by states on specific facilities, units or stacks. This packet type is only used in the ptnonipm and pt_oilgas sectors.
2. PROJECTION: This packet allows the user to increase or decrease emissions for virtually any geographic and/or inventory source level. Projection factors are applied as multiplicative factors to the 2011 emissions inventories prior to the application of any possible subsequent CONTROLs. A PROJECTION packet is necessary whenever emissions increase from 2011 and is also desirable when information is based more on activity assumptions rather than known control measures. EPA uses PROJECTION packet(s) in every non-EGU modeling sector.
3. CONTROL: These packets are applied after any/all CLOSURE and PROJECTION packet entries. The user has similar level of control as PROJECTION packets regarding specificity of geographic and/or inventory source level application. Control factors are expressed as a percent reduction (0 to 100) and can be applied in addition to any pre-existing inventory control, or as a replacement control where inventory controls are first backed out prior to the application of a more-stringent replacement control.

All of these packets are stored as data sets within the Emissions Modeling Framework (EMF) and use comma-delimited formats. As mentioned above, CoST first applies any/all CLOSURE information for point sources, then applies PROJECTION packet information, followed by CONTROL packets. A hierarchy is used by CoST to separately apply PROJECTION and CONTROL packets. In short, in a separate process for PROJECTION and CONTROL packets, more specific information is applied in lieu of less-specific information in ANY other packets. For example, a facility-level PROJECTION factor will be replaced by a unit-level, or facility and pollutant-level PROJECTION factor. It is important to note that this hierarchy does not apply between packet types; for example, CONTROL packet entries are applied irrespective of PROJECTION packet hierarchies. A more specific example: a state/SCC-level PROJECTION factor will be applied before a stack/pollutant-level CONTROL factor that impacts the same inventory record. However, an inventory source that is subject to a CLOSURE packet record is removed from consideration of subsequent PROJECTION and CONTROL packets.

The implication for this hierarchy and intra-packet independence is important to understand and quality assure when creating future year strategies. For example, with consent decrees, settlements and state comments, the goal is typically to achieve a targeted reduction (from the 2011NEI) or a targeted future-year emissions value. Therefore, as encountered with this 2017 base case, consent decrees and state comments for specific cement kilns (expressed as CONTROL packet entries), needed to be applied instead of (not in addition to) the more general approach of the PROJECTION packet entries for cement manufacturing. By processing CoST control strategies with PROJECTION and CONTROL packets separated by the type of broad measure/program, it is possible to show actual changes from the 2011 inventory to the 2017 and 2025 inventory due to each packet.

Ultimately, CoST concatenates all PROJECTION packets into one PROJECTION dataset and uses a hierarchal matching approach to assign PROJECTION factors to the inventory. For example, a packet entry with Ranking=1 will supersede all other potential inventory matches from other packets. CoST then computes the projected emissions from all PROJECTION packet matches and then performs a similar routine for all CONTROL packets. Therefore, when summarizing "emissions reduced" from CONTROL packets, it is important to note that these reductions are not relative to the 2011 inventory, but rather, to the intermediate inventory ***after*** application of any/all PROJECTION packet matches (and CLOSURES). A subset of the more than 70 hierarchy options is shown in Table 4-2, although the fields in Table 4-2 are not necessarily named the same in CoST, but rather are similar to those in the SMOKE FF10 inventories. For example, "REGION_CD" is the county-state-county FIPS code (e.g., Harris county Texas is 48201) and "STATE" would be the 2-digit state FIPS code with three trailing zeroes (e.g., Texas is 48000).

Table 4-2. Subset of CoST Packet Matching Hierarchy

Rank	Matching Hierarchy	Inventory Type
1	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID, PROCESS_ID, SCC, POLL	point
2	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID, PROCESS_ID, POLL	point
3	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID, SCC, POLL	point
4	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID, POLL	point
5	REGION_CD, FACILITY_ID, UNIT_ID, SCC, POLL	point
6	REGION_CD, FACILITY_ID, UNIT_ID, POLL	point
7	REGION_CD, FACILITY_ID, SCC, POLL	point
8	REGION_CD, FACILITY_ID, POLL	point
9	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID, PROCESS_ID	point
10	REGION_CD, FACILITY_ID, UNIT_ID, REL_POINT_ID	point
11	REGION_CD, FACILITY_ID, UNIT_ID	point
12	REGION_CD, FACILITY_ID	point
13	REGION_CD, NAICS, SCC, POLL	point, nonpoint
14	REGION_CD, NAICS, POLL	point, nonpoint
15	STATE, NAICS, POLL	point, nonpoint
16	REGION_CD, NAICS	point, nonpoint
17	NAICS	point, nonpoint
18	REGION_CD, SCC, POLL	point, nonpoint
19	STATE, SCC, POLL	point, nonpoint
20	SCC, POLL	point, nonpoint
21	REGION_CD, SCC	point, nonpoint
22	STATE, SCC	point, nonpoint
23	SCC	point, nonpoint
24	REGION_CD, POLL	point, nonpoint
25	REGION_CD	point, nonpoint
26	STATE, POLL	point, nonpoint

Rank	Matching Hierarchy	Inventory Type
27	STATE	point, nonpoint
28	POLL	point, nonpoint

The contents of the controls, local adjustments and closures for the 2017 and 2025 base cases are described in the following subsections. Year-specific projection factors (PROJECTION packets) for years 2017 and 2025 were used for creating the 2017 and 2025 base cases unless noted otherwise. The contents of a few of these projection packets (and control reductions) are provided in the following subsections where feasible. However, most sectors used growth or control factors that varied geographically and their contents could not be provided in the following sections (e.g., facilities and units subject to the Boiler MACT reconsideration has thousands of records). The remainder of Section 4.2 is divided into several subsections that are summarized in Table 4-3. Note that future year inventories were used rather than projection or control packets for some sources.

Table 4-3. Summary of non-EGU stationary projections subsections

Subsection	Title	Sector(s)	Brief Description
4.2.2	CoST Plant CLOSURE packet	ptnonipm, pt_oilgas	All facility/unit/stack closures information, primarily from Emissions Inventory System (EIS), but also includes information from states and other organizations.
4.2.3	CoST PROJECTION packets	All	Introduces and summarizes national impacts of all CoST PROJECTION packets to years 2017 and 2025.
4.2.3.1	Paved and unpaved roads VMT growth	Afdust	PROJECTION packet: county-level resolution, based on VMT growth.
4.2.3.2	Livestock population growth	Ag	PROJECTION packet: national, by-animal type resolution, based on animal population projections.
4.2.3.3	Locomotives and Category 1 & 2 commercial marine vessels	c1c2rail, ptnonipm	PROJECTION packet: national, by-equipment type and pollutant, based on cumulative growth and control impacts from rulemaking.
4.2.3.4	Category 3 commercial marine vessels	c3marine	PROJECTION packet: region-level by-pollutant, based on cumulative growth and control impacts from rulemaking.
4.2.3.5	OTAQ upstream distribution, pipelines and refineries	nonpt, ptnonipm, pt_oilgas	PROJECTION packet: national, by-broad source category, based on upstream impacts from mobile source rulemakings.
4.2.3.6	Oil and gas and industrial source growth	nonpt, np_oilgas, ptnonipm, pt_oilgas	Several PROJECTION packets: varying geographic resolutions from state, county, to oil/gas play-level and by-process/fuel-type applications. Data derived from AEO2014 with several modifications.
4.2.3.7	Data from comments on previous platforms	nonpt, ptnonipm	Several PROJECTION packets: varying geographic resolutions and by-process/fuel-type applications. Data derived from various sources in response to the previous (2011v6.0) version of the emissions modeling platform.
4.2.3.8	Aircraft	ptnonipm	PROJECTION packet: by-airport for all direct matches to FAA Terminal Area Forecast data, with state-level factors for non-matching NEI airports.

Subsection	Title	Sector(s)	Brief Description
4.2.3.9	Cement manufacturing	ptnonipm	PROJECTION packet: by-kiln projections based on Industrial Sectors Integrated Solutions (ISIS) model of demand growth and Portland Cement NESHAP.
4.2.3.10	Corn ethanol plants	ptnonipm	PROJECTION packet: national, based on 2014 AEO renewable fuel production forecast.
4.2.3.11	Residential wood combustion	rwc	PROJECTION packet: national with exceptions, based on appliance type sales growth estimates and retirement assumptions and impacts of recent NSPS.
4.2.4	CoST CONTROL packets	nonpt, np_oilgas, ptnonipm, pt_oilgas	Introduces and summarizes national impacts of all CoST CONTROL packets to years 2017 and 2025.
4.2.4.1	Oil and gas NSPS	np_oilgas, pt_oilgas	CONTROL packet: national, oil and gas NSPS impacting VOC only for some activities.
4.2.4.2	RICE NESHAP	nonpt, np_oilgas, ptnonipm, pt_oilgas	CONTROL packet: national, reflects NESHAP amendments on compression and spark ignition stationary reciprocating internal combustion engines (RICE).
4.2.4.3	RICE NSPS	nonpt, np_oilgas, ptnonipm, pt_oilgas	CONTROL packet: state and county-level new source RICE controls, whose reductions by-definition, are a function of growth factors and also equipment retirement assumptions.
4.2.4.4	ICI Boilers	nonpt, ptnonipm, pt_oilgas	CONTROL packet: by-fuel, and for point sources, by-facility-type controls impacting Industrial and Commercial/Institutional boilers from rulemaking and state-provided information.
4.2.4.5	Fuel sulfur rules	nonpt, ptnonipm, pt_oilgas	CONTROL packet: state and MSA-level fuel sulfur control programs provided by several northeastern U.S. states.
4.2.4.6	Natural gas turbines NSPS	ptnonipm, pt_oilgas	CONTROL packet: state and county-level new source natural gas turbine controls, whose reductions by-definition, are a function of growth factors and also equipment retirement assumptions.
4.2.4.7	Process heaters NSPS	ptnonipm, pt_oilgas	CONTROL packet: state and county-level new source process heaters controls, whose reductions by-definition, are a function of growth factors and also equipment retirement assumptions.
4.2.4.8	Arizona Regional Haze	ptnonipm	CONTROL packet: Regional haze controls for Arizona provided by Region 9.
4.2.4.9	CISWI	ptnonipm	CONTROL packet reflecting EPA solid waste rule cobenefits.
4.2.4.10	Data from comments on previous platforms	nonpt, ptnonipm, pt_oilgas	CONTROL packets for all other programs, including Regional Haze, consent decrees/settlements, and other information from states/other agencies in prior platforms.
4.2.5	Stand-alone future year inventories	nonpt, ptnonipm	Introduction to future-year inventories not generated via CoST strategies/packets.

Subsection	Title	Sector(s)	Brief Description
4.2.5.1	Portable fuel containers	nonpt	Reflects impacts of Mobile Source Air Toxics (MSAT2) on PFCs.
4.2.5.2	Biodiesel plants	ptnonipm	Year 2018 new biodiesel plants provided by OTAQ reflecting planned sited-plants production volumes.
4.2.5.3	Cellulosic plants	nonpt	Year 2018 new cellulosic ethanol plants based on cellulosic biofuel refinery siting provided by OTAQ and 2018 NODA.
4.2.5.4	New cement plants	nonpt, ptnonipm	Year 2018 and 2025 ISIS policy case-derived new cement kilns, permitted (point) and model-generated based on shifted capacity from some closed units to open units (nonpt)

4.2.2 CoST Plant CLOSURE packet (ptnonipm, pt_oilgas)

Packet: "CLOSURES_2011v6.2_v3_23feb2015.txt"
This packet contains facility, unit and stack-level closure information derived from the following sources:

1. Emissions Inventory System (EIS) facilities report from December 20, 2014 with closure status equal to "PS" (permanent shutdown)
2. EIS unit-level report from November 29, 2014 with status = 'PS'
3. Concatenation of all 2011v6.0 closures information; see Section 4.2.11.3 at: http://www.epa.gov/ttn/chief/emch/2011v6/outreach/2011v6_2018base_EmisMod_TSD_26feb2014.pdf
4. Comments from states and regional planning organizations.

The EIS sources, accessible at http://www.epa.gov/ttnchie1/eis/gateway/, report post-2011 permanent facility/unit shutdowns through the date of the EIS report, assuming reporting agencies provided the information. The 2011v6.0 closure information is from a concatenation of previous facility and unit-level closure information used in the 2008 NEI-based emissions modeling platform (http://epa.gov/ttn/chief/emch/2007v5/2007v5_2020base_EmisMod_TSD_13dec2012.pdf). In addition, comments on the 2011v6.0 emissions modeling platform received by states and other agencies indicated the removal of some closure information (keep open). Ultimately, all data were updated to match the SMOKE FF10 inventory key fields, with all duplicates removed, and a single CoST packet was generated. The cumulative reductions in emissions from this packet are shown in Table 4-4. Note that these reductions are the same for both 2017 and 2025 future years.

Table 4-4. Reductions from all facility/unit/stack-level closures by modeling sector

Pollutant	ptnonipm	pt_oilgas	Cumulative
CO	7,542	1,473	9,015
NH_3	727	0	727
NO_X	12,250	2,300	14,550
PM_{10}	4,940	108	5,048
$PM_{2.5}$	3,882	104	3,986
SO_2	39,491	184	39,675
VOC	12,695	641	13,336

4.2.3 CoST PROJECTION packets (afdust, ag, c1c2rail, c3marine, nonpt, np_oilgas, ptnonipm, pt_oilgas, rwc)

As previously discussed, for point inventories, after application of any/all CLOSURE packet information, the next step in running a CoST control strategy is the application of all CoST PROJECTION packets. Regardless of inventory type (point or nonpoint), the PROJECTION packets applied prior to the CoST packets. For several emissions modeling sectors (afdust, ag, c1c2rail, c3marine and rwc), there is only one CoST PROJECTION packet. For all other sectors, there are several different sources of PROJECTIONS data and therefore there are multiple PROJECTION packets that are concatenated and quality-assured for duplicates and applicability to the inventories in the CoST strategy. The PROJECTION (and CONTROL) packets were separated into a few "key" control program types to allow for quick summaries of these distinct control programs. The remainder of this section is broken out by CoST packet, with the exception of discussion of the various packets used for oil and gas and industrial source projections; these packets are a mix of different sources of data that targeted similar sources.

4.2.3.1 Paved and unpaved roads VMT growth (afdust)

Packet:
For 2017: "PROJECTION_2011_2017_AFDUST_VMT_2011v6.2_10mar2015.txt"
For 2025: "PROJECTION_2011_2025_AFDUST_VMT_2011v6.2_10mar2015.txt"

We received comments from the 2018 NODA (search for 'EPA-HQ-OAR-2013-0809' at www.regulations.gov) suggesting we grow emissions from paved and unpaved road dust as a function of vehicle miles traveled (VMT). The future year VMT used to project this sector was consistent with the VMT used for the onroad mobile source modeling as described in Section 4.3.1.1. The resulting national sector-total increase in $PM_{2.5}$ emissions are provided in Table 4-5. Note that this packet does not impact any other sources of fugitive dust emissions in the afdust sector (e.g., no impact on construction dust, mining and quarrying, etc.).

Table 4-5. Increase in total afdust $PM_{2.5}$ emissions from VMT projections

2011 Emissions	2017 Emissions	2025 Emissions	% Increase 2017	% Increase 2025
2,510,307	2,623,572	2,792,127	4.5%	11.2%

4.2.3.2 Livestock population growth (ag)

Packet:
For 2017: "PROJECTION_2011_2017_ag_2011v6.2_no_RFS2_04feb2015.txt"
For 2025: "PROJECTION_2011_2025_ag_2011v6.2_no_RFS2_23jan2015.txt"

EPA estimated animal population growth in ammonia (NH_3) emissions from livestock in the ag sector. Except for dairy cows and turkey production, the animal projection factors are derived from national-level animal population projections from the U.S. Department of Agriculture (USDA) and the Food and Agriculture Policy and Research Institute (FAPRI). This methodology was initiated in 2005 for the 2005 NEI, but was updated on July 24, 2012 in support of the 2007v5 platform (EPA, 2012). For dairy cows, EPA assumed that there would be no growth in emissions based on little change in U.S. dairy cow populations from year 2011 through 2025 according to linear regression analyses of the FAPRI projections. This assumption was based on an analysis of historical trends in the number of such animals compared to production rates. Although productions rates have increased, the number of animals has declined. Based on this analysis, EPA concluded that production forecasts do not provide representative estimates of the future number of cows and turkeys; therefore, these forecasts were not used for estimating future-year emissions from these animals. In particular, the dairy cow population is projected to decrease in the future as it has for the past few decades; however, milk production will be increasing over the same period. Note that the ammonia emissions from dairies are not directly related to animal population but also nitrogen excretion. With the cow numbers going down and the production going up the excretion value will change, but no change was assumed because a quantitative estimate was not available. Appendix C provides the animal population data and regression curves used to derive the growth factors.

The projection factors by animal category and ag sector total impacts are provided in Table 4-5. As discussed below, dairy cows are assumed to have no growth in animal population, and therefore the projection factor for these animals is 1.0 (no growth). Impacts from the renewable fuels mandate are not included in projections for this sector.

Table 4-5. NH_3 projection factors and total impacts to years 2017 and 2025 for animal operations

Animal Category	2017 Projection Factors & Total Emissions	2025 Projection Factors & Total Emissions
Dairy Cow	1.0	1.0
Beef	0.988	0.974
Pork	1.069	1.118
Broilers	1.087	1.130
Turkeys	0.947	0.921
Layers	1.063	1.094
Poultry Average	1.057	1.085
Overall Average	1.026	1.041
Total Emissions	**3,584,419**	**3,617,575**
% Increase from 2011	**1.8%**	**2.7%**

4.2.3.3 Locomotives and Category 1 & 2 commercial marine vessels (c1c2rail, ptnonipm)

Packet:
For 2017: "PROJECTION_2011v6.2_2017_c1c2rail_BASE_06feb2015.txt"
For 2025: "PROJECTION_2011v6.2_2025_c1c2rail_BASE_06feb2015.txt"

There are two components used to create projection factors for years 2017 and 2025. The first component of the future year c1c2rail inventory is the non-California data projected from the 2011 base case. The second component is the CARB-supplied year 2011, 2017 and 2025 data for California.

For all states outside of California, national projection factors by SCC and pollutant between 2011 and future years reflect the May 2004 "Tier 4 emissions standards and fuel requirements" (http://www.epa.gov/otaq/documents/nonroad-diesel/420r04007.pdf) as well as the March 2008 "Final locomotive-marine rule" controls (http://www.epa.gov/otaq/regs/nonroad/420f08004.pdf) . The future-year c1c2rail emissions account for increased fuel consumption based on Energy Information Administration (EIA) fuel consumption projections for freight, and emissions reductions resulting from emissions standards from the Final Locomotive-Marine rule (EPA, 2009d).[30] For locomotives, EPA applied HAP factors for VOC HAPs by using VOC projection factors to obtain 1,3-butadiene, acetaldehyde, acrolein, benzene, and formaldehyde. Similar to locomotives, C1/C2 VOC HAPs were projected based on the VOC factor. C1/C2 diesel emissions were projected based on the Final Locomotive Marine rule national-level factors. These non-California projection ratios are provided in Table 4-6. Note that projection factors for "…Yard Locomotives"

[30] This rule lowered diesel sulfur content and tightened emission standards for existing and new locomotives and marine diesel emissions to lower future-year PM, SO_2, and NO_X, and is documented at: http://www.epa.gov/otaq/marine.htm#2008final.

(SCC=2285002010) are applied to the ptnonipm (point inventory) "yard locomotives" (SCC=28500201) reported by a couple of states in the 2011 NEI.

Table 4-6. Non-California projection factors for locomotives and Category 1 and Category 2 Commercial Marine Vessel Emissions

SCC	Description	Poll	2017 Factor	2025 Factor
2280002XXX	Marine Vessels, Commercial; Diesel; Underway & port emissions	CO	0.957	0.955
2280002XXX	Marine Vessels, Commercial; Diesel; Underway & port emissions	NO_X	0.801	0.537
2280002XXX	Marine Vessels, Commercial; Diesel; Underway & port emissions	PM	0.712	0.491
2280002XXX	Marine Vessels, Commercial; Diesel; Underway & port emissions	SO_2	0.157	0.069
2280002XXX	Marine Vessels, Commercial; Diesel; Underway & port emissions	VOC	0.814	0.523
2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations	CO	1.100	1.249
2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations	NO_X	0.840	0.621
2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations	PM	0.716	0.457
2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations	SO_2	0.031	0.036
2285002006	Railroad Equipment; Diesel; Line Haul Locomotives: Class I Operations	VOC	0.656	0.430
2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations	CO	1.100	1.249
2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations	NO_X	1.056	1.065
2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations	PM	1.025	1.012
2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations	SO_2	0.031	0.036
2285002007	Railroad Equipment; Diesel; Line Haul Locomotives: Class II / III Operations	VOC	1.100	1.249
2285002008	Railroad Equipment; Diesel; Line Haul Locomotives: Passenger Trains (Amtrak)	CO	1.049	1.118
2285002008	Railroad Equipment; Diesel; Line Haul Locomotives: Passenger Trains (Amtrak)	NO_X	0.703	0.458
2285002008	Railroad Equipment; Diesel; Line Haul Locomotives: Passenger Trains (Amtrak)	PM	0.661	0.337
2285002008	Railroad Equipment; Diesel; Line Haul Locomotives: Passenger Trains (Amtrak)	SO_2	0.030	0.033
2285002008	Railroad Equipment; Diesel; Line Haul Locomotives: Passenger Trains (Amtrak)	VOC	0.600	0.275
2285002009	Railroad Equipment; Diesel; Line Haul Locomotives: Commuter Lines	CO	1.049	1.118
2285002009	Railroad Equipment; Diesel; Line Haul Locomotives: Commuter Lines	NO_X	0.703	0.458
2285002009	Railroad Equipment; Diesel; Line Haul Locomotives: Commuter Lines	PM	0.661	0.337
2285002009	Railroad Equipment; Diesel; Line Haul Locomotives: Commuter Lines	SO_2	0.030	0.033
2285002009	Railroad Equipment; Diesel; Line Haul Locomotives: Commuter Lines	VOC	0.600	0.275
2285002010	Railroad Equipment; Diesel; Yard Locomotives	CO	1.100	1.249
2285002010	Railroad Equipment; Diesel; Yard Locomotives	NO_X	0.980	0.837
2285002010	Railroad Equipment; Diesel; Yard Locomotives	PM	0.951	0.810
2285002010	Railroad Equipment; Diesel; Yard Locomotives	SO_2	0.032	0.036
2285002010	Railroad Equipment; Diesel; Yard Locomotives	VOC	0.950	0.767

For California projections, CARB provided to EPA the locomotive, and Category 1 and 2 commercial marine emissions used to reflect years 2011, 2017 and year 2025. These CARB inventories included nonroad rules reflected in the December 2010 Rulemaking Inventory (http://www.arb.ca.gov/regact/2010/offroadlsi10/offroadisor.pdf), those in the March 2011 Rule Inventory, the Off-Road Construction Rule Inventory for "In-Use Diesel", cargo handling equipment rules in place as of 2011 (see http://www.arb.ca.gov/ports/cargo/cargo.htm), and the 2007 and 2010 regulations to reduce emissions diesel engines on commercial harbor craft operated within California waters and 24 nautical miles of the California baseline.

The California C1/C2 CMV emissions were obtained from the CARB nonroad mobile dataset "ARMJ_RF#2002_ANNUAL_MOBILE.txt". These emissions were developed using Version 1 of the CEPAM which supports various California off-road regulations. The locomotive emissions were obtained from the CARB trains dataset "ARMJ_RF#2002_ANNUAL_TRAINS.txt". Documentation of the CARB off-road methodology, including c1c2rail sector data, is provided here: http://www.arb.ca.gov/msei/categories.htm#offroad_motor_vehicles. EPA converted the CARB inventory TOG to VOC by dividing the inventory TOG by the available VOC-to-TOG speciation factor. The CARB year-2011 inventory (provided with the 2017 and 2025 emissions) did not match the CARB-submitted inventory in Version 2 of the 2011 NEI; therefore, we used the CARB 2011/2017/2025 data to compute projection ratios that were then applied to the 2011 emissions modeling platform (2011NEIv2). California projection factors were "capped" at 2.5; we found that those counties/SCCs/pollutants with projection factors greater than 2 (100% increase) were all under 100 tons for any given pollutant. The California projection factors are county-level and therefore not provided here.

The non-California projection factors were applied to all "offshore" c1c2 CMV emissions. These offshore emissions, in the 2011 NEI, start at the end of state waters, and extend out to the Economic Exclusion Zone (EEZ). A summary of the national impact for US (including California) and offshore c1c2rail sector emissions are provided in Table 4-7.

Table 4-7. Difference in c1c2rail sector emissions between 2011 and future years

Region	Pollutant	2011	2017	2025	Difference 2017 - 2011	Difference 2025 - 2011
U.S.	CO	185,074	198,436	219,537	13,362	34,463
U.S.	NO_X	1,097,162	933,414	691,890	-163,749	-405,273
U.S.	PM_{10}	36,079	26,484	18,034	-9,594	-18,045
U.S.	$PM_{2.5}$	33,713	24,741	16,850	-8,972	-16,863
U.S.	SO_2	12,869	1,202	905	-11,667	-11,963
U.S.	VOC	48,810	34,956	24,777	-13,854	-24,032
Offshore	CO	66,395	63,515	63,390	-2,880	-3,005
Offshore	NO_X	326,631	261,637	175,482	-64,994	-151,149
Offshore	PM_{10}	10,795	7,687	5,297	-3,108	-5,499
Offshore	$PM_{2.5}$	10,471	7,457	5,138	-3,015	-5,334
Offshore	SO_2	4,014	632	278	-3,382	-3,736
Offshore	VOC	7,472	6,080	3,910	-1,392	-3,562

4.2.3.4 Category 3 commercial marine vessels (c3marine, othpt)

Packet:
For 2017: "PROJECTION_2011_2017_C3_CMV_ECA_IMO_2011v6.2_10feb2015.txt"
For 2025: "PROJECTION_2011_2025_C3_CMV_ECA_IMO_2011v6.2_10feb2015.txt

As discussed in Section 2.4.2, the EPA estimates for C3 CMV emissions data were developed for year 2002 and projected to year 2011 for the 2011 base case and used where states did not submit data to Version 2 of the 2011 NEI. Pollutant and geographic-specific projection factors to year 2011 were applied, along with projection factors to years 2017 and 2025 that reflect assumed growth and final ECA-IMO controls. These emissions estimates reflect EPA's coordinated strategy for large marine vessels. More information on EPA's coordinated strategy for large marine vessels can be found in our Category 3 Marine Diesel Engines and Fuels regulation published in April 2010. That rule, as well as information about the North American and U.S. Caribbean Sea ECAs, designated by amendment to MARPOL Annex VI, can be found here: http://www.epa.gov/otaq/oceanvessels.htm.

Projection factors for creating the year 2017 and 2025 c3marine inventories from the 2011 base case are provided in Table 4-8. Background on the region and Exclusive Economic Zone (EEZ) FIPS is provided in the discussion on the c3marine inventory for 2011 –Section 2.4.2. For example, Washington state emissions are grown the same as all North Pacific offshore emissions.

Table 4-8. Growth factors to project the 2011 ECA-IMO inventory to 2017 and 2025

Region	EEZ (Offshore) FIPS	Year	2017 and 2025 Adjustments Relative to 2011					
			CO	NO_X	PM_{10}	PM_{25}	SO_2	VOC
North Pacific (NP)	85001	2017	1.215	0.989	0.168	0.167	0.047	1.215
		2025	1.575	0.798	0.217	0.216	0.061	1.575
South Pacific (SP)	85002	2017	1.350	1.084	0.187	0.185	0.053	1.351
		2025	2.027	0.909	0.285	0.283	0.081	2.028
East Coast (EC)	85004	2017	1.302	1.039	0.177	0.176	0.047	1.302
		2025	1.852	0.838	0.252	0.250	0.066	1.852
Gulf Coast (GC)	85003	2017	1.187	0.947	0.162	0.161	0.042	1.187
		2025	1.492	0.679	0.204	0.202	0.053	1.492
Great Lakes (GL)	n/a	2017	1.106	0.972	0.146	0.145	0.039	1.106
		2025	1.266	0.940	0.168	0.166	0.045	1.266
Outside ECA	98001	2017	1.298	1.182	1.298	1.298	1.298	1.298
		2025	1.858	1.463	0.409	0.405	0.337	1.858

As discussed in Section 2.4.2, emissions outside the 3 to 10 mile coastal boundary but within the approximately 200 nm EEZ boundaries were projected to years 2017 and 2025 using the same regional adjustment factors as the U.S. emissions; however, the FIPS codes were assigned as “EEZ” FIPS and these emissions are processed in the “othpt” sector (see Section 2.5.1 and 4.5.1). Note that state boundaries in the Great Lakes are an exception, extending through the middle of each lake such that all emissions in the Great Lakes are assigned to a U.S. county or Ontario. The classification of emissions to U.S. and Canadian FIPS codes is needed to avoid double-counting of Canadian-provided C3 CMV emissions in the Great Lakes.

The cumulative impact of these ECA-IMO projections and controls to the U.S. + near-offshore (c3marine sector) and far-offshore emissions (othpt sector) in 2017 and 2025 is provided in Table 4-9.

Table 4-9. Difference in c3marine sector and othpt C3 CMV emissions between 2011 and future years

Region	Pollutant	2011 emissions	2017 emissions	2025 emissions	Difference 2017 - 2011	Difference 2025 - 2011
U.S. + near offshore	CO	13,705	17,057	22,941	3,353	9,237
U.S. + near offshore	NO_X	145,729	147,369	121,177	1,640	-24,552
U.S. + near offshore	PM_{10}	11,370	2,013	2,606	-9,357	-8,764
U.S. + near offshore	$PM_{2.5}$	10,148	1,790	2,322	-8,358	-7,826
U.S. + near offshore	SO_2	95,306	5,093	5,998	-90,213	-89,309
U.S. + near offshore	VOC	5,645	7,047	9,515	1,401	3,870
far-offshore (othpt sector)	CO	251,654	324,915	461,376	73,261	209,722
far-offshore (othpt sector)	NO_X	2,935,480	3,361,627	3,864,871	426,147	929,391
far-offshore (othpt sector)	PM_{10}	216,192	249,379	83,553	33,187	-132,639
far-offshore (othpt sector)	$PM_{2.5}$	198,750	229,369	76,127	30,619	-122,623
far-offshore (othpt sector)	SO_2	1,617,893	1,825,762	486,412	207,870	-1,131,480
far-offshore (othpt sector)	VOC	106,860	137,972	195,924	31,112	89,064

4.2.3.5 Upstream distribution, pipelines and refineries (nonpt, ptnonipm, pt_oilgas)

Packet:
For 2017: “PROJECTION_2011_2017_OTAQ_upstream_GasDist_pipelines_refineries_2011v6.2_05feb2015.txt”
For 2025: “PROJECTION_2011_2025_OTAQ_upstream_GasDist_pipelines_refineries_2011v6.2_05feb2015.txt”

To account for projected increases in renewable fuel volumes due to the Renewable Fuel Standards (RFS2)/EISA (EPA, 2010a) and decreased gasoline volumes due to RFS2 and light-duty greenhouse gas standards as quantified in AEO 2014 (http://www.eia.gov/forecasts/archive/aeo14/), EPA developed county-level inventory adjustments for gasoline and gasoline/ethanol blend transport and distribution for 2018 and 2025. Here, 2018 adjustments are used for 2017. These adjustments account for losses during truck, rail and waterways loading/unloading and intermodal transfers such as highway-to-rail, highways-to-waterways, and all other possible combinations of transfers. Adjustments for 2018 only account for impacts of RFS2, and the 2025 adjustments also account for additional impacts of greenhouse gas emission standards for motor vehicles (EPA, 2012b) on transported volumes. These emissions are entirely evaporative and therefore limited to VOC.

A 2018 inventory which included impacts of the EISA mandate was developed by applying adjustment factors to the 2011NEIv2 inventory. These adjustments were made using an updated version of EPA’s model for upstream emission impacts, developed for the RFS2 rule[31]. The methodology used to make these adjustments is described in a 2014 memorandum included in the docket for the EPA Tier 3 rule (EPA, 2014).[32]

Ethanol emissions were estimated in SMOKE by applying the ethanol to VOC ratios from headspace profiles to VOC emissions for E10 and E15, and an evaporative emissions profile for E85. These ratios are 0.065 for E10, 0.272 for E15, and 0.61 for E85. The E10 and E15 profiles were obtained from an ORD analysis of fuel samples from EPAct exhaust test program[33] and were submitted for incorporation into the EPA’s SPECIATE database. The E85 profile was obtained from data collected as part of the CRC E-80 test program (Environ, 2008) and was also submitted into EPA’s SPECIATE database. For more details on the change in speciation profiles between 2011 and 2018, see Section 3.2.1.4.

Pipeline usage and refinery emissions were adjusted to account for impacts of the 2017-2025 light duty vehicle greenhouse gas emission standards, as well as renewable fuel volume projections. These adjustments were developed by EPA OTAQ and impact processes such as process heaters, catalytic cracking units, blowdown systems, wastewater treatment, condensers, cooling towers, flares and fugitive emissions. Calculation of the emission inventory impacts of decreased gasoline and diesel production, due to renewable fuel volume projections, on nationwide refinery emissions was done in EPA’s spreadsheet model for upstream emission impacts (EPA, 2009b). Emission inventory changes reflecting these impacts were used to develop adjustment factors that were applied to inventories for each petroleum refinery in the U.S. These impacts of decreased production were assumed to be spread evenly across all U. S. refineries. Toxic emissions were estimated in SMOKE by applying speciation to VOC emissions. It should be noted that the adjustment factors are estimated relative to that portion of refinery emissions associated with gasoline and diesel fuel production. Production of jet fuel, still gas and other products also produce emissions. If these emissions were included, the adjustment factors would not be as large.

[31] U.S. EPA. 2013. Spreadsheet “upstream_emissions_rev T3.xls.
[32] U. S. EPA. Development of Air Quality Reference Case Upstream and Portable Fuel Container Inventories for the Tier 3 Final Rule. Memorandum from Rich Cook, Margaret Zawacki and Zoltan Jung to the Docket. February 25, 2014. Docket EPA-HQ-OAR-2011-0135.
[33] U.S. EPA. 2011. Hydrocarbon Composition of Gasoline Vapor Emissions from Enclosed Fuel Tanks. Office of Research and Development and Office of Transportation and Air Quality. Report No. EPA-420-R-11-018. EPA Docket EPA-HQ-OAR-2011-0135.

The resulting adjustments for pipelines, refineries and the gasoline distribution processes (RBT, BPS and BTP) are provided in Table 4-10. Separate adjustments were applied to refinery to bulk terminal (RBT), bulk plant storage (BPS), and bulk terminal to gasoline dispensing pump (BTP) components. Emissions for the BTP component are greater than the RBT and BPS components. See Appendix B for the complete cross-walk between SCC, for all component types of petroleum transport and storage components. An additional adjustment was applied for 2025 at a national scale to account for impacts of gasoline volume reductions of the 2017-2025 light-duty greenhouse gas rule.

Notice that the "2011 Emissions" are not the same in Table 4-10. This is because these "2011" emissions are actually an intermediate set up projections applied after a first CoST strategy used to apply most other PROJECTION and CONTROL packets. We decided to first apply these other packets because we have multiple PROJECTION and CONTROL programs that impact the same emission sources. For this example, we applied year-specific industrial sector AEO-based growth (discussed in the next section) with our first CoST strategy, then applied these "EISA" adjustments on the results of this first CoST strategy. Similarly, we have IC Engine (RICE) existing (NESHAP) as well as new source (NSPS) controls that need to be applied in separate strategies. Alternatively, we could have made "compound" CoST packets that combine these PROJECTION (and CONTROL) factors, but preferred to keep these packets separate for transparency. If we tried to process the multiple packets affecting the same sources in a single CoST strategy, CoST would either fail if the packet entries were are the same key-field resolution (duplicate error), or, if packets were at a different key-field resolution, CoST would only apply the packet entry with higher priority according to Table 4-2.

Table 4-10. Petroleum pipelines & refineries and production storage and transport factors and reductions

Poll	Year	Factors: Pipelines & Refineries	Factors: RBT	Factors: BTP/BPS	2011 Emissions	Reduction	% Reduction
CO	2018	0.9896	n/a		53,527	557	1.0%
	2025	0.9295			53,206	3,733	7.0%
NO_X	2018	0.9877	n/a		68,406	838	1.2%
	2025	0.9172			62,713	5,191	8.3%
PM_{10}	2018	0.9938	n/a		24,486	152	0.6%
	2025	0.9578			24,140	1,017	4.2%
$PM_{2.5}$	2018	0.9940	n/a		21,602	130	0.6%
	2025	0.9592			21,269	867	4.1%
SO_2	2018	0.9909	n/a		79,391	719	0.9%
	2025	0.9386			78,766	4,812	6.1%
VOC	2018	0.9934	0.9940	0.9581	750,311	21,629	2.9%
	2025	0.9555	0.8172	0.7878	744,678	143,906	19.3%

4.2.3.6 Oil and gas and industrial source growth from 2011v6.0 NODA (nonpt, np_oilgas, ptnonipm, pt_oilgas)

2017 Packets:
"PROJECTION_2011v6.2_2018_nonpoint_SCC_SRAcapped_05dec2014"
"PROJECTION_2011v6.2_2018_SCC_NONPOINT_LADCO_09dec2014"
"PROJECTION_2011v6.2_2018_SCC_NONPOINT_SCA_orig_CAPPED_09dec2014"
"PROJECTION_2011v6.2_2018_SRAcapped_POINT_05dec2014"
"PROJECTION_2011v6.2_2018_SCC_POINT_LADCO_09dec2014"
"PROJECTION_2011v6.2_2018_SCC_POINT_SCA_orig_CAPPED_09dec2014"
"PROJECTION_2011v6.2_2018_NAICS_SCC_SCA_orig_NEI_matched_CAPPED2.5_04dec2014"

2025 Packets:
"PROJECTION_2011v6.2_2025_nonpoint_SCC_SRAcapped_05dec2014"
"PROJECTION_2011v6.2_2025_SCC_NONPOINT_LADCO_09dec2014"
"PROJECTION_2011v6.2_2025_SCC_NONPOINT_SCA_orig_CAPPED_09dec2014"
"PROJECTION_2011v6.2_2025_SRAcapped_POINT_05dec2014"
"PROJECTION_2011v6.2_2025_SCC_POINT_LADCO_09dec2014"
"PROJECTION_2011v6.2_2025_SCC_POINT_SCA_orig_CAPPED_09dec2014"
"PROJECTION_2011v6.2_2025_NAICS_SCC_SCA_orig_NEI_matched_CAPPED2.5_04dec2014"

The EPA provided a Notice of Data Availability (NODA, search for the docket 'EPA-HQ-OAR-2013-0809' on regulations.gov) for the 2011v6.0 emissions modeling platform and projected 2018 inventory in January, 2014. A significant number of the comments were about the EPA's "no growth" assumption for industrial stationary sources and about the current projection approach for oil and gas sources that was applied similarly to 5 broad geographic (NEMS) regions and limited to only oil and gas drilling activities.

With limited exceptions, the EPA has used a no-growth assumption for all industrial non-EGU emissions since the 2005 NEI-based emissions modeling platform (EPA, 2006). However, comments provided to the EPA for this platform (via the NODA) and for previous modeling platforms suggested that this approach was insufficient. In addition, the NO_X Budget program, which had a direct impact on post-2002 emissions reductions, is in full compliance in the 2011 NEI. This means that additional large-scale industrial reductions should not be expected beyond 2011 in the absence of on-the-books state and federal rules.

In response to the comments about EPA's no-growth approach, the EPA developed industrial sector activity-based growth factors. In response to the NODA, many states have additionally provided detailed activity-based projection factors for industrial sources, including oil and gas sources. To develop the methods described here, we have blended the state-provided growth factors with the EPA-developed industrial sector growth factors. This approach has attempted to balance using the specific information that is available with EPA's interest in consistency for a given sector and technical credibility. Table 4-11 lists the resulting data sources for industrial sector non-EGU growth factors that EPA applied to this emissions modeling platform. Note that this list does not include the revised "projection packets" from the 2011v6.0-based platform, which were also sent to the EPA via the docket process. That additional data were considered and included in our projections as well, and are discussed separately in Section 4.2.3.7.

Ultimately, there were 3 broad sources of projection information for industrial sources, including oil and gas; these sources are referenced as the following for simplicity (e.g., realizing that not all data from Mid-Atlantic Regional Air Management Association (MARAMA) states are limited to MARAMA states):

1) EPA: Reflects EPA-sponsored data provided by a contractor (SC&A, 2014a; SC&A, 2014b). Packet file names for these data include "SCA".

2) MARAMA: Reflects data submitted on behalf of Atlantic seaboard states from North Carolina through Maine, and extending west through Pennsylvania and West Virginia. Packet file names for these data include "SRA" (SRA, 2014).

3) LADCO: Reflects data submitted on behalf of Lake Michigan Air Directors Consortium (LADCO) states (MN, WI, MI, IL, IN, OH). Projection data from this data source are reflected in packet names containing "LADCO" (Alpine Geophysics, 2014).

Table 4-11. Sources of new industrial source growth factor data from the 2011v6.0 NODA

Abbrev.	Source	Geographic Resolution	Inventory Resolution	Use/Caveat
EPA	2014 AEO fuel consumption/production for EPA "priority" categories: IC Engines, Gas Turbines and ICI Boilers/Process Heaters	Census Division	NAICS/SCC or SCC	Impacts almost all non-EGU stationary industrial and commercial sources. These data are used where LADCO and MARAMA data (below) are not also provided. Growth factors are "capped" to 1.25 (25% cumulative growth) and outlier values (e.g., commercial residual oil) set to no-growth, consistent with MARAMA growth factor data (below).
EPA	2014 AEO Crude Oil Production, Natural Gas Production and Lease plant fuel + pipeline fuel natural gas consumption	AEO Oil/Gas Play-level and "Rest of Census Division"	NAICS/SCC or SCC	Impacts both point and nonpoint oil and gas sectors as well as some non-EGU point sources not in the pt_oilgas sector. These data supersede any/all other projections data, including LADCO/MARAMA information with minor exceptions (PA drilling, NY state no-growth, point source MARAMA data). These data also "cap" growth factors to 2.5 (150% cumulative growth).
MARAMA	MARAMA/SRA/states	State or county for nonpoint and facility and below for most point sources	Facility and sub-facility for point, SCC-level for nonpoint	Many projection factors are unchanged from the 2011v6.0 platform; however, many new data provided were included in our 2011v6.2 platform. However, the provided oil and gas projection data were not used, as we opted for single data source "EPA" approach. Emissions assigned a cap of 1.25 for many non-oil/gas production related sources (regardless of future year); we retain this cap and also apply this cap to all non-oil and gas sources.
LADCO	LADCO/Alpine/states	State or county	SCC	Most projection factors are unchanged from 2011v6.0 platform. Oil and Gas factors from 2014 AEO but state-level only. We only used the new growth factor data, essentially limited to a couple priority (LADCO) source categories and did NOT use any oil and gas production-based projections data, opting instead to use the single data source "EPA" approach. As a result, these data have very limited impact on point and nonpoint oil and gas projections.

A discussion of each projection component in Table 4-11 is discussed below.

"EPA" factors

As previously discussed, the EPA created a nationally-consistent set of industrial source projection factors for several future years. We relied on 2014 AEO fuel consumption/production projections data to develop growth factors for our first two "priority" source categories: IC Engines/Gas Turbines and ICI Boilers/Process Heaters. Table 4-12 provides a summary of the approaches used. We selected specific AEO energy consumption data sets that reflect the best available indicator of each source's emissions activity. The discussion below provides more details on the approaches summarized in Table 4-12. This discussion is generally organized from the most straightforward approach, to the most complex. Growth factors were only developed for the specific NAICS codes that the AEO identifies as associated with economic sector-specific fuel consumption projections. These NAICS codes are listed in Table 4-13. The EPA mapped and expand the resulting NAICS/SCC and SCC growth factors to all relevant SCCs in the 2011v6.2 inventories. In cases where the AEO data showed a fuel type with zero consumption in each year, we set the growth factors for these fuels to "1.0" for each relevant year. This approach holds the growth flat for those fuels rather than zeros out the emissions in future years.

For all applicable commercial/institutional fuel combustion priority category SCCs, we compiled 2014 AEO regional commercial sector energy consumption projections data by fuel type for 2011, 2018, 2025 and 2030, and computed growth factors for each projection year/fuel type as the ratio of each future year's energy consumption to 2011 energy consumption. The AEO's commercial sector fuel consumption regions are equivalent to Census Divisions (see www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf). Because Census Divisions are groups of states, commercial/institutional fuel combustion growth factors were developed at the state-level, with each state in a given division assigned the same growth factors.

Table 4-12. Summary of "EPA" Projection Approaches for IC Engines/Gas Turbines and ICI Boilers/Process Heaters

Source Category	Industry Sector[1]	NAICS Code(s)	Fuel Type(s)	Summary of Approach
Commercial/ Institutional			All	AEO Commercial sector energy consumption projections by fuel type by Census Division
Industrial	Food	311	All	Calculate national energy intensity factors by AEO industry sector and fuel type; multiply by projected industry sector output at Census Division level to yield estimated regional energy consumption by sector/fuel type; and calculate regional growth factors by fuel type from these estimates
	Paper	322		
	Refining	32411		
	Bulk Chemical	3251, 3252, 3253		
	Glass	3272		
	Cement	32731, 32741		
	Iron and Steel	3311		
	Aluminum	3313		
	Metal Based Durables	332-336		
	Other Manufacturing	all other 31-33		
Other	Agriculture	111,112,113,115	All	Calculate national energy intensity factors by AEO industry sector and fuel type; multiply by projected industry sector output at Census Division level to yield estimated regional energy consumption by sector/fuel type; and calculate regional growth factors by fuel type from these estimates
	Construction	233-238		
	Mining	211, 2121, 2122-2123		
	Oil/Gas Production[2]	211, 213111, 213112, 2212, 4861, 4862,	Natural Gas	***AEO Oil/Gas Play-level***: Calculate ratios of national oil/gas production to oil/gas sector constant dollar output; multiply ratios by AEO Census Division-level oil/gas sector constant dollar output to estimate Census Division-level oil/gas production; calculate Census Division-level ratios representing the sum of lease plant fuel + pipeline fuel natural gas consumption to the estimated volume of oil/gas produced; multiply these ratios by the volume of oil/gas produced in each applicable oil/gas play to yield oil/gas play-level projections of lease plant fuel + pipeline fuel natural gas consumption; finally, calculate play-level growth factors from these estimates. ***Rest of Nation***: Calculate "rest-of-Census Division" consumption estimates for pipeline fuel natural gas + lease and plant fuel by subtracting oil/gas play consumption estimates from the Census Division estimates published in the AEO. This yields nine sets of growth factors for each year, corresponding to each of the nine Census Divisions.
			All other	***AEO Oil/Gas Plays***: Calculate the national ratio of oil/gas sector constant dollar output to the volume of oil and gas produced for each year; multiply these national ratios by AEO estimates of oil and gas production in each oil/gas play to yield estimates of oil/gas sector constant dollar output in each play; multiply the oil/gas sector constant dollar output estimates for each play by ratios of national Mining sector fuel consumption to national oil/gas sector constant dollar output (this procedure develops estimates of mining sector energy consumption by fuel type within each oil/gas play); and calculate growth factors by play/fuel type from these estimates. ***Rest of Nation***: develop "rest-of-Supply Region" oil/gas production estimates by subtracting the AEO's oil/gas production estimates for these plays from AEO's total oil/gas Supply region production estimates (the residual production values are then used to calculate the "rest-of-Supply Region" growth factors). This yields six sets of growth factors for each year, corresponding to each of the AEO's six oil/gas Supply Regions.
	All Other		All	AEO total energy consumption projections by fuel type and Census Division

Notes: Though not displayed in this table, a no-growth assumption was applied to 3 rocket engine SCCs, and applied AEO transportation sector fuel consumption projections to aircraft and railroad equipment-related SCCs.
[1] Identified based either on NAICS code or SCC/NAICS code-see text for discussion.
[2] In addition to priority category SCC records with oil/gas production NAICS codes, factors will also be applied to natural gas production SCCs (e.g., 31000203-Natural Gas Production/Compressors).

Table 4-13. NAICS Codes for which NAICS/SCC-level Growth Factors were developed

NAICS Code	NAICS Code Description
111	Crop Production
112	Vegetable and Melon Farming
113	Fruit and Tree Nut Farming
115	Support Activities for Agriculture and Forestry
211	Oil and Gas Extraction
2121	Coal Mining
2122	Iron Ore Mining
2123	Nonmetallic Mineral Mining and Quarrying
213111	Drilling Oil and Gas Wells
213112	Support Activities for Oil and Gas Operations
2212	Natural Gas Distribution
233	Nonresidential Building Construction
234	Heavy Construction
235	Special Trade Contractors
236	Construction of Buildings
237	Heavy and Civil Engineering Construction
238	Specialty Trade Contractors
311	Food Manufacturing
312	Beverage and Tobacco Product Manufacturing
313	Textile Mills
314	Textile Product Mills
315	Apparel Manufacturing
316	Leather and Allied Product Manufacturing
321	Wood Product Manufacturing
322	Paper Manufacturing
323	Printing and Related Support Activities
32411	Petroleum Refineries
32412	Asphalt Paving, Roofing, and Saturated Materials Manufacturing
32419	Other Petroleum and Coal Products Manufacturing
3251	Basic Chemical Manufacturing
3252	Resin, Synthetic Rubber, and Artificial Synthetic Fibers and Filaments Manufacturing
3253	Pesticide, Fertilizer, and Other Agricultural Chemical Manufacturing
3254	Pharmaceutical and Medicine Manufacturing
3255	Paint, Coating, and Adhesive Manufacturing
3256	Soap, Cleaning Compound, and Toilet Preparation Manufacturing
3259	Other Chemical Product and Preparation Manufacturing
326	Plastics and Rubber Products Manufacturing
3272	Glass and Glass Product Manufacturing
32731	Cement Manufacturing
32732	Ready-Mix Concrete Manufacturing
32733	Concrete Pipe, Brick, and Block Manufacturing
32739	Other Concrete Product Manufacturing

NAICS Code	NAICS Code Description
32741	Lime Manufacturing
3279	Other Nonmetallic Mineral Product Manufacturing
3311	Iron and Steel Mills and Ferroalloy Manufacturing
3312	Steel Product Manufacturing from Purchased Steel
3313	Alumina and Aluminum Production and Processing
3314	Nonferrous Metal (except Aluminum) Production and Processing
3315	Foundries
332	Fabricated Metal Product Manufacturing
333	Machinery Manufacturing
334	Computer and Electronic Product Manufacturing
335	Electrical Equipment, Appliance, and Component Manufacturing
336	Transportation Equipment Manufacturing
337	Furniture and Related Product Manufacturing
339	Miscellaneous Manufacturing
4861	Pipeline Transportation of Crude Oil
4862	Pipeline Transportation of Natural Gas

For all IC Engine/Gas Turbines and ICI Boilers/Process Heaters SCCs in the 2011 NEI that have no NAICS code, or a NAICS code for which there is no economic sector-specific AEO energy forecast available, we compiled growth factors based on the SCC process description. For example, SCC 10200101 (External Combustion Boilers; Industrial; Anthracite Coal; Pulverized Coal) is assigned to AEO's Total Industrial sector coal consumption projections.

For all oil and gas production priority category SCCs (e.g., SCC 23100xxxxx) and all other priority category SCCs with oil/gas production-related NAICS codes, we used two separate approaches for AEO oil/gas plays (see Table 4-14). The first approach is specific to natural gas consumption, and the other approach is for consumption of all other individual fuel types. Because the AEO does not have information on the counties that comprise each of the oil/gas plays represented by the AEO data, we developed the necessary county lists using an internet search of oil/gas play maps and other related information. For counties not included in one of the AEO data's oil/gas plays, "rest-of-Census Division" oil/gas consumption estimates were computed to develop growth factors for projecting energy consumption for all fuel types except natural gas (e.g., residual and distillate oil, coal, LPG, kerosene). Details on the oil/gas production sector growth factor development methods are described below.

Table 4-14. AEO Oil/Gas Plays

Tight Oil Play*	Shale Gas Play
Austin Chalk	Antrim
Avalon/Bone Springs	Bakken
Bakken	Barnett
Eagle Ford	Eagle Ford
Monterey	Fayetteville
Niobrara	Haynesville/Bossier
Sprayberry	Marcellus
Wolfcamp	
Woodford	

* AEO also publishes estimates for an "Other" tight oil plays category, however, EIA was unable to provide a list of what plays should be considered included in this "Other" category. "Tight" oil (not to be confused with oil, or "kerogen" shale) refers to heterogeneous formations of low-permeability that vary widely over relatively short distances.

Natural Gas Consumption and Crude Oil Production

For natural gas consumption-related growth factor records, we developed oil/gas production area ("play")-level estimates of natural gas consumption and "rest-of-Census Division" estimates, which were applied to counties outside these play areas. For each relevant year, we first calculated from AEO's projections, the ratio of national oil/gas production (in BTUs) to national oil/gas sector constant dollar output. These values were then multiplied by AEO projections of Census Division-level oil/gas sector constant dollar output to yield Division-level estimates of oil/gas production by year (in BTUs). Next, we computed AEO Census Division-level ratios of the sum of pipeline fuel natural gas + lease and plant fuel consumption[35] to the estimated volume of oil/gas produced in each year. Then we developed oil/gas play-level projections of pipeline fuel natural gas + lease and plant fuel consumption by multiplying the Census Division-level ratios by the AEO estimates of oil/gas production in each play by year. Growth factors for each play/forecast year were developed by dividing each forecast year's estimated consumption of pipeline fuel natural gas + lease and plant fuel by the estimated 2011 total volume of these fuels.

We calculated "rest-of-Census Division" consumption estimates for pipeline fuel natural gas + lease and plant fuel by subtracting the oil/gas play consumption estimates from the Census Division estimates published in the AEO. This yielded nine sets of growth factors for each year, corresponding to each of the nine Census Divisions. These growth factors reflect "rest-of-Census Division" estimated consumption of pipeline fuel natural gas + lease and plant fuel, and were applied to the non-AEO oil/gas play counties in each Division.

Crude oil production growth factors were also generated for crude oil production-specific sources (SCCs). These growth factors were generated at similar spatial resolution as natural gas consumption factors: oil/gas production "play"-level and rest of Census Division resolution. These data are based on AEO reference table "14" Crude Oil Production and Supply projections.

Other Fuels

The AEO prepares fuel consumption projections for the mining sector, which is comprised of the Oil & Gas Extraction & Support Activities, Coal Mining, and Other Mining and Quarrying sectors. On a national basis, AEO data indicate that the Oil & Gas Extraction & Support Activities sector contributed 85 percent of total

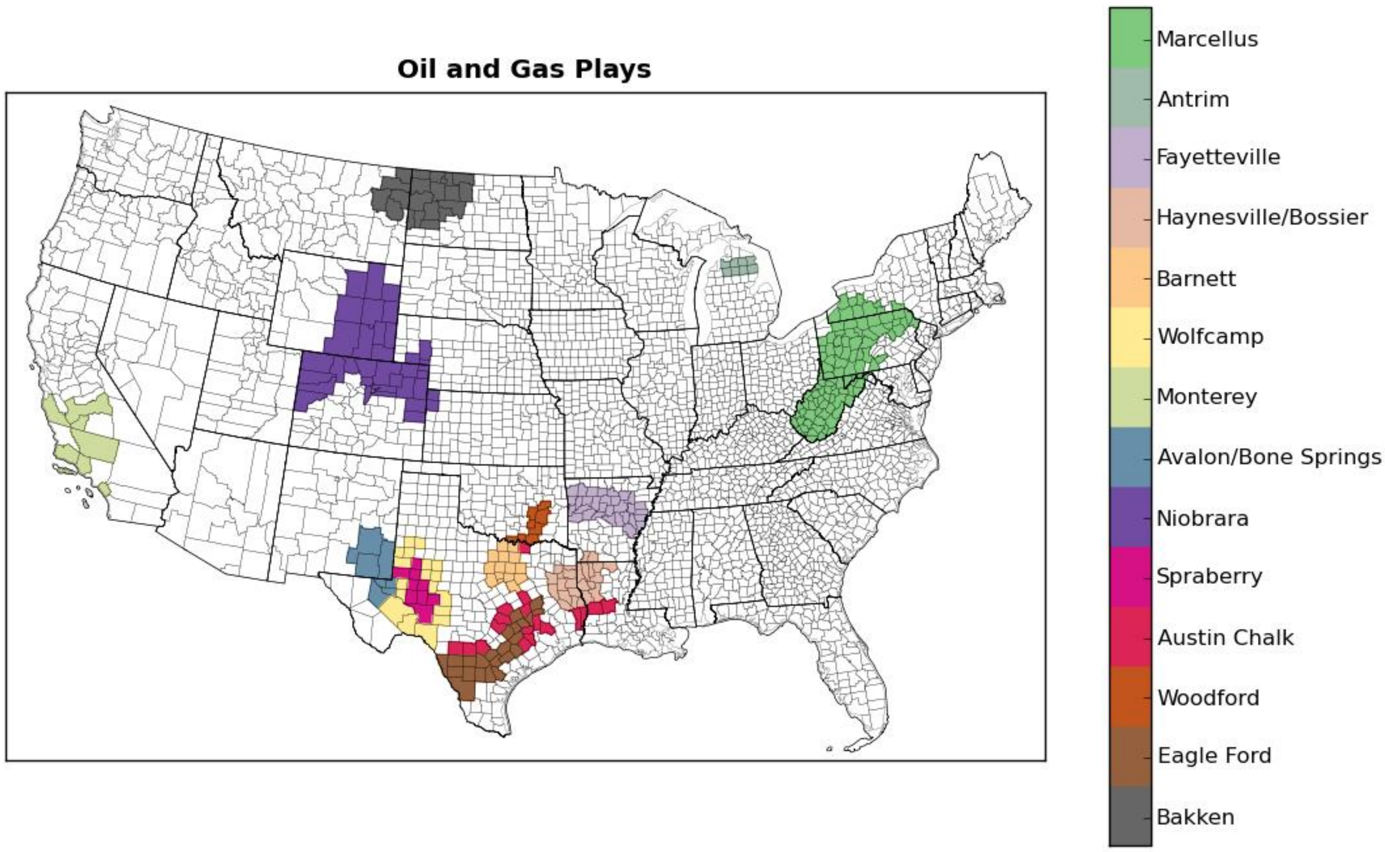
[35] While pipeline fuel natural gas should be self-explanatory, lease and plant fuel refers to "natural gas used in well, field, and lease operations, in natural gas processing plant machinery, and for liquefaction in export facilities."

mining sector output (NAICS codes 211, 2121, 2122-2123) in the 2011 NEI, and is projected to account for a similar contribution (86 percent) in 2030. Estimates of mining sector energy consumption by fuel type for the AEO oil and gas plays were developed, and assumed that mining sector fuel consumption growth rates approximate growth rates in the oil/gas sector for these plays. Because of concerns that oil/gas production may not represent as significant a contribution to total mining activity in other areas (outside oil/gas plays), we chose not to use estimated Mining sector fuel consumption data to project oil/gas production sector fuel consumption in other areas of the country.

Oil/Gas Plays

As listed in Table 4-14 and displayed in Figure 4-1, the AEO reports oil and natural gas production projections for a number of individual oil and gas plays. The first step in estimating oil/gas sector energy consumption projections for these plays was to calculate, for each relevant year, the national ratio of Oil/Gas sector constant dollar output to the volume of oil and gas produced (expressed in BTUs) from the AEO. We then estimated Oil/Gas sector constant dollar output in each oil/gas play by multiplying these national ratios by AEO estimates of oil and gas production (BTUs) in each oil/gas play. These oil/gas play-level output estimates were then multiplied by year-specific national AEO ratios of Mining sector fuel consumption to Oil/Gas sector output, which produced Mining sector fuel consumption estimates by play/year. As noted above, these Mining sector estimates are deemed to be reasonable surrogates for Oil/Gas sector activity in the AEO oil/gas play areas.

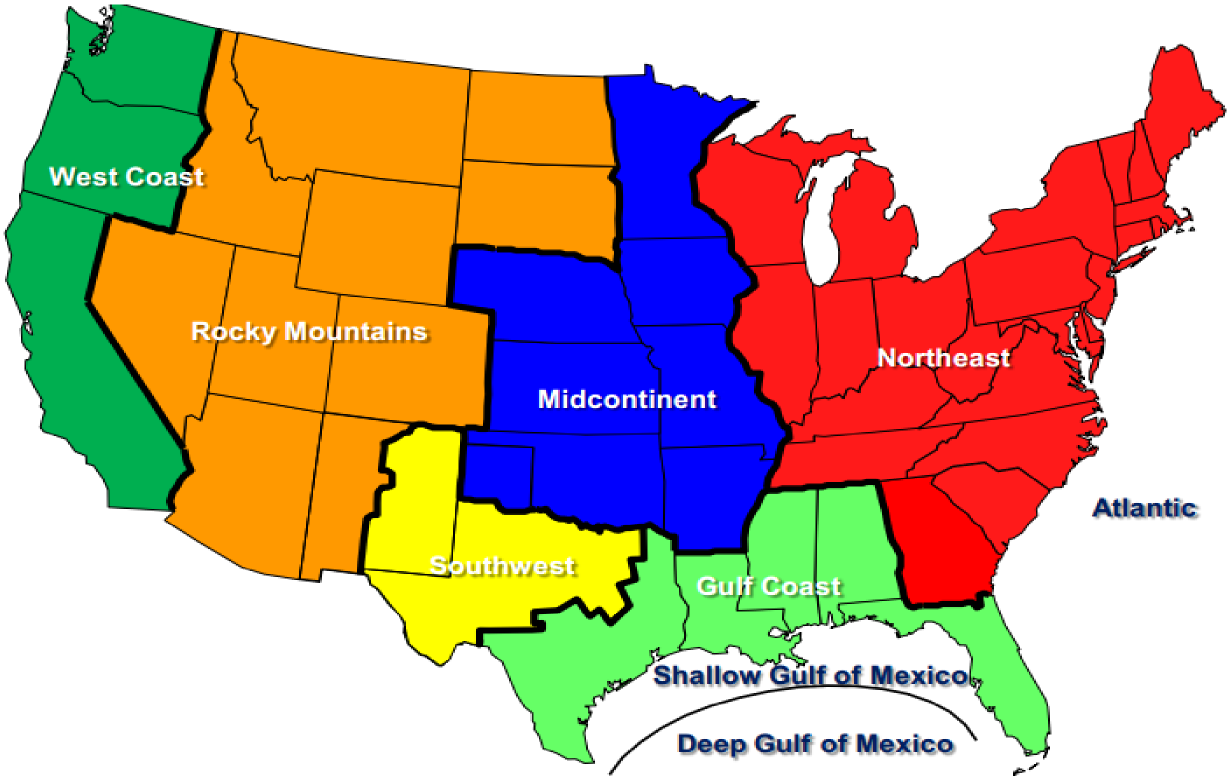
Figure 4-1. Oil and gas plays with AEO projection data



Remaining Areas

For all non-AEO gas/oil play counties, we developed "rest-of-Supply Region" (National Energy Modeling System, or "NEMS") oil/gas production estimates as the surrogate growth indicator for projecting fuel consumption in the Oil/Gas sector. These NEMS regions are shown in Figure 4-2. Since we address oil/gas play areas separately, this approach reflects oil/gas production occurring outside these areas. To accomplish this, we subtracted the AEO's oil/gas production estimates for these plays from AEO's total Oil/Gas Supply region production estimates, and used the result to calculate the growth factors for areas outside the oil/gas plays. After implementing this procedure, we produced six sets of "rest-of-Oil/Gas Supply Region" growth factors (one for each of the six Supply Regions) for application to counties in each supply region not in one of the AEO oil/gas plays. All oil and gas production related growth factors were capped at 2.5 (150% increase). Note that raw AEO growth factors of 4-6+ were not uncommon for 2018 and 2025. The cap addresses concerns that the uncertainty in these projections was too great to allow such dramatic growth.

Figure 4-2. Oil and Gas NEMS Regions



"MARAMA" factors

The MARAMA states provided usable projections and controls data for 15 states (SRA, 2014). The growth data for oil and gas-specific processes (SCC-level) were not used. Rather, we used the EPA approach for nonpoint oil and gas emissions because it was more comprehensive and consistent nationally. We used the MARAMA facility and sub-facility (point inventory) growth factors; only a small subset of these factors impact oil and gas point sources (facilities). We capped growth factors related to employment growth for both point and nonpoint factors at 1.25 (25% cumulative growth) to prevent excessive overestimation of future-year emissions.

The MARAMA point inventory projection factors were included in our projection packets at facility and sub-facility resolution and supersede any/all "EPA"-based SCC and NAICS/SCC projection factors (recall the CoST hierarchy described in Section 4.2.1). We used the other (i.e., non-oil and gas) MARAMA nonpoint projection factors which cover a large portion of the nonpoint sectors, including ICI fuel combustion, construction and mining, surface coating and degreasing processes, dry cleaners and waste water treatment.

"LADCO" factors

Similar to the MARAMA data, the LADCO (Midwest RPO) states provided usable projections and controls data for some states: MI, OH, IN. IL, WI, MN, IA, MO and KY (Alpine Geophysics, 2014). We did not use the growth data for oil and gas-specific processes (SCC-level). Rather, we used the EPA approach for nonpoint oil and gas emissions because it was more comprehensive and consistent nationally. The only facility or sub-facility growth factors for LADCO's "priority" source categories that remained were limited to (hydraulic) frac sanding mining and petroleum mining. Our use of the nonpoint factors were limited to agriculture tilling and pesticide application, degreasing operations and residential wood combustion (RWC); we split out RWC factors and merged with our "rest of the country" set of projection factors (discussed in Section 4.2.3.11). These growth factors were all deemed reasonable, in that the values were well under 2.0 -a 100% increase and did not rely on employment growth projections, and as such these were used essentially as-is. Note that the impact of these factors will be seen more for RWC than other stationary non-EGU emissions modeling sectors.

Net impacts of projection factors

Net impacts of these projection packets for each of the modeling sectors is provided in Table 4-15. There are a couple of items to note:

1) All projection factors are for years 2018 and 2025; we used 2018 factors for year 2017.
2) The "2011 Emissions Subject to PROJECTION factors" in Table 4-15 are different in the 2017 and 2025 projection processes/routines (CoST strategies) because other previously-applied PROJECTIONS or CLOSURES data differ for year 2017 and 2025, making the remaining 2011 emissions subject to these specific PROJECTION packets different.
3) The largest increases are to the nonpoint oil and gas sector; however, these are not the final future year impacts, as significant new and existing controls, discussed in 4.2.4, have not yet been applied in creating the future-year emissions values shown in this table.

Table 4-15. Industrial source projections net impacts from 2011v6.0 NODA

		2011 Emissions Subject to PROJECTION factors		Intermediate Projected (not yet controlled) Emissions		Difference (Future - 2011)		% Difference (Future - 2011)	
Poll	**Sector**	**For 2017**	**For 2025**	**2017**	**2025**	**2017**	**2025**	**2017**	**2025**
CO	nonpt	672,183	673,783	698,363	720,949	26,179	47,167	4%	7%
CO	np_oilgas	532,211	532,211	683,021	795,874	150,811	263,663	28%	50%
CO	pt_oilgas	228,664	228,577	233,940	307,594	5,276	79,016	2%	35%
CO	ptnonipm	572,046	568,599	611,005	625,670	38,959	57,071	7%	10%
CO	**Total**	**2,005,104**	**2,003,169**	**2,226,329**	**2,450,086**	**221,224**	**446,917**	**11%**	**22%**
NH_3	nonpt	15,938	15,938	16,465	16,581	528	643	3%	4%
NH_3	pt_oilgas	222	222	165	207	-57	-15	-26%	-7%
NH_3	ptnonipm	12,364	12,233	12,958	13,113	593	880	5%	7%
NH_3	**Total**	**28,524**	**28,392**	**29,588**	**29,900**	**1,064**	**1,508**	**4%**	**5%**
NO_X	nonpt	477,769	472,942	497,051	498,126	19,281	25,184	4%	5%
NO_X	np_oilgas	576,626	576,626	775,875	902,334	199,250	325,709	35%	56%

Poll	Sector	2011 Emissions Subject to PROJECTION factors		Intermediate Projected (not yet controlled) Emissions		Difference (Future - 2011)		% Difference (Future - 2011)	
		For 2017	For 2025	2017	2025	2017	2025	2017	2025
NO_X	pt_oilgas	522,192	522,026	476,963	622,751	-45,229	100,725	-9%	19%
NO_X	ptnonipm	586,160	575,044	610,221	615,481	24,061	40,437	4%	7%
NO_X	**Total**	**2,162,747**	**2,146,637**	**2,360,110**	**2,638,692**	**197,362**	**492,055**	**9%**	**23%**
PM_{10}	nonpt	260,831	260,792	278,565	293,743	17,734	32,951	7%	13%
PM_{10}	np_oilgas	15,270	15,270	19,537	23,691	4,267	8,421	28%	55%
PM_{10}	pt_oilgas	13,266	13,243	12,726	15,837	-540	2,594	-4%	20%
PM_{10}	ptnonipm	130,488	128,764	141,695	146,538	11,207	17,775	9%	14%
PM_{10}	**Total**	**419,855**	**418,069**	**452,524**	**479,809**	**32,669**	**61,740**	**8%**	**15%**
$PM_{2.5}$	nonpt	209,188	209,206	223,913	236,507	14,725	27,302	7%	13%
$PM_{2.5}$	np_oilgas	13,761	13,761	17,847	20,865	4,086	7,104	30%	52%
$PM_{2.5}$	pt_oilgas	13,020	12,997	12,494	15,549	-526	2,551	-4%	20%
$PM_{2.5}$	ptnonipm	105,943	104,219	115,864	119,787	9,921	15,568	9%	15%
$PM_{2.5}$	**Total**	**341,912**	**340,183**	**370,117**	**392,708**	**28,205**	**52,525**	**8%**	**15%**
SO_2	nonpt	248,793	249,431	251,323	247,483	2,531	-1,948	1%	-1%
SO_2	np_oilgas	17,598	17,598	36,797	38,206	19,199	20,607	109%	117%
SO_2	pt_oilgas	51,588	51,477	54,423	55,180	2,835	3,703	5%	7%
SO_2	ptnonipm	514,616	512,441	499,393	504,215	-15,223	-8,226	-3%	-2%
SO_2	**Total**	**832,595**	**830,948**	**841,937**	**845,084**	**9,342**	**14,135**	**1%**	**2%**
VOC	nonpt	874,870	874,951	885,095	891,556	10,226	16,605	1%	2%
VOC	np_oilgas	2,417,715	2,417,715	3,737,520	4,389,231	1,319,805	1,971,516	55%	82%
VOC	pt_oilgas	131,691	131,395	137,535	167,923	5,843	36,528	4%	28%
VOC	ptnonipm	131,016	129,910	140,787	142,621	9,771	12,711	7%	10%
VOC	**Total**	**3,555,292**	**3,553,970**	**4,900,937**	**5,591,332**	**1,345,645**	**2,037,361**	**38%**	**57%**

4.2.3.7 Data from comments on previous platforms (nonpt, ptnonipm, pt_oilgas)

2017 Packets:
“PROJECTION_2011v6.2_2018_TCEQ_v6_leftovers_NONPOINT_30jan2015.txt”
“PROJECTION_VA_ME_TCEQ_AL_comments_2011v6_2018_03dec2013.txt”
“PROJECTION_TCEQ_ptnonipm_NAICS_comments_2011v6_2018”

2025 Packets:
“PROJECTION_2011v6.2_2025_TCEQ_v6_leftovers_NONPOINT_30jan2015.txt”
“PROJECTION_VA_ME_TCEQ_AL_comments_2011v6_2019_03dec2013.txt”
”PROJECTION_TCEQ_ptnonipm_NAICS_comments_2011v6_2025”

These projection packets includes projection factors used in the development of the 2011v6.0 emissions modeling platform, specifically, those discussed in Section 4.2.9 in the 2011v6.1 emissions modeling platform TSD (EPA, 2014b). Most of these data were originally received from the Texas Commission on Environmental Quality (TCEQ).

TCEQ nonpoint projection data
Packet: PROJECTION_2011v6.2_20YY_TCEQ_v6_leftovers_NONPOINT_30jan2015.txt, where "YY" is 18 or 25 for year 2018 (2017 as well) and 2025 respectively.

Most of the "old" TCEQ nonpoint projections data are superseded by the 2011v6.0 NODA data, particularly the SCC-level growth factors discussed in Section 4.2.3.6. We removed all TCEQ projection factors for SCCs that overlapped. The remaining TCEQ nonpoint projection data are unchanged from the 2011v6.0 emissions modeling platform.

State comments from 2013
Packet: PROJECTION_VA_ME_TCEQ_AL_comments_2011v6_20YY_03dec2013.txt, where "YY" is 18 or 19 for year 2018 (used for 2017) and year 2019 (used for 2025 projections), respectively.

This packet includes comments received prior to 2011v6.0 emissions modeling platform processing from Alabama, Maine, Texas and Virginia. These projections data target specific point sources in each of these states, generally impacting only a couple of facilities/units in a couple of counties in each state.

TCEQ point county/NAICS projections data
Packet: PROJECTION_TCEQ_ptnonipm_NAICS_comments_2011v6_20YY, where "YY" is 18 or 25 for year 2018 (2017 as well) and 2025 respectively.

This packet was provided by TCEQ for minor point source emissions. Projections are applied by county and NAICS codes and are based on gross product projections for various types of industry, population and economy.com data. We did not apply these to oil and gas sources, opting to instead use the approach discussed in Section 4.2.3.6; in fact, most of these entries are not used because they are lower in the CoST hierarchy than the county/NAICS/SCC projection factors discussed in the same section.

Summary impacts
A summary of the impacts of these three projection factors for the three affected sectors are provided in Table 4-16. Most of these impacts are in Texas. Note that the 2011 emissions differ for 2017 and 2025 projection scenarios; one reason for this is that projection factors equal to 1.0 (no change) were dropped from the TCEQ projections data; for some sources, year 2017 (2018) factors were equal to 1.0 while year 2025 factors were not, and vice versa. When this happens, emissions in 2011 do not appear in 2017 but they do for 2025 summaries.

Table 4-16. Impact of 2011v6.0 projection factors for Texas

		2011 Emissions Subject to PROJECTION factors		**Projected Emissions**		**Tons Difference (Future - 2011)**		**% Difference (Future - 2011)**	
Poll	**Sector**	**For 2017**	**For 2025**	**2017**	**2025**	**2017**	**2025**	**2017**	**2025**
CO	nonpt	61,056	59,457	74,709	75,350	13,653	15,893	22%	27%
CO	pt_oilgas	6,096	6,181	6,097	6,120	1	-61	0%	-1%
CO	ptnonipm	54,891	66,329	73,297	100,156	18,406	33,827	34%	51%
CO	**Total**	**122,043**	**131,967**	**154,103**	**181,626**	**32,060**	**49,659**	**26%**	**38%**
NH_3	nonpt	2,443	2,444	2,485	2,511	42	67	2%	3%
NH_3	pt_oilgas	32	32	29	27	-3	-5	-9%	-16%
NH_3	ptnonipm	1,754	2,179	2,259	3,170	505	991	29%	45%

Poll	Sector	2011 Emissions Subject to PROJECTION factors For 2017	2011 Emissions Subject to PROJECTION factors For 2025	Projected Emissions 2017	Projected Emissions 2025	Tons Difference (Future - 2011) 2017	Tons Difference (Future - 2011) 2025	% Difference (Future - 2011) 2017	% Difference (Future - 2011) 2025
NH_3	**Total**	**4,229**	**4,655**	**4,773**	**5,708**	**544**	**1,053**	**13%**	**23%**
NO_X	nonpt	21,650	26,477	22,619	28,182	969	1,705	4%	6%
NO_X	pt_oilgas	4,423	4,587	4,322	4,320	-101	-267	-2%	-6%
NO_X	ptnonipm	54,820	70,536	74,610	104,624	19,790	34,088	36%	48%
NO_X	**Total**	**80,893**	**101,600**	**101,551**	**137,126**	**20,658**	**35,526**	**26%**	**35%**
PM_{10}	nonpt	20,101	20,140	24,535	27,003	4,434	6,863	22%	34%
PM_{10}	pt_oilgas	1,071	1,103	1,040	1,060	-31	-43	-3%	-4%
PM_{10}	ptnonipm	16,002	22,293	20,484	30,777	4,482	8,484	28%	38%
PM_{10}	**Total**	**37,174**	**43,536**	**46,059**	**58,840**	**8,885**	**15,304**	**24%**	**35%**
$PM_{2.5}$	nonpt	15,672	15,655	19,439	21,629	3,767	5,974	24%	38%
$PM_{2.5}$	pt_oilgas	1,037	1,069	1,005	1,022	-32	-47	-3%	-4%
$PM_{2.5}$	ptnonipm	12,528	18,024	16,237	24,993	3,709	6,969	30%	39%
$PM_{2.5}$	**Total**	**29,237**	**34,748**	**36,681**	**47,644**	**7,444**	**12,896**	**25%**	**37%**
SO_2	nonpt	4,415	3,776	4,367	3,649	-48	-127	-1%	-3%
SO_2	pt_oilgas	9,077	9,172	8,757	8,634	-320	-538	-4%	-6%
SO_2	ptnonipm	22,376	44,050	27,964	56,702	5,588	12,652	25%	29%
SO_2	**Total**	**35,868**	**56,998**	**41,088**	**68,985**	**5,220**	**11,987**	**15%**	**21%**
VOC	nonpt	259,815	259,734	276,439	286,184	16,624	26,450	6%	10%
VOC	pt_oilgas	14,796	15,178	14,399	13,914	-397	-1,264	-3%	-8%
VOC	ptnonipm	51,020	70,148	68,586	103,803	17,566	33,655	34%	48%
VOC	**Total**	**325,631**	**345,060**	**359,424**	**403,901**	**33,793**	**58,841**	**10%**	**17%**

4.2.3.8 Aircraft (ptnonipm)

Packet:
For 2017: “PROJECTION_2011_2017_aircraft_ST_and_by_airport_22jan2015.txt”
For 2025: “PROJECTION_2011_2025_aircraft_ST_and_by_airport_22jan2015.txt”

Aircraft emissions are contained in the ptnonipm inventory. These 2011 point-source emissions are projected to future years by applying activity growth using data on itinerant (ITN) operations at airports. The ITN operations are defined as aircraft take-offs whereby the aircraft leaves the airport vicinity and lands at another airport, or aircraft landings whereby the aircraft has arrived from outside the airport vicinity. EPA used projected ITN information available from the Federal Aviation Administration’s (FAA) Terminal Area Forecast (TAF) System: http://www.apo.data.faa.gov/main/taf.asp (publication date March, 2014). This information is available for approximately 3,300 individual airports, for all years up to 2040. The methods that the FAA used for developing the ITN data in the TAF are documented in: http://www.faa.gov/about/office_org/headquarters_offices/apl/aviation_forecasts/taf_reports/media/TAF_Summary_Report_FY2013-2040.pdf.

None of our aircraft emission projections account for any control programs. EPA considered the NO_X standard adopted by the International Civil Aviation Organization's (ICAO) Committee on Aviation Environmental Protection (CAEP) in February 2004, which is expected to reduce NO_X by approximately 3% by 2020. However, this rule has not yet been adopted as an EPA (or U.S.) rule; therefore, its effects were not included in the future-year emissions projections.

EPA developed two sets of projection factors for aircraft. The first set was a simple state-level aggregation, used primarily for airports with very little activity, by ITN operation type (commercial, general aviation, military and air taxi) to be used as a default method for projecting from 2011 to future years. The second set of projection factors was by airport, where EPA projects emissions for each individual airport with significant ITN activity.

Where NEI facility identifiers were not matched to FAA airport identifiers we simply summed the ITN operations to state totals by year and aircraft operation and computed projection factors as future-year ITN to year-2011 ITN. EPA assigned factors to inventory SCCs based on the operation type shown in Table 4-17.

Table 4-17. NEI SCC to FAA TAF ITN aircraft categories used for aircraft projections

SCC	Description	FAA ITN Type
2265008005	Commercial Aircraft: 4-stroke Airport Ground Support Equipment	Commercial
2267008005	Commercial Aircraft: LPG Airport Ground Support Equipment	Commercial
2268008005	Commercial Aircraft: CNG Airport Ground Support Equipment	Commercial
2270008005	Commercial Aircraft: Diesel Airport Ground Support Equipment	Commercial
2275000000	All Aircraft Types and Operations	Commercial
2275001000	Military Aircraft, Total	Military
2275020000	Commercial Aviation, Total	Commercial
2275050011	General Aviation, Piston	General
2275050012	General Aviation, Turbine	General
2275060011	Air Taxi, Total: Air Taxi, Piston	Air Taxi
2275060012	Air Taxi, Total: Air Taxi, Turbine	Air Taxi
2275070000	Commercial Aircraft: Aircraft Auxiliary Power Units, Total	Commercial
27501015	Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Military; Jet Engine: JP-5	Military
27502011	Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Commercial; Jet Engine: Jet A	Commercial
27505001	Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Civil; Piston Engine: Aviation Gas	General
27505011	Internal Combustion Engines; Fixed Wing Aircraft L & TO Exhaust; Civil; Jet Engine: Jet A	General

Most NEI airports matched FAA TAF identifiers and therefore use airport-specific projection factors. We applied a cap on projection factors of 2.0 (100% increase) for state-level defaults and 5.0 for airport-specific entries. None of the largest airports/larger-emitters had projection factors close to these caps. A national summary of aircraft emissions between 2011 and future years 2017 and 2025 are provided in Table 4-18.

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Table 4-18. National aircraft emission projection summary

	Emissions			Difference		% Difference	
	2011	2017	2025	2017	2025	2017	2025
CO	489,854	509,687	565,678	19,833	75,824	4.0%	15.5%
NO_X	120,968	131,678	161,297	10,710	40,328	8.9%	33.3%
PM_{10}	9,164	9,373	10,121	208	956	2.3%	10.4%
$PM_{2.5}$	7,891	8,084	8,787	194	896	2.5%	11.4%
SO_2	14,207	15,256	18,536	1,049	4,329	7.4%	30.5%
VOC	32,023	33,601	38,591	1,578	6,568	4.9%	20.5%

4.2.3.9 Cement manufacturing (ptnonipm)

Packet:
For 2017: "PROJECTION_2011_2018_ISIS_cement_by_CENSUS_DIVISION_04dec2013.txt"
For 2025: "PROJECTION_2011_2025_ISIS_cement_by_CENSUS_DIVISION_25nov2013.txt"

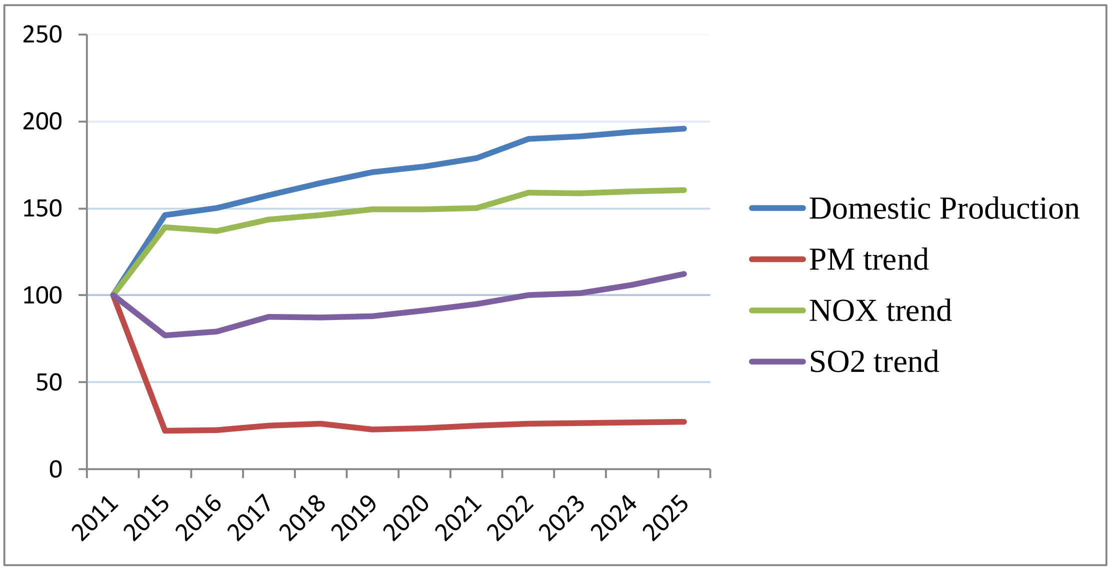
As indicated in Table 4-1, the Industrial Sectors Modeling Platform (ISMP) (EPA, 2010b) was used to project the cement industry component of the ptnonipm emissions modeling sector to 2018 and 2025; we used year 2018 as a surrogate for year 2017. This approach provided reductions of criteria and select hazardous air pollutants. The ISMP cement emissions were developed in support for the Portland Cement NESHAPs and the NSPS for the Portland cement manufacturing industry.

The ISMP model produced a Portland Cement NESHAP policy case of multi-pollutant emissions for individual cement kilns (emission inventory units) that were relevant for years 2015 through 2030. These ISMP-based emissions are reflected using a CoST packet for all existing kilns that are not impacted by more local information from states (or consent decrees). ISMP also generates new cement kilns that are permitted (point inventory) and not-permitted, but generated based on ISMP assumptions on demand and infrastructure (nonpt inventory). These new cement kilns are discussed in Section 4.2.5.4.

The PROJECTION packets contain U.S. census division level based projection factors for each NEI unit (kiln) based on ISMP updated policy case emissions at existing cement kilns. The units that closed before 2018 (and 2025) are included in the 2018 (and 2025) base case but are included in other CoST packets that reflect state comments and consent decrees (discussed in Section 4.2.4.10).

The ISMP model, version August 2013 was used for these projections. Recent data updates include updated matching of kilns to better capture recent retirements, capacity additions and projections of capacity additions from Portland Cement Association (PCA) Plant Information Summary of December 31, 2010 and feedback from Portland Cement NESHAP reconsideration comments. Updated cement consumption projections are based on a post-recession (July 2012) PCA long-term cement consumption outlook. Updated emissions controls in 2015 from the NESHAP are also reflected. Overall, as seen in Figure 4-3, domestic production of cement grows significantly between 2011 and 2015, then more slowly through 2018. Meanwhile, emissions from NESHAP-regulated pollutants such as PM and SO_2 drop significantly based on regulated emissions rates. Emissions for NO_X increase, though not as much as production because the ISMP model continues the recent trend in the cement sector of the replacement of lower capacity, inefficient wet and long dry kilns with bigger and more efficient preheater and precalciner kilns.

Figure 4-3. Cement sector trends in domestic production versus normalized emissions



Multiple regulatory requirements such as the NESHAP and NSPS currently apply to the cement industry to reduce CAP and HAP emissions. Additionally, state and local regulatory requirements might apply to individual cement facilities depending on their locations relative to ozone and $PM_{2.5}$ nonattainment areas. The ISMP model provides the emission reduction strategy that balances: 1) optimal (least cost) industry operation, 2) cost-effective controls to meet the demand for cement, and 3) emission reduction requirements over the time period of interest.

The first step in using ISMP 2018 and 2025 projected emissions is matching the kilns in future years to those in the 2011 NEI. While ISMP provides by-kiln emissions for each future year, EPA cement kilns experts preferred that the Agency project existing cement kilns based on a more-smooth geographic approach to reduce the “on”/”off” switching that ISMP assigns to each kiln based on production and capacity demands. It would be inefficient and unrealistic to project existing cement kilns to operate as essentially 0% or 100% capacity based strictly on ISMP output. Therefore, EPA developed a U.S. Census Division approach where ISMP emissions in 2011 and future years, that matched the 2011 NEI (e.g., not new ISMP kilns), were aggregated by pollutant for each year within each of the 9 census divisions in the contiguous U.S. (http://www.eia.gov/consumption/commercial/images/cendivco.gif). These aggregate emissions were used to create 2018/2011 and 2025/2011 emissions ratios for each pollutant and geographic area. The projection ratios, provided in Table 4-19, were then applied to all 2011 NEI cement kilns –except for kilns where specific local information (e.g., consent decrees/settlements/local information) was available.

Table 4-19. U.S. Census Division ISMP-based projection factors for existing kilns

		NO_X		PM		SO_2		VOC	
Region	**Division**	**2018**	**2025**	**2018**	**2025**	**2018**	**2025**	**2018**	**2025**
Midwest	East North Central	2.024	2.053	0.106	0.144	1.800	3.034	0.527	0.670
Midwest	West North Central	0.930	1.279	0.614	0.673	0.695	1.262	0.317	0.492
Northeast	Middle Atlantic	1.853	1.221	0.058	0.119	0.904	0.867	0.561	0.569
Northeast	New England	2.560	2.560	0.004	0.004	3.563	3.563	0.713	0.713
South	East South Central	0.999	0.999	0.109	0.109	0.402	0.402	0.323	0.323
South	South Atlantic	1.042	1.077	0.284	0.339	0.911	0.936	0.413	0.420
South	West South Central	1.220	1.526	0.079	0.174	0.484	0.664	0.225	0.252
West	Mountain	1.453	1.321	2.542	1.032	1.917	1.366	0.310	0.345
West	Pacific	1.465	1.465	0.001	0.006	0.300	0.251	0.321	0.290

Table 4-20 shows the magnitude of the ISMP census division based projected cement industry emissions at existing NEI facilities from 2011 to future years 2018 and 2025; we use 2018 projected emissions for year 2017. Additional new kiln emissions generated by ISMP are discussed in Section 0. There are some local exceptions where EPA did not use ISMP-based projections for cement kilns where local information from consent decrees/settlements and state comments were used instead. Cement kilns projected using these non-ISMP information are not reflected here in Table 4-20.

Table 4-20. ISMP-based cement industry projected emissions

	Emissions			Tons Difference		% Difference	
	2011	**2017**	**2025**	**2017**	**2025**	**2017**	**2025**
NO_X	53,240	70,432	75,680	17,193	22,440	32.3%	42.1%
PM_{10}	2,954	1,185	1,033	-1,769	-1,921	-59.9%	-65.0%
$PM_{2.5}$	1,709	717	657	-992	-1,052	-58.0%	-61.6%
SO_2	15,876	18,053	25,579	2,177	9,702	13.7%	61.1%
VOC	2,503	861	1,026	-1,642	-1,477	-65.6%	-59.0%

4.2.3.10 Corn ethanol plants (ptnonipm)

Packet:
For 2017: “PROJECTION_2011_2017_Corn_Ethanol_Plants_AEO2014_Table17_2011v6.2_19feb2015.txt“
For 2025: “PROJECTION_2011_2025_Corn_Ethanol_Plants_AEO2014_Table17_2011v6.2_19feb2015.txt”

We used the AEO 2014 renewable forecast projections of “From Corn and Other Starch” to compute national year 2017 and 2025 growth in ethanol plant production. Per OTAQ direction, we exempted two facilities (‘Highwater Ethanol LLC’ in Redwood county MN and ‘Life Line Foods LLC-St. Joseph’ in Buchanan county MO) from these projections; future year emissions were equal to their 2011 NEI v2 values for these two facilities.

The 2011 corn ethanol plant emissions were projected to account for the change in domestic corn ethanol production between 2011 and future years, from approximately 13.9 Bgal (billion gallons) in 2011 to 13.0 Bgal by 2017 and 13.2 Bgal in 2025, based on AEO 2014 projections. The projection was applied to all pollutants and all facilities equally. Table 4-21 provides the summaries of estimated emissions for the corn ethanol plants in 2011 and future years 2017 and 2025.

Table 4-21. 2011 and 2017/2025 corn ethanol plant emissions [tons]

	Emissions			Difference		% Change	
	2011	2017	2025	2017	2025	2017	2025
CO	1,172	1,092	1,111	-80	-61	-6.9%	-5.2%
NO_X	1,552	1,445	1,471	-107	-81	-6.9%	-5.2%
PM_{10}	1,386	1,290	1,314	-96	-72	-6.9%	-5.2%
$PM_{2.5}$	339	316	322	-23	-17	-6.9%	-5.2%
SO_2	12	11	11	-1	-1	-6.9%	-5.2%
VOC	3,379	3,147	3,204	-232	-175	-6.9%	-5.2%

4.2.3.11 Residential wood combustion (rwc)

Packet:
For 2017: "PROJECTION_2011_2017_RWC_2011v6.2_03mar2015.txt"
For 2025: "PROJECTION_2011_2025_RWC_2011v6.2_03mar2015.txt"

EPA applied the recently-promulgated national New Source Performance Standards (NSPS) for wood stoves to the Residential Wood Combustion (RWC) projections methodology for this platform. To learn more about the strengthened NSPS for residential wood heaters, see http://www2.epa.gov/residential-wood-heaters/regulatory-actions-residential-wood-heaters. EPA projected residential wood combustion (RWC) emissions to years 2017 and 2025 based on expected increases and decreases in various residential wood burning appliances. As newer, cleaner woodstoves replace ***some*** older, higher-polluting wood stoves, there will be an overall reduction of the emissions from older "dirty" stoves but an overall increase in total RWC due to population and sales trends in all other types of wood burning devices such as indoor furnaces and outdoor hydronic heaters (OHH). It is important to note that our RWC projection methodology does not explicitly account for state or local residential wood control programs. There are a number more-stringent state and local rules in place in 2011, specifically in California, Oregon and Washington. However, at this time, EPA does not have enough detailed information to calculate state specific or local area growth rates. Therefore, with the exception of California, Oregon and Washington, EPA is using national level growth rates for each RWC SCC category. After discussions with California air districts, regional office contacts and EPA experts, EPA decided to hold RWC emissions flat (unchanged) for all SCCs in California, Oregon and Washington.

Assumed Appliance Growth and Replacement Rates

The development of projected growth in RWC emissions to years 2017 and 2025 starts with the projected growth in RWC appliances derived from year 2012 appliance shipments reported in the Regulatory Impact Analysis (RIA) for Proposed Residential Wood Heaters NSPS Revision Final Report (EPA, 2013b), also available at: http://www2.epa.gov/sites/production/files/2013-12/documents/ria-20140103.pdf. The 2012 shipments are based on 2008 shipment data and revenue forecasts from a Frost & Sullivan Market Report (Frost & Sullivan, 2010). Next, to be consistent with the RIA (EPA, 2013b), growth rates for new appliances for certified wood stoves, pellet stoves, indoor furnaces and OHH were based on forecasted revenue (real GDP) growth rate of 2.0% per year from 2013 through 2025 as predicted by the U.S. Bureau of Economic Analysis (BEA, 2012). While this approach is not perfectly correlated, in the absence of specific shipment projections, the RIA assumes the overall trend in the projection is reasonable. The growth rates for appliances not listed in the RIA (fireplaces, outdoor wood burning devices (not elsewhere classified) and residential fire logs) are estimated based on the average growth in the number of houses between 2002 and 2012, about 1% (U.S. Census, 2012).

In addition to new appliance sales and forecasts extrapolating beyond 2012, assumptions on the replacement of older, existing appliances are needed. Based on long lifetimes, no replacement of fireplaces, outdoor wood burning devices (not elsewhere classified) or residential fire logs is assumed. It is assumed that 95% of new woodstoves will replace older non-EPA certified freestanding stoves (pre-1988 NSPS) and 5% will replace existing EPA-certified catalytic and non-catalytic stoves that currently meet the 1988 NSPS (Houck, 2011).

EPA RWC NSPS experts assume that 10% of new pellet stoves and OHH replace older units and that because of their short lifespan, that 10% of indoor furnaces are replaced each year; these are the same assumptions used since the 2007 emissions modeling platform (EPA, 2012d). The resulting growth factors for these appliance types varies by appliance type and also by pollutant because the emission rates, from EPA RWC tool (EPA, 2013rwc), vary by appliance type and pollutant. For EPA certified units, the projection factors for PM are lower than those for all other pollutants. The projection factors also vary because the total number of existing units in 2011 varies greatly between appliance types.

NSPS Overview

The residential wood heaters NSPS Final Rule was promulgated on February 3, 2015. This rule does not affect existing woodstoves or other wood burning devices; however, it does provide more stringent emissions standards for new woodstoves, outdoor hydronic heaters and indoor wood-burning forced air furnaces. New “Phase 1” less-polluting heater standards begin in 2015, with even more-stringent Phase 2 standards beginning in 2020. The associated reduced emission rates for each appliance type (SCC) are applied to all new units sold, some of which are assumed to replace retired units, since year 2015.

Currently the 1988 NSPS limits primary $PM_{2.5}$ emissions from adjustable burn rate stoves, including fireplace inserts and freestanding woodstoves, to 7.5 grams/hour (g/hr) for non-catalytic stoves and 4.1 g/hr for catalytic stoves. The final NSPS limits $PM_{2.5}$ emissions for room heaters, which include adjustable and single burn rate stoves and pellet stoves to 4.5 g/hr in 2015 and 1.3 g/hr in 2020. In addition, the final NSPS limits $PM_{2.5}$ emissions from hydronic heaters to 0.32 lb/MMBtu heat output in 2015, and 0.06 lb/MMBtu in 2020. The final NSPS limits $PM_{2.5}$ emissions from indoor furnaces to 0.93 lb/MMBtu in 2015 and 0.06/MMBtu in 2020.

Emission factors were estimated from the 2011v2 NEI based on tons of emissions per appliance for $PM_{2.5}$, VOC and CO. This calculation was based on estimated appliance (SCC) population and total emissions by SCC. EPA-certified wood stove emission factors are provided in the wood heaters NSPS RIA Tables 4-3, 4-7 and 4-11 for $PM_{2.5}$, VOC and CO, respectively. For all RWC appliances subject to the NSPS, baseline RIA emission factors, when lower than the computed emission factors (2011 NEI), are used for new appliances sold between 2012 and 2014. Starting in 2015, Phase 1 emission limits are 60% stronger (0.45 g/hr / 0.75 g/hr) than the RIA baseline emission factors. There are also different standards for catalytic versus non-catalytic EPA-certified stoves. Similar calculations are performed for Phase 2 emission limits that begin in 2020 and for different emission rates for different appliance types. Because the 2011NEI and RIA baseline (2012-2014) emission factors vary by pollutant, all RWC appliances subject to the NSPS have pollutant-specific “projection” factors. We realize that these “projection” factors are a composite of growth, retirements and potentially emission factors in 4 increments. More detailed documentation on the EPA RWC Projection Tool, including information on baseline, new appliances pre-NSPS, and Phase 1 and Phase 2 emission factors, is available upon request.

Caveats and Results

California, Oregon and Washington have state-level RWC control programs, including local burn bans in place. Without an ability to incorporate significant local RWC control programs/burn bans for a future year inventory, EPA left RWC emissions unchanged in the future for all three states. The RWC projections factors for states other than California, Oregon and Washington are provided in Table 4-22. VOC HAPs use the same projection factors as VOC, PM_{10} uses the same factor as $PM_{2.5}$, and all other pollutants use the CO projection factor. Note that appliance types not subject to the wood heaters NSPS (e.g., fire pits, fire logs) have pollutant-independent projection factors because there is no assumed change in future year emission factors.

Table 4-22. Non-West Coast RWC projection factors, including NSPS impacts

		Default if pollutant not defined		**PM**		**VOC and VOC HAPs**		**CO and remaining CAPs**	
		2017	**2025**	**2017**	**2025**	**2017**	**2025**	**2017**	**2025**
2104008100	Fireplace: general	1.062	1.149						
2104008210	Woodstove: fireplace inserts; non-EPA certified	0.903	0.754						
2104008220	Woodstove: fireplace inserts; EPA certified; non-catalytic	1.171	1.26	1.071	1.113				
2104008230	Woodstove: fireplace inserts; EPA certified; catalytic	1.171	1.317	1.076	1.145				
2104008310	Woodstove: freestanding, non-EPA certified	0.932	0.795	0.937	0.791	0.94	0.809	0.932	0.795
2104008320	Woodstove: freestanding, EPA certified, non-catalytic	1.171	1.26	1.071	1.113				
2104008330	Woodstove: freestanding, EPA certified, catalytic	1.171	1.317	1.077	1.146				
2104008400	Woodstove: pellet-fired, general	1.55	1.952	1.551	2.014				
2104008510	Furnace: Indoor, cordwood-fired, non-EPA certified	0.746	0.12	0.831	0.147	0.745	0.119	0.746	0.12
2104008610	Hydronic heater: outdoor	1.062	1.038	1.094	1.074				
2104008700	Outdoor wood burning device, NEC	1.062	1.149						
2104009000	Residential Firelog Total: All Combustor Types	1.062	1.149						

National emission summaries for the RWC sector in 2011, 2017 and 2025 are provided in **Table 4-23**. For direct PM, the NSPS emission factor reductions mostly offset the growth in appliances by year 2017; by year 2025, continued penetration of Phase 1 and 2 standards and replacement of non-EPA certified units with much cleaner EPA-certified appliances result in a net reduction for primary PM.

Table 4-23. Cumulative national RWC emissions from growth, retirements and NSPS impacts

	Emissions			**Difference**		**% Difference**	
Pollutant	**2011**	**2017**	**2025**	**2017 - 2011**	**2025 -2011**	**2017 - 2011**	**2025 -2011**
CO	2,527,054	2,513,621	2,332,033	-13,434	-195,021	-0.5%	-7.7%
NH_3	19,759	19,611	18,210	-148	-1,549	-0.7%	-7.8%
NO_X	34,577	35,652	34,863	1,074	285	3.1%	0.8%
PM_{10}	382,817	385,356	357,054	2,539	-25,763	0.7%	-6.7%
$PM_{2.5}$	382,591	385,119	356,802	2,528	-25,789	0.7%	-6.7%
SO_2	8,977	8,837	7,626	-140	-1,351	-1.6%	-15.1%
VOC	444,349	439,738	409,947	-4,610	-34,402	-1.0%	-7.7%

4.2.4 CoST CONTROL packets (nonpt, np_oilgas, ptnonipm, pt_oilgas)

The final step in a CoST control strategy, after application of any/all CLOSURE packet(s) (point inventories only) and any/all PROJECTION packet(s) is the application of CoST CONTROL packets. While some controls are embedded in our PROJECTION packets (e.g., NSPS controls for RWC and loco-marine controls for rail and commercial marines vessels), we attempted to separate out the control (program) component in our modeling platform where feasible. In our platform, CoST control packets only impact the nonpt, np_oilgas, ptnonipm and pt_oilgas sectors.

There are several different sources of CONTROL data that are concatenated and quality-assured for duplicates and applicability to the inventories in the CoST strategies. We broke up the CONTROL (and PROJECTION) packets into a few "key" control program types to allow for quick summaries of these distinct control programs. The remainder of this section is broken out by CoST packet, with the exception of discussion of the various packets gathered from previous versions of the emissions modeling platform; these packets are a mix of different sources of data, only some of which have not been replaced by more recent information gathered for this platform.

For future-year NSPS controls (oil and gas, RICE, Natural Gas Turbines, and Process Heaters), we attempted to control only new sources/equipment using the following equation to account for growth and retirement of existing sources and the differences between the new and existing source emission rates.

$$Qn = Qo \{ [(1 + Pf) t – 1] Fn + (1 - Ri) t \ Fe + [1 - (1 - Ri) t] Fn] \} \qquad \textbf{\textit{Equation 1}}$$

where:

- Qn = emissions in projection year
- Qo = emissions in base year
- Pf = growth rate expressed as ratio (e.g., 1.5=50% cumulative growth)
- t = number of years between base and future years
- Fn = emission factor ratio for new sources
- Ri = retirement rate, expressed as whole number (e.g., 3.3%=0.033)
- Fe = emission factor ratio for existing sources

The first term in Equation 1 represents new source growth and controls, the second term accounts for retirement and controls for existing sources, and the third term accounts for replacement source controls. For computing the CoST % reductions (Control Efficiency), the simplified Equation 2 was used for 2025 projections:

$$Control\_Efficiency_{2025}(\%) = 100 * (1- [(Pf_{2025}-1)*Fn + (1-Ri)^{14} + (1-(1-Ri)^{14})*Fn]/ Pf_{2025}) \qquad \textbf{\textit{Equation 2}}$$

Here, the existing source emissions factor (Fe) is set to 1.0, 2025 (future year) minus 2011 (base year) is 14, and new source emission factor (Fn) is the ratio of the NSPS emission factor to the existing emission factor. Table 4-24 shows the values for Retirement rate and new source emission factors (Fn) for each NSPS regulation and other conditions within; this table also provides the subsection where the CONTROL packets are discussed.

Table 4-24. Assumed retirement rates and new source emission factor ratios for new sources for various NSPS rules

NSPS Rule	TSD Section	Retirement Rate years (%/year)	Pollutants Impacted	Applied where?	New Source Emission Factor (Fn)
Oil and Gas	4.2.4.1	No assumption	VOC	Storage Tanks: 70.3% reduction in growth-only (>1.0)	0.297
				Gas Well Completions: 95% control (regardless)	0.05
				Pneumatic controllers, not high-bleed >6scfm or low-bleed: 77% reduction in growth-only (>1.0)	0.23
				Pneumatic controllers, high-bleed >6scfm or low-bleed: 100% reduction in growth-only (>1.0)	0.00
				Compressor Seals: 79.9% reduction in growth-only (>1.0)	0.201
RICE	4.2.4.3	40, (2.5%)	NO_X	Lean burn: PA, all other states	0.25, 0.606
				Rich Burn: PA, all other states	0.1, 0.069
				Combined (average) LB/RB: PA, other states	0.175, 0.338
			CO	Lean burn: PA, all other states	1.0 (n/a), 0.889
				Rich Burn: PA, all other states	0.15, 0.25
				Combined (average) LB/RB: PA, other states	0.575, 0.569
			VOC	Lean burn: PA, all other states	0.125, n/a
				Rich Burn: PA, all other states	0.1, n/a
				Combined (average) LB/RB: PA, other states	0.1125, n/a
Gas Turbines	4.2.4.6	45 (2.2%)	NO_X	California and NO_X SIP Call states	0.595
				All other states	0.238
Process Heaters	4.2.4.7	30 (3.3%)	NO_X	Nationally to Process Heater SCCs	0.41

4.2.4.1 Oil and gas NSPS (np_oilgas, pt_oilgas)

Packet:
For 2017: “CONTROL_2011v6.2_2018_OilGas_VOC_NSPS_12dec2014.txt”
For 2025: “CONTROL_2011v6.2_2025_OilGas_VOC_NSPS_12dec2014.txt”

For oil and gas NSPS controls, with the exception of gas well completions (a 95% control) the assumption of no equipment retirements through year 2025 dictates that NSPS controls are applied to the growth component only of any PROJECTION factors. For example, if a growth factor is 1.5 for storage tanks (indicating a 50% increase activity), then, using Table 4-24, the 70.3% VOC NSPS control to this new growth will result in a 23.4% control: 100 *(70.3 * (1.5 -1) / 1.5); this yields an “effective” growth rate (combined PROJECTION and CONTROL) of 1.1485, or, a 70.3% reduction from 1.5 to 1.0. The impacts of all non-drilling completion VOC NSPS controls are therefore greater where growth in oil and gas production is assumed highest. Conversely, for oil and gas basins with assumed negative growth in activity/production, VOC NSPS controls will be limited to well completions only. Because these impacts are so geographically varying, we are providing the VOC NSPS reductions by each of the 6 broad NEMS regions, with Texas and New Mexico aggregated because these states include multiple NEMS regions (see Figure 4-2). These reductions are year-specific because projection factors for these sources are year-specific. For the 2017 modeling case, because the projection factors are for year 2018, the reductions are based on year 2018 growth as well.

Table 4-25. NSPS VOC oil and gas reductions from projected pre-control 2018 and 2025 grown values

	Pre-NSPS Emissions		**Post-NSPS Emissions**		**NSPS Reductions**		**NSPS % Reductions**	
Region	**2018**	**2025**	**2018**	**2025**	**2018**	**2025**	**2018**	**2025**
Gulf Coast	75,152	137,990	57,951	110,054	17,201	27,937	23%	20%
Midcontinent	7,882	222,288	4,238	189,474	3,644	32,814	46%	15%
New Mexico/Texas	1,184,448	1,389,112	716,616	881,695	467,832	507,417	39%	37%
Northeast	33,300	33,327	14,903	14,909	18,397	18,418	55%	55%
Rocky Mountains	517,266	993,574	313,729	529,956	203,536	463,618	39%	47%
West Coast	15	15	1	1	14	14	95%	95%
Overall	1,818,063	2,776,306	1,107,438	1,726,089	710,625	1,050,217	39%	38%

4.2.4.2 RICE NESHAP (nonpt, np_oilgas, ptnonipm, pt_oilgas)

Packet: "CONTROL_2011v6.2_RICE_NESHAP_v2_30jan2015.txt"

There are two rulemakings for National Emission Standards for Hazardous Air Pollutants (NESHAP) for Reciprocating Internal Combustion Engines (RICE). These rules reduce HAPs from existing and new RICE sources. In order to meet the standards, existing sources with certain types of engines will need to install controls. In addition to reducing HAPs, these controls have co-benefits that also reduce CAPs, specifically, CO, NO_X, VOC, PM, and SO_2. In 2014 and beyond, compliance dates have passed for both rules and are thus included in emissions projections. These RICE reductions also reflect the Reconsideration Amendments (proposed in January, 2012), which result in significantly less stringent NO_X controls (fewer reductions) than the 2010 final rules.

The rules can be found at http://www.epa.gov/ttn/atw/icengines/ and are listed below:

- National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; Final Rule (FR 9648) published 03/03/10

- National Emission Standards for Hazardous Air Pollutants for Reciprocating Internal Combustion Engines; Final Rule (75 FR 51570) published 08/20/2010

The difference among these two rules is that they focus on different types of engines, different facility types (major for HAPs, versus area for HAPs) and different engine sizes based on horsepower. In addition, they have different compliance dates, though both are after 2011 and fully implemented prior to 2017. EPA projects CAPs from the 2011NEIv2 RICE sources, based on the requirements of the rule for existing sources only because the inventory includes only existing sources. EPA estimates the NSPS (new source) impacts from RICE regulations in a separate CONTROL packet and CoST strategy; the RICE NSPS is discussed in the next section.

The Regulatory Impact Analysis (RIA) for the Reconsideration of the Existing Stationary Compression Ignition (CI) Engines NESHAP: Final Report (EPA, 2013ci) is available at: http://www.epa.gov/ttn/ecas/regdata/RIAs/RICE_NESHAPreconsideration_Compression_Ignition_Engines_RIA_final2013_EPA.pdf. The Regulatory Impact Analysis (RIA) for Reconsideration of the Existing Stationary Spark Ignition (SI) RICE NESHAP: Final Report (EPA, 2013si) is available at: http://www.epa.gov/ttn/ecas/regdata/RIAs/NESHAP_RICE_Spark_Ignition_RIA_finalreconsideration2013_EPA.pdf. Together, EPA calls these the RICE NESHAP amendment RIA's for SI and CI engines. From these RICE NESHAP RIA documents, EPA obtained cumulative RICE reductions for all SCCs represented by CI and SI engines. These aggregate reductions and percent reductions from baseline emissions (not the 2011NEIv2) are provided in Table 4-26.

Table 4-26. Summary RICE NESHAP SI and CI percent reductions prior to 2011NEIv2 analysis

	CO	**NO_X**	**PM**	**SO_2**	**VOC**
RIA Baseline: SI engines	637,756	932,377			127,170
RIA Reductions: SI engines	22,211	9,648			9,147
RIA Baseline: CI engines	81,145		19,369	11,053	79,965
RIA Reductions: CI engines	14,238		2,818	5,100	27,142
RIA Cumulative Reductions	36,449	9,638	2,818	5,100	36,289
SI % reduction	3.5%	1.0%	n/a	n/a	7.2%
CI % reduction	17.5%	n/a	14.5%	46.1%	33.9%

These RIA percent reductions were used as an ***upper-bound*** for reducing emissions from RICE SCCs in the 2011NEIv2 point and nonpoint modeling sectors (ptnonipm, nonpt, pt_oilgas and np_oilgas). To begin with, the RIA inventories are based on the 2005 NEI, so EPA wanted to ensure that our 2011 reductions did not exceed those in the RICE RIA documents. For the 2011 platform EPA worked with EPA RICE NESHAP experts and developed a fairly simple approach to estimate RICE NESHAP reductions. Most SCCs in the inventory are not broken down by horsepower size range, mode of operation (e.g., emergency mode), nor major versus area source type. Therefore, EPA summed NEI emissions nationally by-SCC for RICE sources and also for sources that were at least partially IC engines (e.g., "Boiler and IC engines"). Then, EPA applied the RIA percent reductions to the 2011NEIv2 for SCCs where national totals exceeded 100 tons; EPA chose 100 tons as a threshold, assuming there would be little to no application of RICE NESHAP controls on smaller existing sources.

Next, EPA aggregated these national reductions by engine type (CI vs. SI) and pollutant and compared these to the RIA reductions. As expected, for most pollutants and engine types, the cumulative reductions were significantly less than those in the RIA. The only exception was for SO_2 CI engines, where EPA scaled the RIA percent reduction from 46.1% to 14.4% for four broad nonpoint SCCs that were not restricted to only RICE engines. These four SCCs were the "Boilers and IC Engines" or "All processes" that would presumably contain some fraction of non-RICE component. This had minimal impact as sulfur content in distillate fuel for many IC engine types has decreased significantly since 2005. Reducing the SO_2 percent reduction for these four SCCs resulted in slightly less than 5,100 tons of SO_2 reductions overall from only RICE NESHAP controls. However, more specific CoST projection packets would later override these RICE NESHAP reductions for SO_2. Recall the CoST hierarchy discussed earlier; these RICE NESHAP reductions are national by pollutant and SCC and thus easily overridden by more-specific information such as state-level fuel sulfur rules (discussed in the next section).

Additional comments from the NODA were also implemented; specifically, CO controls were modified for a couple of distillate-fueled industrial/commercial boiler sources. Impacts of the RICE NESHAP controls on nonpt, ptnonipm, pt_oilgas and np_oilgas sector emissions are provided in Table 4-27.

Table 4-27. National by-sector reductions from RICE Reconsideration controls (tons)

Pollutant	Year	Nonpoint Oil & Gas (np_oilgas)	Point Oil & Gas (pt_oilgas)	Nonpoint (nonpt)	Point (ptnonipm)	Total
CO	2018	7,993	4,533	3,214	6,146	21,886
CO	2025	8,783	6,146	3,215	6,394	24,538
NO_X	2018	2,240	1,749	192	81	4,262
NO_X	2025	2,441	2,411	197	84	5,133
PM_{10}	2018	0	8	929	305	1,242
PM_{10}	2025	0	10	922	311	1,243
$PM_{2.5}$	2018	0	8	828	289	1,124
$PM_{2.5}$	2025	0	10	821	294	1,124
SO_2	2018	0	9	71	296	376
SO_2	2025	0	14	71	294	378
VOC	2018	1,989	2,874	586	942	6,392
VOC	2025	2,224	4,217	588	956	7,986

4.2.4.3 RICE NSPS (nonpt, np_oilgas, ptnonipm, pt_oilgas)

Packet:
For 2017: “CONTROL_2011v6.2_2018_RICE_NSPS_29dec2014.txt”
For 2025: “CONTROL_2011v6.2_2025_RICE_NSPS_29dec2014.txt”

Controls for existing RICE source emissions were discussed in the previous section. This section discusses control for new equipment sources, NSPS controls that impact CO, NO_X and VOC. EPA emission requirements for stationary engines differ according to whether the engine is new or existing, whether the engine is located at an area source or major source, and whether the engine is a compression ignition or a spark ignition engine. Spark ignition engines are further subdivided by power cycle, two vs. four stroke, and whether the engine is rich burn or lean burn.

RICE engines in the NO_X SIP Call area are covered by state regulations implementing those requirements. EPA estimated that NO_X emissions within the control region were expected to be reduced by about 53,000 tons per five month ozone season in 2007 from what they would otherwise be without this program. Federal rules affecting RICE included the NESHAP for RICE 40 CFR Part 63, Subpart ZZZZ, NSPS for Stationary Spark Ignition IC engines 40 CFR Part 60 Subpart JJJJ, and NSPS for Compression Ignition IC engines 40 CFR Part 60 Subpart IIII. SI engine operators were affected by the NSPS if the engine was constructed after June 12, 2006, with some of the smaller engines affected by the NSPS 1-3 years later. The recommended RICE equipment lifetime is 30 to 40 years depending on web searches. We chose 40 years as a conservative estimate.

The 2011 estimates of the RICE engine average emission rates for lean burn and rich burn engines was developed using the stationary engine manufacturers data submitted to EPA for the NSPS analysis (Parise, 2005). Emission factors by pollutant for engines 500-1200 horsepower (hp) were used to develop the average emission rates. The analysis was organized this way because lean vs. rich burn engine type is such a significant factor in the NO_X emissions rate. Any state emission regulations that require stationary RICE engines to achieve emission levels lower than the 2012 NSPS could be included by using lower new source emission ratios that account for the additional emission reductions associated with having more stringent state permit rules. Information is provided for Pennsylvania in Table 4-28. That information shows that the PA regulations have different emission standards for lean burn vs. rich burn engines, and that the emission limits also vary by engine size (100-500 hp or greater than 500 hp). While some of the newer RICE SCCs (oil and gas sector in particular) allow states to indicate whether engines are lean vs. rich burn, some SCCs lump these two together. None of the RICE point source SCCs have information about engine sizes. However, the EPA regulatory impact analysis for the RICE NSPS and NESHAP analysis (RTI, 2007) provides a table that shows the NO_X (CO, NMHC and HAP emission estimates are provided as well) emissions in 2015 by engine size, along with engine populations by size. In the future, more rigorous analysis can use this table to develop computations of weighted average emission reductions by rated hp to state regulations like Pennsylvania's.

Table 4-28. RICE NSPS Analysis and resulting 2011v6.2 new emission rates used to compute controls

Engine type & fuel	**Max Engine Power**	**Geographic Applicability**	**Emission standards g/HP-hr**		
			NO_X	**CO**	**VOC**
2011 pop lean burn	500-1200 hp		1.65	2.25	0.7
2011 pop rich burn	500-1200 hp		14.5	8	0.45
Non-Emerg. SI NG and Non-E. SI Lean Burn LPG (except LB 500≤HP<1,350)	HP≥100	2006 NSPS	2.0	4.0	1.0
Non-Emerg. SI NG and Non-E. SI Lean Burn LPG (except LB 500≤HP<1,350)	HP≥100	2012 NSPS	1.0	2.0	0.7
	HP≥100	PA (Previous GP-5)	2.0	2.0	2.0
New NG Lean Burn	100<HP<500	PA (New GP-5)	1.0	2.0	0.7
New NG Lean Burn	HP >500	PA (New GP-5)	0.5	2.0	0.25
New NG Rich Burn	100<HP<500	PA (New GP-5)	0.25	0.3	0.2
New NG Rich Burn	HP >500	PA (New GP-5)	0.2	0.3	0.2
	HP≥100	Maryland	1.5		
	HP>7500	Colorado	1.2 - 2		
		Wyoming	None	None	None
Notes: the above table compares the criteria pollutant emission standards from the recent NSPS with the emission limits from selected states for stationary IC engines to determine whether future year emission rates are likely to be significantly lower than for the existing engine population. States in the NO_X SIP Call region instituted NO_X emission limits for large engines well before 2011. Most of the values in the above table come from an analysis posted on the PA DEP website. The state emission limits listed above are those in place prior to 2011. Some states (like PA) have instituted tougher RICE emission limits for new and modified engines more recently.					
Note 2: Wyoming exempts all but the largest RICE engines from emission limits.					
Note 3: PA has had a size limit for new RICE engines of 1500 hp until recently (i.e., not engines bigger than 1500 hp can be installed). Their new General Permit-5 removed the engines size cap, but requires new or modified larger engines to be cleaner (i.e., has emission limits lower than the NSPS). PA expects that the new emission limits will result in an increase in larger engines being installed, and bringing the average emission rate much lower than it is currently.					
New source Emissions Rate (Fn): Controls % =100 * (1-Fn)			**NO_X**	**CO**	**VOC**
Pennsylvania	NG-Comb. LB & RB		0.175	0.575	0.113
All other states	NG-Comb. LB & RB		0.338	0.569	1.278
Pennsylvania	NG-lean burn		0.250	1.000	0.125
All other states	NG-lean burn		0.606	0.889	1.000
Pennsylvania	NG-rich burn		0.100	0.150	0.100
All other states	NG-rich burn		0.069	0.250	1.556

We applied NSPS reduction for lean burn, rich burn and “combined” (not specified). We also computed scaled-down (less-stringent) NSPS controls for SCCs that were “IC engines + Boilers” because boiler emissions are not subject to RICE NSPS. For these SCCs, we used the 2011NEIv2 point inventory to aggregate eligible (fuel and type) boiler and IC engine emissions for each pollutant. We found that for CI engines, almost all emissions were boiler-related; therefore, there are no CI engine RICE NSPS reductions for “IC engines + Boilers”. For SI engines, we found that approximately 9% of NOX, 10% Of CO and 19% of VOC “IC engines + Boilers” were IC engines; these splits were then applied to the NSPS reductions in Table 4-28. Finally, we limited RICE NSPS-eligible sources (SCCs) to those that have at least 100 tons nationally for NO_X, CO or VOC, and ignored resulting controls that were under 1%.

PA DEP staff note that until recently they have limited RICE engines to a maximum of 1500 hp. That cap is lifted under the new General Permit-5 regulations. With that cap lifting, PA expects that new applications will choose to install larger engines which have lower emission limits. However, that potential effect will be difficult to capture with no information about how this might occur. These controls were then plugged into *Equation 2* (see Section 4.2.4) as a function of the projection factor. Resulting controls greater than or equal to 1% were retained. Note that where new Emissions Factors >=1.0 (uncontrolled, as represented by red cells at the bottom of Table 4-28), no RICE NSPS controls were computed. National RICE NSPS reductions from projected pre-NSPS 2018 and 2025 inventories are shown in Table 4-29.

Table 4-29. National by-sector reductions from RICE NSPS controls (tons)

Pollutant	Year	Nonpoint Oil & Gas (np_oilgas)	Point Oil & Gas (pt_oilgas)	Nonpoint (nonpt)	Point (ptnonipm)	Total NSPS Reductions	Pre-NSPS Total Emissions	NSPS % Reduction
CO	2018	93,422	19,321	758	861	114,363	503,266	23%
CO	2025	161,075	51,249	2,277	1,366	215,968	762,028	28%
NOX	2018	156,942	44,949	1,685	1,242	204,818	777,041	26%
NOX	2025	252,770	122,603	3,903	2,063	381,339	1,072,744	36%
VOC	2018	1,656	422	0	1	2,079	3,986	52%
VOC	2025	1,838	484	0	2	2,324	3,990	58%

4.2.4.4 ICI Boilers (nonpt, ptnonipm, pt_oilgas)

Packets:
CONTROL_2011v6.2_20xx_BoilerMACT_POINT_v2_30jan2015.txt
CONTROL_2011v6.2_20xx_BoilerMACT_NONPT_08jan2015.txt

The Industrial/Commercial/Institutional Boilers and Process Heaters MACT Rule, hereafter simply referred to as the “Boiler MACT” was promulgated on January 31, 2013 based on reconsideration. Background information on the Boiler MACT can be found at: http://www.epa.gov/ttn/atw/boiler/boilerpg.html. The Boiler MACT promulgates national emission standards for the control of HAPs (NESHAP) for new and existing industrial, commercial, and institutional (ICI) boilers and process heaters at major sources of HAPs. The expected cobenefit for CAPs at these facilities is significant and greatest for SO_2 with lesser impacts for direct PM, CO and VOC. These packets address only the expected cobenefits to existing ICI boilers.

Boiler MACT reductions were computed from a non-NEI database of ICI boilers. As seen in the Boiler MACT Reconsideration RIA (http://www.epa.gov/ttn/atw/boiler/boilersriaproposalrecon111201.pdf), this Boiler MACT Information Collection Request (ICR) dataset computed over 558,000 tons of SO_2 reductions by year 2015. However, the Boiler MACT ICR database and reductions are based on the assumption that if a unit *could* burn oil, it *did* burn oil, and often to capacity. With high oil prices and many of these units also able to burn cheaper natural gas, the 2011NEIv2 inventory has a lot more gas combustion and a lot less oil combustion than the boiler MACT database. For this reason, EPA decided to target units that potentially could be subject to the Boiler MACT and compute preliminary reductions for several CAPs prior to building a control packet.

Step 1: Extract facilities/sources potentially subject to Boiler MACT

This step is only applicable to point inventory sources. EPA did not attempt to map each ICR unit to the NEI units, instead choosing to use a more general approach to extract NEI sources that would be potentially subject to, and hence have emissions reduced by the Boiler MACT. The NEI includes a field that indicates whether a facility is a major source of HAPs and/or CAPs. This field in our FF10 point inventory modeling file is called "FACIL_CATEGORY_CODE" and the possible values for that field are shown in Table 4-30. Because the Boiler MACT rule applies to only major sources of HAPs, EPA restricted the universe of facilities potentially subject to the Boiler MACT to those classified as HAP major or unknown (UNK). The third column indicates whether the facility was a candidate for extraction as being potentially subject to the Boiler MACT.

Table 4-30. Facility types potentially subject to Boiler MACT reductions

Code	Facility Category	Subject to Boiler MACT?	Description
CAP	CAP Major	N	Facility is Major based upon 40 CFR 70 Major Source definition paragraph 2 (100 tpy any CAP. Also meets paragraph 3 definition, but NOT paragraph 1 definition).
HAP	HAP Major	Y	Facility is Major based upon only 40 CFR 70 Major Source definition paragraph 1 (10/25 tpy HAPs).
HAPCAP	HAP and CAP Major	Y	Facility meets both paragraph 1 and 2 of 40 CFR 70 Major Source definitions (10/25 tpy HAPs and 100 tpy any CAP).
HAPOZN	HAP and O3 n/a Major	Y	Facility meets both paragraph 1 and 3 of 40 CFR 70 Major Source definitions (10/25 tpy HAPs and Ozone n/a area lesser tons for NO_X or VOC).
NON	Non-Major	N	Facility's Potential To Emit is below all 40 CFR 70 Major Source threshold definitions without a FESOP.
OZN	O3 n/a Major	N	Facility is Major based upon only 40 CFR 70 Major Source definition paragraph 3 (Ozone n/a area lesser tons for NO_X or VOC).
SYN	Synthetic non-Major	N	Facility has a FESOP which limits its Potential To Emit below all three 40 CFR 70 Major Source definitions.
UNK	Unknown	N	Facility category per 40 CFR 70 Major Source definitions is unknown.

Step 2: Obtain "MARAMA" control information

From the (point inventory) facilities extracted in Step 1, we merged in ICI Boiler controls/adjustments developed under MARAMA in support of the Ozone Transport Commission (OTC) 2007 modeling platform future year analyses. These adjustments are discussed in a White Paper "White Paper for ICI Blr Emissions V6.doc" (available upon request). This white paper provides methodology and summary future year adjustments and emission estimates based on the OTC 2007 platform for the purpose of estimating emissions changes in ICI point and nonpoint sources due to the Boiler MACT, 1-hour SO2 NAAQS and economic factors related to natural gas prices. This MARAMA approach relies on Council of Industrial Boilers (CIBO) analysis of cost-effectiveness of boiler controls and retrofits in order to maintain the Boiler MACT. In short, the CIBO analyses showed that many ICI boilers were converting (or replacing coal units) to natural gas rather than applying more costly controls. Specifically, CIBO determined that 63% of coal units found it more economical to replace their coal boilers with natural gas boilers.

ICI boilers were categorized by fuel: Light Oil (distillate), Heavy Oil (residual), Pulverized Coal and Stoker/Other Coal. Next, AP42 (http://www.epa.gov/ttn/chief/ap42/) emission factors for each fuel was converted to consistent units (lb/MMBtu) via heat content and these normalized emission factors were used to develop emission factor ratios of natural gas to non-natural gas fuel type. Finally, the estimated number of ICI boiler replacements and retrofits were used to create weighted-average adjustment ("control") factors from these normalized emission factor ratios. This methodology makes the following assumptions:

- Natural Gas NO_X emissions rates: 0.10 lb/MMBtu for new boilers,
0.1961 lb/MMBtu for burner retrofits
- Natural gas emission rates for SO_2, $PM_{2.5}$ and VOC are the same for both boiler replacement and burner retrofits
- Any unit that finds it economical to replace the entire boiler, will do so. Those that don't replace the boiler but find it economical to retrofit the burner will do so. Other units remain unchanged for NO_X, SO_2, $PM_{2.5}$ and VOCs emissions.
- Analyses are based on OTC 2007 modeling platform and applied to 2011 emissions modeling platform

Step 3: Merge control information with 2011 NEI and apply state NODA comments

EPA analyzed the SCCs in the OTC 2007 inventories and tweaked the SCC mapping of these ICI boiler adjustments to map to those in the 2011 NEI point and nonpoint inventory with non-zero emissions. EPA also removed some duplicate and incorrect mappings and expanded the SCC mapping in some cases to SCCs that were in the NEI but not the OTC inventory (and thus missing from the analysis). In addition, the MARAMA approach only includes adjustments for NOX, PM and SO2. Therefore, EPA merged in existing VOC, CO, HCl controls (applying VOC controls to VOC HAPs as well) from the 2011v6.0 emissions modeling platform (see Section 4.2.7 in the 2011v6.0 Emissions Modeling TSD) to the same set of facilities (point) and SCCs as those for the pollutants provided by the MARAMA approach.

Some states commented on the 2011v6.0 ICI boiler controls via the 2018 NODA (docket # EPA-HQ-OAR-2013-0809 on http://www.regulations.gov). Wisconsin provided alternative SO_2, VOC and HCl controls for stoker and pulverized coal fueled units. The national-level and Wisconsin-specific ICI boiler adjustments, applied at the unit-level for point sources and by SCC (and state for Wisconsin) are provided in Table 4-31; note that we applied the same national-level adjustments to CO, NO_X and PM for coal units in Wisconsin. New York and New Jersey, via the MARAMA comment/data to the 2018 NODA, provided boiler rule NO_X reductions that also supersede these nationally-applied factors. The NJ and NY factors are provided in Table 4-32; note that NJ controls apply only to nonpoint sources and that NY controls vary by fuel for point sources.

The impacts of these ICI boiler reductions are provided in Table 4-33. Overall, the CO and $PM_{2.5}$ reductions are reasonably close to the year-2015 expected reductions in the Boiler MACT Reconsideration RIA: http://www.epa.gov/ttn/atw/boiler/boilersriaproposalrecon111201.pdf. It is worth noting that the SO_2 reductions in the preamble (http://www.epa.gov/ttn/atw/boiler/fr21mr11m.pdf) were estimated at 442,000 tons; the additional SO_2 reductions in the reconsideration are from an additional co-benefit from more stringent HCl controls. The 2011NEIv2 SO_2 emissions are actually less than the estimated Boiler MACT reductions, likely a result of numerous units undergoing fuel switching from coal or oil to natural gas.

Table 4-31. National-level, with Wisconsin exceptions, ICI boiler adjustment factors by base fuel type

Unit/Fuel Type	Default % Reduction (Adjustments)					
	CO	NOX	PM	SO2	VOC	HCl
Stoker Coal	98.9	70.7	96	97.4	98.9	95
Pulverized Coal	98.9	60.6	72.2	73	98.9	95
Residual Oil	99.9	57	92.4	97.1	99.9	95
Distillate Oil	99.9	38.8	68.4	99.9	99.9	88.6
Wisconsin: Stoker Coal	98.9	70.7	96	30	0	45
Wisconsin: Pulverized Coal	98.9	60.6	72.2	30	0	45

Table 4-32. New York and New Jersey NO_X ICI Boiler Rules that supersede national approach

NJ and NY Boiler Rule controls	NOX % Reduction
New Jersey Small Boiler Rule (nonpoint only): Default for Distillate, Residual, natural gas and LPG	25
New York Small Boiler Rule (nonpoint only): Default for Distillate, Residual, natural gas and LPG	10
NY Boiler Rule: Industrial /Distillate Oil /< 10 Million Btu/hr	10
NY Boiler Rule: Industrial /Residual Oil /10-100 Million Btu/hr	33.3
NY Boiler Rule: Electric Gen /Residual Oil /Grade 6 Oil: Normal Firing	40
NY Boiler Rule: Electric Gen /Natural Gas /Boilers, < 100 Million Btu/hr except Tangent	50
NY Boiler Rule: Electric Gen /Natural Gas /Boilers, 100 Million Btu/hr except Tangent	60
NY Boiler Rule: Industrial /Bitum Coal /Cyclone Furnace	66.7
NY Boiler Rule: Industrial /Natural Gas /> 100 Million Btu/hr	70
NY Boiler Rule: Electric Gen /Bituminous Coal /Pulverized Coal: Dry Bottom	73.3

Table 4-33. Summary of ICI Boiler reductions

Year	Pollutant	Emissions Eligible for Control	Controlled (Final) Emissions	Reductions (tons)	% Reductions
2017	CO	35,118	336	34,782	99.0%
2017	NO_X	128,943	64,596	64,347	49.9%
2017	PM_{10}	34,592	7,401	27,191	78.6%
2017	$PM_{2.5}$	13,973	2,504	11,469	82.1%
2017	SO_2	273,449	29,451	243,998	89.2%
2017	VOC	1,778	43	1,735	97.6%
2025	CO	35,883	346	35,537	99.0%
2025	NO_X	130,862	65,259	65,603	50.1%
2025	PM_{10}	35,729	7,700	28,030	78.4%
2025	$PM_{2.5}$	14,273	2,572	11,701	82.0%
2025	SO_2	272,425	30,579	241,846	88.8%
2025	VOC	1,791	43	1,747	97.6%

4.2.4.5 Fuel sulfur rules (nonpt, ptnonipm, pt_oilgas)

Packet: CONTROL_2011v6.2_20xx_Fuel_Sulfur_Rules_09jan2015.txt

Fuel sulfur rules, based on web searching and the 2011 emissions modeling NODA comments are currently limited to the following states: Connecticut, Delaware, Maine, Massachusetts, New Jersey, New York, Pennsylvania, Rhode Island and Vermont. The fuel limits for these states are incremental starting after year 2012, but are fully implemented by July 1, 2018 in all of these states.

A summary of all fuel sulfur rules provided back to EPA by the 2011 emissions modeling NODA comments is provided in Table 4-34. State-specific control factors were computed for distillate, residual and #4 fuel oil using each state's baseline sulfur contents and the sulfur content in the rules. For most states, the baseline sulfur content was 3,000 ppm (0.3%) for distillate oil, and 2.25% for residual and #4 oil. However, many states had lower baseline sulfur contents for residual oil, which varied by state and county. SRA used state- or county-specific baseline residual oil sulfur contents to calculate a state- or county-specific control factors for residual oil (SRA, 2014).

Table 4-34. State Fuel Oil Sulfur Rules data provided by MANE-VU

State	Reference
Connecticut	Section 22a-174-19a. Control of sulfur dioxide emissions from power plants and other large stationary sources of air pollution: Distillate and Residual: 3000 ppm effective April 15, 2014. Section 22a – 174 - 19b. Fuel Sulfur Content Limitations for Stationary Sources (except for sources subject to Section 22a-174-19a). Distillate: 500 ppm effective July 1, 2014; 15 ppm effective July 1, 2018 Residual: 1.0% effective July 1, 2014; 0.3% effective July 1, 2018 Connecticut General Statute 16a-21a. Sulfur content of home heating oil and off-road diesel fuel. Number 2 heating oil and off-road diesel fuel: 500 ppm effective July 1, 2014; 15 ppm effective July 1, 2018 See: http://www.ct.gov/deep/cwp/view.asp?a=2684&Q=322184&deepNav_GID=1619
Delaware	1108 Sulfur Dioxide Emissions from Fuel Burning Equipment Distillate: 15 ppm effective July 1, 2017 Residual: 0.5% effective July 1, 2017 #4 Oil: 0.25% effective July 1, 2017 See: http://regulations.delaware.gov/AdminCode/title7/1000/1100/1108.shtml
Maine	Chapter l06: Low Sulfur Fuel Distillate: 500 ppm effective July 1, 2014; 15 ppm effective July 1, 2018 Residual: 0.5% effective July 1, 2018 See: http://www.mainelegislature.org/legis/bills/bills_124th/billpdfs/SP062701.pdf.
Massachusetts	310 CMR 7.05 (1)(a)1: Table 1 : Sulfur Content Limit of Liquid Fossil Fuel Distillate: 500 ppm effective July 1, 2014; 15 ppm effective July 1, 2018 Residual: 1.0% effective July 1, 2014; 0.5% effective July 1, 2018 See: http://www.mass.gov/eea/docs/dep/service/regulations/310cmr07.pdf
New Jersey	Title 7, Chapter 27, Subchapter 9 Sulfur in Fuels Distillate: 500 ppm effective July 1, 2014; 15 ppm effective July 1, 2016 Residual: 0.5% or 0.3%, depending on county, effective July 1, 2014 #4 Oil: 0.25% effective July 1, 2014 See: http://www.nj.gov/dep/aqm/rules27.html
New York	Subpart 225-1 Fuel Composition and Use - Sulfur Limitations Distillate: 15 ppm effective July 1, 2016 Residual: 0.3% in New York City effective July 1, 2014; 0.37% in Nassau, Rockland and Westchester counties effective July 1, 2014; 0.5% remainder of state effective July 1, 2016 See: http://www.nyc.gov/html/dep/html/news/dep_stories_p3-109.shtml and http://green.blogs.nytimes.com/2010/07/20/new-york-mandates-cleaner-heating-oil/?_r=1 and http://switchboard.nrdc.org/blogs/rkassel/governor_paterson_signs_new_la.html
Pennsylvania	§ 123.22. Combustion units Distillate: 500 ppm effective July 1, 2016 Residual: 0.5% effective July 1, 2016

	#4 Oil: 0.25% effective July 1, 2016 See: http://www.pacode.com/secure/data/025/chapter123/s123.22.html
Rhode Island	Air Pollution Control Regulations No. 8 Sulfur Content of Fuels Distillate: 500 ppm effective July 1, 2014; 15 ppm effective July 1, 2018 Residual: 0.5% effective July 1, 2018 See: http://www.dem.ri.gov/pubs/regs/regs/air/air08_14.pdf
Vermont	5-221(1) Sulfur Limitations in Fuel Distillate: 500 ppm effective July 1, 2014; 15 ppm effective July 1, 2018 Residual: 0.5% effective July 1, 2018 #4 Oil: 0.25% effective July 1, 2018 See: http://www.epa.gov/region1/topics/air/sips/vt/VT_Section5_221.pdf

A summary of the sulfur rules by state, with emissions reductions is provided in Table 4-35. Most of these reductions (98+%) occur in the nonpt sector; a small amount of reductions occur in the ptnonipm sector (approximately 1,600 tons in 2025 and 580 tons in 2017), and a negligible amount of reductions occur in the pt_oilgas sector. Note that these reductions are based on intermediate 2017 and 2025 inventories, those grown from 2011 to the specific future years. In addition, with implementation (effective) dates after June 30, 2017 for several of these rules, there are more eligible sources for control in 2025 than 2017.

Table 4-35. Summary of fuel sulfur rule impacts on SO_2 emissions

Year	Emissions Eligible for Control	Controlled (Final) Emissions	Reductions	% Reductions
2017	76,177	12,849	63,328	83.1%
2025	99,975	21,172	78,803	78.8%

4.2.4.6 Natural gas turbines NO_X NSPS (ptnonipm, pt_oilgas)

Packet:
For 2017: "CONTROL_2011v6.2_2018_NOX_GasTurbines_16dec2014.txt"
For 2025: "CONTROL_2011v6.2_2025_NOX_GasTurbines_16dec2014.txt"

These controls were generated based on examination of emission limits for stationary combustion turbines that are not in the power sector. In 2006, EPA promulgated standards of performance for new stationary combustion turbines in 40 CFR subpart KKKK. The standards reflect changes in NO_X emission control technologies and turbine design since standards for these units were originally promulgated in 40 CFR part 60, subpart GG. The 2006 NSPSs affecting NO_X and SO_2 were established at levels that bring the emission limits up-to-date with the performance of current combustion turbines. Stationary combustion turbines were also regulated by the NO_X SIP (State Implementation Plan) Call, which required affected gas turbines to reduce their NO_X emissions by 60 percent.

Table 4-36 compares the 2006 NSPS emission limits with the NO_X RACT regulations in selected states within the NO_X SIP Call region. The map showing the states and partial-states in the NO_X SIP Call Program can be found at: http://www3.epa.gov/airmarkets/progress/reports/program_basics.html. We assigned only those counties in Alabama, Michigan and Missouri as NO_X SIP call based on the map on page 8. The state NO_X RACT regulations summary (Pechan, 2001) is from a year 2001 analysis, so some states may have updated their rules since that time.

Table 4-36. Stationary gas turbines NSPS analysis and resulting 2011v6.2 new emission rates used to compute controls

NO_X Emission Limits for New Stationary Combustion Turbines				
Firing Natural Gas	**<50 MMBTU/hr**	**50-850 MMBTU/hr**	**>850 MMBTU/hr**	
Federal NSPS	100	25	15	ppm
State RACT Regulations	**5-100 MMBTU/hr**	**100-250 MMBTU/hr**	**>250 MMBTU/hr**	
Connecticut	225	75	75	ppm
Delaware	42	42	42	ppm
Massachusetts	65*	65	65	ppm
New Jersey	50*	50	50	ppm
New York	50	50	50	ppm
New Hampshire	55	55	55	ppm
* Only applies to 25-100 MMBTU/hr				
Notes: The above state RACT table is from a 2001 analysis. The current NY State regulations have the same emission limits.				
	New source emission rate (Fn)		**NO_X ratio**	**Control (%)**
NO_X SIP Call states plus CA	= 25 / 42 =		0.595	40.5%
Other states	= 25 / 105 =		0.238	76.2%

Regarding stationary gas turbine lifetimes, the Integrated Planning Model (IPM) financial modeling documentation lists the book life of combustion turbines as 30 years, with a debt life of 15 years, and a US MACRS Depreciation Schedule of 15 years (EPA, 2013). This same documentation lists the book life of nuclear units at 40 years. IPM uses a 60 year lifetime for nuclear units in its simulations of unit retirements. Using the same relationship between estimated lifetime and book life for nuclear units of 1.5, the estimated lifetime for a combustion turbine would be 45 years. This is the same as an annual retirement rate of 2.2 percent.

For projection factor development, the existing source emission ratio was set to 1.0 for combustion turbines. The new source emission ratio for the NO_X SIP Call states and California is the ratio of state NO_X emission limit to the Federal NSPS. A complicating factor in the above is the lack of size information in the stationary source SCCs. Plus, the size classifications in the NSPS do not match the size differentiation used in state air emission regulations. We accepted a simplifying assumption that most industrial applications of combustion turbines are in the 100-250 MMBtu/hr size range, and computed the new source emission rates as the NSPS emission limit for 50-850 MMBtu/hr units divided by the state emission limits. We used a conservative new source emission ratio by using the lowest state emission limit of 42 ppmv (Delaware). This yields a new source emission ratio of 25/42, or 0.595 (40.5% reduction) for states with existing combustion turbine emission limits. States without existing turbine NO_X limits would have a lower new source emission ratio - the uncontrolled emission rate (105 ppmv via AP-42) divided into 25 ppmv = 0.238 (76.2% reduction). This control was then plugged into *Equation 2* (see Section 4.2.4) as a function of the year-specific projection factor. Resulting controls greater than or equal to 1% were included in our projections. National Process Heaters NSPS reductions from projected pre-NSPS 2018 and 2025 inventories are shown in Table 4-37.

Table 4-37. National by-sector NO_X reductions from Stationary Natural Gas Turbine NSPS controls

Sector	Pre-NSPS Emissions		NSPS Reductions		NSPS % Reductions	
	2018	2025	2018	2025	2018	2025
Non-EGU Point (ptnonipm)	14,238	15,593	2,400	4,405	17%	28%
Point Oil & Gas (pt_oilgas)	70,267	75,310	8,783	24,536	12%	33%
Total	84,505	90,903	11,183	28,941	13%	32%

4.2.4.7 Process heaters NO_X NSPS (ptnonipm, pt_oilgas)

Packet:
For 2017: "CONTROL_2011v6.2_2018_NOX_Process_heaters_09dec2014.txt"
For 2025: "CONTROL_2011v6.2_2025_NOX_Process_heaters_09dec2014.txt"

Process heaters are used throughout refineries and chemical plants to raise the temperature of feed materials to meet reaction or distillation requirements. Fuels are typically residual oil, distillate oil, refinery gas, or natural gas. In some sense, process heaters can be considered as emission control devices because they can be used to control process streams by recovering the fuel value while destroying the VOC. The criteria pollutants of most concern for process heaters are NO_X and SO_2.

In 2011, process heaters have not been subject to regional control programs like the NO_X SIP Call, so most of the emission controls put in-place at refineries and chemical plants have resulted from RACT regulations that were implemented as part of SIPs to achieve ozone NAAQS in specific areas, and refinery consent decrees. The boiler/process heater NSPS established NO_X emission limits for new and modified process heaters. These emission limits are displayed in Table 4-38.

In order to develop a relationship between the typical process heater emission rates in 2011 compared with what the NSPS will require of new and modified sources, an analysis of the materials in the EPA docket (EPA-HQ-OAR-2007-0011) for the NSPS was performed. This docket contained an EPA memorandum that estimated the NO_X emissions impacts for process heaters. Table 1 in that memo—titled: Summary of Representative Baseline NO_X Concentrations for Affected Process Heaters. That analysis can be used to establish an effective 2011 process heater NO_X emission rate, although the information that EPA-SPPD used in the revised NO_X impact estimates probably uses data from a few years before 2011. It is likely that the data used are representative of 2011 emissions because the only wide-ranging program that has affected process heater emission rates recently have been consent decrees, and the emission reductions associated with these agreements should have been achieved before 2011. However, the compliance schedules are company-specific, and differ by company, so it is difficult to make overarching conclusions about when compliance occurred.

Table 4-38. Process Heaters NSPS analysis and 2011v6.2 new emission rates used to compute controls

NO_X emission rate Existing (Fe)	Fraction at this rate		
PPMV	**Natural Draft**	**Forced Draft**	**Average**
80	0.4	0	
100	0.4	0.5	
150	0.15	0.35	
200	0.05	0.1	
240	0	0.05	
Cumulative, weighted: Fe	104.5	134.5	**119.5**
NSPS Standard	40	60	
New Source NO_X ratio (Fn)	0.383	0.446	**0.414**
NSPS Control (%)	61.7	55.4	**58.6**

EPA states that because it "does not have much data on the precise proportion of process heaters that are forced versus natural draft, so the nationwide impacts are expressed as a range bounded by these two scenarios". (Scenario 1 assumes all of the process heaters are natural draft process heaters and Scenario 2 assumes all of the process heaters are forced draft process heaters.)

For computations, the existing source emission ratio (Fe) was set to 1.0. The computed (average) NO_X emission factor ratio for new sources (Fn) is 0.41 (58.6% control). The retirement rate is the inverse of the expected unit lifetime. There is limited information in the literature about process heater lifetimes. This information was reviewed at the time that the Western Regional Air Partnership (WRAP) developed its initial regional haze program emission projections, and energy technology models used a 20 year lifetime for most refinery equipment. However it was noted that in practice, heaters would probably have a lifetime that was on the order of 50 percent above that estimate. Therefore, a 30 year lifetime was used to estimate the effects of process heater growth and retirement. This yields a 3.3 percent retirement rate. This control was then plugged into *Equation 2* (see Section 4.2.4) as a function of the year-specific projection factor. Resulting controls greater than or equal to 1% were retained. National Process Heaters NSPS reductions from projected pre-NSPS 2018 and 2025 inventories are shown in Table 4-39.

Table 4-39. National by-sector NO_X reductions from Process Heaters NSPS controls

	Pre-NSPS Emissions		NSPS Reductions		NSPS % Reductions	
Sector	**2018**	**2025**	**2018**	**2025**	**2018**	**2025**
Non-EGU Point (ptnonipm)	74,129	75,936	14,200	21,306	19%	28%
Point Oil & Gas (pt_oilgas)	7,086	7,170	1,114	1,816	16%	25%
Total	81,215	83,106	15,313	23,123	19%	28%

4.2.4.8 Arizona Regional Haze controls (ptnonipm)

Packet: CONTROL_2011v6.2_20xx_AZ_Regional_Haze_PT_24feb2015.txt

U.S. EPA Region 9 provided regional haze Federal Implementation Plan (FIP) controls for a few industrial facilities. Information on these controls are available in the Federal Register (EPA-R09-OAR-2013-0588;

FRL-9912-97-OAR) at http://www.federalregister.com . These non-EGU controls have implementation dates between September 2017 and December 2018 and therefore do not reduce emissions in year 2017 projections. Year 2025 emissions are reduced at 5 smelter and cement units: NO_X by 1,722 tons and SO_2 by 26,423 tons.

4.2.4.9 CISWI (ptnonipm)

Packet: CONTROL_CISWI_2011v6_22nov2013.txt

On March 21, 2011, EPA promulgated the revised NSPS and emission guidelines for Commercial and Industrial Solid Waste Incineration (CISWI) units. This was a response to the voluntary remand that was granted in 2001 and the vacatur and remand of the CISWI definition rule in 2007. In addition, the standards re-development included the 5-year technology review of the new source performance standards and emission guidelines required under Section 129 of the Clean Air Act (CAA). The history of the CISWI implementation is documented here: http://www.epa.gov/ttn/atw/129/ciwi/ciwipg.html. Baseline and CISWI rule impacts associated with the CISWI rule are documented here: http://www.epa.gov/ttn/atw/129/ciwi/baseline_emission_reductions_memo.pdf. EPA mapped the units from the CISWI baseline and controlled dataset to the 2011 NEI inventory and because the baseline CISWI emissions and the 2011 NEI emissions were not the same, EPA computed percent reductions such that our future year emissions matched the CISWI controlled dataset values. CISWI controls are applied in Arkansas and Louisiana only, totaling 3,100 and 3,552 tons of SO_2 reductions in years 2017 and 2025 respectively. The reductions are greater in year 2025 because they are applied to year-specific projected (grown) emissions.

4.2.4.10 Data from comments on previous platforms (nonpt, ptnonipm, pt_oilgas)

Packets:
“CONTROL_2011v6.2_20xx_Consent_Decrees_State_comments_2018docket_pt_v2_09mar2015.txt”
“CONTROL_2011v6.2_20xx_State_comments_2018docket_nonpt_15jan2015.txt”

All remaining non-EGU point and nonpoint controls are discussed in this section. For the nonpoint sector, these controls are limited to comments/data-responses on the previous (2011v6.0) emissions modeling platforms, and the 2018 NODA process. For point sources, controls include data from the 2018 NODA process as well as a concatenation of all remaining controls not already discussed. These controls are split into separate packets for point and nonpoint sources.

Nonpoint packet: (CONTROL_2011v6.2_20xx_State_comments_2018docket_nonpt_15jan2015.txt)
This packet contains all nonpoint controls not already discussed in previous sections (e.g., Fuel Sulfur rules, ICI boilers) provided in response to the 2018 NODA, and is restricted to VOC controls for Delaware, Massachusetts, Pennsylvania and Virginia, with the great majority of these controls restricted to Virginia. These VOC controls cover various state programs and rules such as Auto refinishing, Adhesives and Surface Coatings. Cumulatively, these VOC controls reduce nonpoint VOC by approximately 3,900 tons in 2017 and 4,100 tons in 2025.

Point packet:
(CONTROL_2011v6.2_20xx_Consent_Decrees_State_comments_2018docket_pt_v2_09mar2015.txt)

This packet contains all point controls not already discussed in previous sections (e.g., Fuel Sulfur rules, ICI boilers). This packet includes new controls information provided in response to the 2018 NODA as well as “legacy” controls from the 2011v6.0 emissions modeling platform from numerous sources such as settlement and consent decree data gathering efforts, comments received during the Cross-State Air Pollution Rule rulemaking process, regional haze modeling, and stack-specific control information provided by TCEQ.

New control information from the 2018 NODA responses is primarily limited to VOC controls from several states: Delaware, Massachusetts, New Jersey, Pennsylvania and Virginia. However, we also received comments with revised compliance dates, removal of existing control information, and updated controls from local settlements. The CONTROL packet comments field provides information on the source of new control information, where available.

The "old" control information includes information discussed in previous emissions modeling platforms; these CONTROL packet components are discussed in Section 4.2.9 in the 2011v6.1 emissions modeling platform TSD (EPA, 2014b).

Cumulative ptnonipm and pt_oilgas reductions to 2017 and 2025 pre-controlled (projection factors already applied) from this CONTROL packet are shown in Table 4-40. While these controls impact both the ptnonipm and pt_oilgas sector, almost all reductions are in the ptnonipm sector; pt_oilgas NO_X is reduced by 1,300 tons in 2025, and VOC by 172 tons in 2025. Reductions to pt_oilgas for PM and SO2 are under 100 tons cumulatively.

Table 4-40. Summary of remaining ptnonipm and pt_oilgas reductions

Year	Pollutant	Emissions Eligible for Control	Controlled (Final) Emissions	Reductions	% Reductions
2017	CO	5,783	764	5,019	86.8%
2017	NH3	32	0	32	100.0%
2017	NOX	85,009	42,609	42,401	49.9%
2017	PM10	4,007	1,932	2,075	51.8%
2017	PM2.5	3,582	1,759	1,823	50.9%
2017	SO2	121,735	26,155	95,580	78.5%
2017	VOC	2,741	2,234	507	18.5%
2025	CO	6,092	712	5,380	88.3%
2025	NH3	757	251	505	66.8%
2025	NOX	88,790	43,415	45,375	51.1%
2025	PM10	4,089	1,927	2,162	52.9%
2025	PM2.5	3,642	1,748	1,893	52.0%
2025	SO2	125,367	26,755	98,612	78.7%
2025	VOC	3,145	2,326	819	26.0%

We discovered an error in year 2017 processing for the pt_oilgas sector. We created a second version of the point CONTROL packet after processing year 2025, but prior to year 2017. For the "v2" packet, we changed the compliance dates from January 1, 2018 to January 1, 2017 for the ptnonipm sector processing because compliance dates after June 30, 2017 would not be applied for year 2017 projections. This was applied correctly for the ptnonipm sector but the pt_oilgas sector used an older version of the point CONTROL packet that had the 1/1/2018 compliance dates. These controls, limited to information provided by TCEQ (for Texas) were therefore not applied to the pt_oilgas sector; however, this impact is assumed small because: 1) the impact was very small in 2025, 2) the pre-controlled emissions in 2025 were larger than 2017 because of smaller oil and gas growth rates in 2017 than 2025, and 3) it is not clear how many of these stacks in the pt_oilgas sector were controlled by other packets as a result. Regarding item 3, recall that the CoST hierarchy for applying CONTROL packet information. The intended control data in this packet is very specific (stack-level), so it supersedes other possible less-specifically applied control information that could apply to several of these stacks, particularly RICE NESHAP (SCC/pollutant-level) and ICI boilers (unit/SCC/pollutant-level) control data.

4.2.5 Stand-alone future year inventories (nonpt, ptnonipm)

This section discusses future year NEI non-EGU point and nonpoint emission inventories that were not created via CoST strategies/programs/packets. These inventories are either new to the future years because they did not exist in 2011 (e.g., new cement kilns, biodiesel and cellulosic plants), or are a complete replacement to the year 2011 NEI inventory in the case of portable fuel containers. New non-EGU facilities provided by South Carolina via the 2018 NODA on the 2011v6.0 platform were mistakenly omitted from both year 2017 and 2025 emissions modeling processing. Cumulatively, these new facilities would have added approximately 200 tons of NO_X, and under 100 tons of each of the remaining CAPs.

4.2.5.1 Portable fuel containers (nonpt)

Future year inventory:
For 2017: "pfc_2018_2011v6.2_ff10_28jan2015_v0.csv"
For 2025: "pfc_2025_2011v6.2_ff10_28jan2015_v0.csv"

EPA used future-year VOC emissions from Portable Fuel Containers (PFCs) from inventories developed and modeled for EPA's MSAT2 rule (EPA, 2007a). The 6 PFC SCCs are summarized below (note that the full SCC descriptions for these SCCs include "Storage and Transport; Petroleum and Petroleum Product Storage" as the beginning of the description).

- 2501011011 Residential Portable Fuel Containers: Permeation
- 2501011012 Residential Portable Fuel Containers: Evaporation
- 2501011014 Residential Portable Fuel Containers: Refilling at the Pump: Vapor Displacement
- 2501012011 Commercial Portable Fuel Containers: Permeation
- 2501012012 Commercial Portable Fuel Containers: Evaporation
- 2501012014 Commercial Portable Fuel Containers: Refilling at the Pump: Vapor Displacement

The future-year emissions reflect projected increases in fuel consumption, state programs to reduce PFC emissions, standards promulgated in the MSAT2 rule, and impacts of the RFS2 standards on gasoline volatility. EPA developed year 2018 and 2025 PFC emissions that include estimated Reid Vapor Pressure (RVP) and oxygenate impacts on VOC emissions, and more importantly, large increases in ethanol emissions from RFS2. These emission estimates also include gas can vapor displacement, tank permeation and diurnal emissions from evaporation. Because the future year PFC inventories contain ethanol in addition to benzene, EPA developed a VOC E-profile that integrated ethanol and benzene; see Section 0 for more details. Note that spillage emissions were not projected and were carried forward from 2011. We received comments and PFC projections data for year 2018 from MARAMA as part of the 2011v6.0 emissions modeling platform NODA (see: http://www.regulations.gov/#!docketDetail;D=EPA-HQ-OAR-2013-0809). We used these projection factors to project MARAMA state PFC emissions to year 2018 and then projected to year 2025 using the existing ratios 2025 to 2018 PFC emissions provided by OTAQ. We used commercial software to blend the MARAMA projection factors and existing PFC inventories to create year 2018 and

2025 PFC inventories for this platform. A summary of the resulting PFC emissions for 2011, 2018 (used for 2017) and 2025 are provided in Table 4-41.

Table 4-41. PFC emissions for 2011, 2018 and 2025 [tons]

	Emissions			Difference		% Change	
	2011	2018	2025	2018	2025	2018	2025
VOC	171,963	32,158	37,617	-139,805	-134,347	-81.3%	-78.1%
Benzene	742	654	758	-88	15	-11.9%	2.1%
Ethanol	0	3,719	4,448	n/a			

4.2.5.2 Biodiesel plants (ptnonipm)

New Future year inventory: "Biodiesel_Plants_2018_ff10"

EPA OTAQ developed an inventory of biodiesel plants for 2018. Plant location and production volume data came from the Tier 3 proposed rule.[36,37] The total volume of biodiesel came from the AEO 2013 early release, 1.3 BG for 2018. To reach the total volume of biodiesel, plants that had current production volumes were assumed to be at 100% production and the remaining volume was split among plants with planned production. Once facility-level production capacities were scaled, emission factors based on soybean oil feedstock were applied. These emission factors in Table 4-42 are in tons per million gallons (Mgal) and were obtained from EPA's spreadsheet model for upstream EISA impacts developed for the RFS2 rule (EPA, 2010a). Inventories were modeled as point sources with Google Earth and web searching validating facility coordinates and correcting state-county FIPS. Table 4-43 provides the 2018 biodiesel plant emissions estimates. Since biofuels were not projected to change significantly between 2017 and 2025 the year 2018 inventory was used for both year 2017 and year 2025. Emissions in 2011 are assumed to be near zero, and HAP emissions in 2017 and 2025 are nearly zero.

Table 4-42. Emission Factors for Biodiesel Plants (Tons/Mgal)

Pollutant	Emission Factor
VOC	4.3981E-02
CO	5.0069E-01
NO_X	8.0790E-01
PM_{10}	6.8240E-02
$PM_{2.5}$	6.8240E-02
SO_2	5.9445E-03
NH_3	0
Acetaldehyde	2.4783E-07
Acrolein	2.1290E-07
Benzene	3.2458E-08
1,3-Butadiene	0
Formaldehyde	1.5354E-06
Ethanol	0

[36] US EPA 2014.Regulatory Impact Analysis for Tier 3 Vehicle Emission and Fuel Standards Program. EPA-420-RD-143-0052.
[37] Cook, R. 2014. Development of Air Quality Reference Case Upstream and Portable Fuel Container Inventories for Tier 3 Final Rule. Memorandum to Docket EPA-HQ-OAR-2010-0162.

Table 4-43. 2018/2025 biodiesel plant emissions [tons]

Pollutant	2018
CO	649
NO_X	1048
PM_{10}	89
$PM_{2.5}$	89
SO_2	8
VOC	57

4.2.5.3 Cellulosic plants (nonpt)

New Future year inventories:
Primary inventory: “2018_cellulosic_inventory”
New Iowa inventory: “cellulosic_new_Iowa_plants_from2018docket_2011v6.2_ff10_28jan2015”

Development of primary inventory
Depending on available feedstock, cellulosic plants are likely to produce fuel through either a biochemical process or a thermochemical process. EPA developed county-level inventories for biochemical and thermochemical cellulosic fuel production for 2018 to reflect AEO2013er renewable fuel volumes. Emissions factors for each cellulosic biofuel refinery reflect the fuel production technology used rather than the fuel produced. Emission rates in Table 4-44 and Table 4-45 were used to develop cellulosic plant inventories. Criteria pollutant emission rates are in tons per RIN gallon. Emission factors from the cellulosic diesel work in the Tier 3 NPRM were used as the emission factors for the thermochemical plants. Cellulosic ethanol VOC and related HAP emission factors from the Tier 3 NPRM were used as the biochemical VOC and related HAP emission factors. Because the future year cellulosic inventory contains ethanol, a VOC E-profile that integrated ethanol was used, see Sections 0 and 3.2.1.3 for more details.

Plants were treated as area sources spread across the entire area of whatever county they were considered to be located in. Cellulosic biofuel refinery siting was based on utilizing the lowest cost feedstock, accounting for the cost of the feedstock itself as well as feedstock storage and the transportation of the feedstock to the cellulosic biofuel refinery. The total number of cellulosic biofuel refineries was projected using volumes from AEO2013 (early release). The methodology used to determine most likely plant locations is described in Section 1.8.1.3 of the RFS2 RIA (EPA, 2010a). Table 4-46 provides the year 2018 cellulosic plant emissions estimates. Since biofuels were not projected to change significantly between 2017 and 2025 the year 2018 inventory was used for both year 2017 and year 2025.

Table 4-44. Criteria Pollutant Emission Factors for Cellulosic Plants (Tons/RIN gallon)

Cellulosic Plant Type	VOC	CO	NO_X	PM_{10}	$PM_{2.5}$	SO_2	NH_3
Thermochemical	5.92E-07	8.7E-06	1.31E-05	1.56E-06	7.81E-07	1.17E-06	1.44E-10
Biochemical	1.82E-06	1.29E-05	1.85E-05	3.08E-06	1.23E-06	6.89E-07	0

Table 4-45. Toxic Emission Factors for Cellulosic Plants (Tons/RIN gallon)

Plant Type	Acetaldehyde	Acrolein	Benzene	1,3-Butadiene	Formaldehyde	Ethanol
Thermochemical	2.95E-08	1.27E-09	9.61E-10	0	5.07E-09	2.09E-07
Biochemical	3.98E-07	1.11E-08	1.39E-08	0	2.28E-08	6.41E-07

Table 4-46. 2017/2025 cellulosic plant emissions [tons]

Pollutant	Emissions
Acrolein	1
Formaldehyde	4
Benzene	1
Acetaldehyde	21
CO	6,088
Ethanol	146
NH_3	0.1
NO_X	9,199
PM_{10}	1,088
$PM_{2.5}$	547
SO_2	819
VOC	414

Development of new Iowa inventory

Iowa DNR (Department of Natural Resources), via the 2018 NODA comments (see docket # EPA-HQ-OAR-2013-0809 under http://www.regulations.gov.), provided information on new cellulosic ethanol capacity information for three facilities. Emissions for these facilities were computed using the emission factors previously discussed in Table 4-44 and Table 4-45. The resulting new facilities and NO_X emissions, used for both years 2017 and 2025, are provided in Table 4-47. Note that these facilities are in a nonpoint inventory because latitude-longitude coordinates were not available.

Table 4-47. New cellulosic plants NOX emissions provided by Iowa DNR**.**

FIPS	County	Facility Name	Approximate Production Capacity (Mgal/yr)	NO_X Emissions
19093	Ida	Quad County Corn Processors' Adding Cellulosic Ethanol (ACE)	2	26
19147	Palo Alto	POET-DSM Project Liberty	25	329
19169	Story	DuPont Cellulosic Ethanol	30	394

4.2.5.4 New cement plants (nonpt, ptnonipm)

Point Inventories:
For 2017: “cement_newkilns_year2018_from_ISIS2013_NEI2011v1”
For 2025: “cement_newkilns_year_2025_from_ISIS2013_NEI2011v1_08nov2013_v0.csv”

Nonpoint Inventories:
For 2017: “cement_newkilns_year_2018_from_ISIS2013_NEI2011v1_NONPOINT_v0.csv”
For 2025: “cement_newkilns_year_2025_from_ISIS2013_NEI2011v1_NONPOINT_12nov2013_v0.csv”

As discussed in Section 4.2.3.9, the ISMP model, was used to project the cement manufacturing sector to future years. This section covers new ISMP-generated kilns that did not exist in the 2011 NEI. For kilns that were new in 2018 and/or 2025, EPA used two different approaches for modeling. For kilns already permitted, known locations (coordinates) allowed us to process these as point sources. However, the ISMP model also created “generic” kilns in specific geographically strategic locations (counties) to cover the need for increased production/capacity in future years. Because these generic kilns are not permitted and the location in these counties is uncertain, EPA decided to model these as county-level to avoid placing large emissions sources from a model (ISMP) artifact in one grid cell. These nonpoint source kilns were then spatially allocated based on industrial land activity in the county. A list of all new point and nonpoint inventory cement kilns in 2018 and 2025 are provided in Table 4-48. Note that as production continues to increase beyond 2018, that additional new kilns are needed in 2025. Not shown here is a cement kiln in Washington (King county) that ISMP generates but according to Washington Department of Ecology, was not correct; this kiln was thus removed from our emissions modeling platform.

Table 4-48. Locations of new ISMP-generated cement kilns

Year(s)	ISMP ID	Permitted?	Facility Name	FIPS	State	County
Both	FLNEW2	Y	Vulcan	12001	FL	Aluchua
2025	FLNEW1	Y	American Cement Company	12119	FL	
Both	GANEW1	Y	Houston American Cement	13153	GA	Houston
Both	NCNEW1	Y	Titan America LLC	37129	NC	New Hanover
Both	NewGA2	N	n/a	13153	GA	Houston
Both	NewPA8	N	n/a	42011	PA	Berks
Both	NewSC1	N	n/a	45035	SC	Dorchester
Both	NewTX1	N	n/a	48029	TX	Bexar
Both	NewTX10	N	n/a	48091	TX	Comal
2025	NewAZ2	N	n/a	04025	AZ	Yavapai
2025	NewCO2	N	n/a	08043	CO	Freemont
2025	NewOK2	N	n/a	40123	OK	Pontotoc
2025	NewPA8	N	n/a	42095	PA	Northampton
2025	NewTX4	N	n/a	48029	TX	Bexar
2025	NewTX5	N	n/a	48091	TX	Comal
2025	NewTX12	N	n/a	48209	TX	Hays

For all ISMP future year emissions, PM_{10} is assigned as 0.85 of total PM provided by ISMP, and $PM_{2.5}$ is assigned as 0.15 of total PM. All new ISMP-generated kilns, point and nonpoint format, are assigned as Precalciner kilns (SCC=30500623). While ISMP provides emissions for mercury, EPA did not retain these in our modeling. Table 4-49 shows the magnitude of the new ISMP-based cement kilns. We split out ISMP-based new kilns in future years with permitted (as of August 2013) kilns modeled as point sources and "generic" ISMP-generated kilns as nonpoint sources.

Table 4-49. ISMP-generated new permitted and non-permitted emissions

	New kilns in 2018		New kilns in 2025		Total New ISMP Emissions	
	Permitted (point)	ISMP-generated (nonpoint)	Permitted (point)	ISMP-generated (nonpoint)	2018	2025
NO_X	3,751	5,697	4,795	13,673	8,546	19,370
$PM_{2.5}$	8	24	11	57	19	81
SO_2	1,775	13	2,004	30	3,779	43
VOC	91	2,969	117	7,115	208	10,084

4.3 Mobile source projections

Mobile source monthly inventories of onroad and nonroad mobile emissions were created for 2017 and 2025 using a combination of the MOVES2014 and the NMIM models. The 2017 and 2025 onroad emissions account for changes in activity data and the impact of on-the-books rules including some of the recent regulations such as the Light Duty Vehicle GHG Rule for Model-Year 2017-2025, and the Tier 3 Motor Vehicle Emission and Fuel Standards Rule (http://www.epa.gov/otaq/tier3.htm). Local inspection and maintenance (I/M) and other onroad mobile programs are included such as California LEVIII, the National Low Emissions Vehicle (LEV) and Ozone Transport Commission (OTC) LEV regulations (http://www.epa.gov/otaq/lev-nlev.htm), local fuel programs, and Stage II refueling control programs. Table 4-1 provides references to many of these programs.

Nonroad mobile emissions reductions for these years include reductions to various nonroad engines such as diesel engines and recreational marine engine types (pleasure craft), fuel sulfur content, and evaporative emissions standards.

Onroad mobile sources are comprised of several components and are discussed in the next subsection (4.3.1). Monthly nonroad equipment mobile emission projections are discussed in subsection 4.4. Locomotives and Category 1 and Category 2 commercial marine vessel (C1/C2 CMV) projections were discussed in Section 4.2.3.3, and Category 3 (C3) CMV projections were discussed in Section 4.2.3.4.

4.3.1 Onroad mobile (onroad)

The onroad emissions for 2017 and 2025 use the same SMOKE-MOVES system as for the base year (see Sections 2.3.1). Meteorology, speed, spatial surrogates and temporal profiles, representative counties, and fuel months were the same as for 2011. EPA had already performed many of the modeling steps to produce 2018 emissions, when the *NRDC v. EPA*[38] decision resulted in 2017 being the last full ozone season to consider for moderate nonattainment designations with respect to the 2008 ozone NAAQS. To accommodate this change within the time available, a two-step process was undertaken for onroad (and nonroad): (1) estimate the emissions for 2018 at a full detailed level (see Sections 4.3.1.1and 4.3.1.2), and (2) adjust the 2018 emissions to 2017 (see Section 4.3.1.3).

[38] D.C. Circuit Court's decision in *NRDC v. EPA*, 777 F.3dFD 456, 469 (D.C. Cir. 2014).

4.3.1.1 Future activity data

Estimates of total national Vehicle Miles Travelled (VMT) in 2018 and 2025 came from DOE's Annual Energy Outlook (AEO) 2014 (http://www.eia.gov/forecasts/aeo/) transportation projections, specifically the reference case that was released on May 7, 2014. Trends were developed by calculating ratios between 2011 AEO and 2018 AEO[39] estimates and applying the trends to the 2011NEIv2 VMT. These ratios were developed for light versus heavy duty and for four fuel types: gasoline, diesel, E-85, and CNG. This same method was used to project 2011NEIv2 VMT to 2025 with the incorporation of 2025 AEO estimates. The projection factors, the national 2011NEIv2 VMT ("VMT_2011") by broad vehicle and fuel type, and the default future VMT ("VMT_2018" and VMT_2025") are show in Table 4-50.

Table 4-50. Projection factors for 2018 and 2025 VMT (in millions of miles)[40]

Classification	MOVES source types	VMT 2011	Ratio 2018	VMT 2018	Ratio 2025	VMT 2025
LD gas	11,21,31,32	2,565,979	1.0154	2,605,570	1.0466	2,685,656
HD gas	42,43,51,52,53,54	21,530	1.0598	22,817	1.0880	23,425
HHD gas	61	10	0.7997	8	0.8414	9
LD diesel	21,31,32	41,645	3.0647	127,631	6.3858	265,938
HD diesel	41,42,43,51,52,53,54	58,995	1.1959	70,551	1.3621	80,357
HHD diesel	61,62	131,706	1.1709	154,216	1.3296	175,120
Bus CNG	42	303	2.1065	639	3.7099	1,125
LD E-85	21,31,32	143,600	1.8800	269,963	2.3570	338,463
Total	N/A	2,963,768	N/A	3,251,394	N/A	3,570,094

In the above table, light duty (LD) includes passenger cars, light trucks, and sometimes motorcycles, heavy duty (HD) includes buses and single unit trucks, and heavy-heavy duty (HHD) includes combination trucks. The specific MOVES source type codes are listed above. These national SCC6 ratios were applied to the 2011NEIv2 VMT to create an EPA estimate of 2018 and 2025 VMT at the county, SCC level.

Two additional steps were incorporated into the VMT projections. First, a set of states provided 2018 VMT projections[41]: AL, CT, GA, ME, MD, MA, MI, MO, NV, NY, NJ, NC, UT, VT, VA, and WY[42]. The state provided VMT projections were used over the EPA default projections in those specific counties. Second, EPA adjusted the national LD ratios so that it would reflect regional differences in growth rate. EPA analyzed LD VMT and corroborated that it had a high correlation with human population. Therefore, if a region has strong human population growth in the future, it will likely have larger VMT growth than the national average. To take account of this spatial difference in growth, EPA used human population to adjust

[39] By "2011 AEO," "2018 AEO," and "2025 AEO," this refers to the AEO2014's estimates of national VMT in those specific calendar years.

[40] Note: these are the default VMT values. The actual VMT used for 2018 and 2025 has slightly different VMT values. This is due to some states providing VMT projections for 2018. In addition, the LD ratios were further adjusted to take into account of high vs low growth of human population (discussed below). On average, the LD ratios match those in this table. For the actual VMT, see the inventory packaged with the cases.

[41] Although some states provided 2018 specific VMT projections, these projections were not consistently available for 2025. Therefore, state projections were not incorporated into the 2025 modeling.

[42] For many of these states, we used the county total from the state data and distributed those totals to EPA's SCCs based on default projected VMT. For MI, SEMCOG provided the Detroit projections and the rest of the counties came from the state. For MO, the state provided the 5 counties around St Louis. For Nevada, EPA received projections only for Clark County. For GA, the state agreed with our default projection method but they wanted to use GA provided human population projections for distributing the LD VMT growth rates to counties. They provided the human population for the 21 Atlanta counties. For the remaining counties, GA asked to use EPA defaults.

the national LD VMT growth rate so that on average the growth rate matched the national average, but any specific county growth rate was adjusted by the human population growth for that county:

$$VMTprojFactor_{sc} = AEOprojFactor_s * (1 + D(\left(\frac{humanProjFactor_c}{natlhumanProjFactor}\right) - 1))$$

where

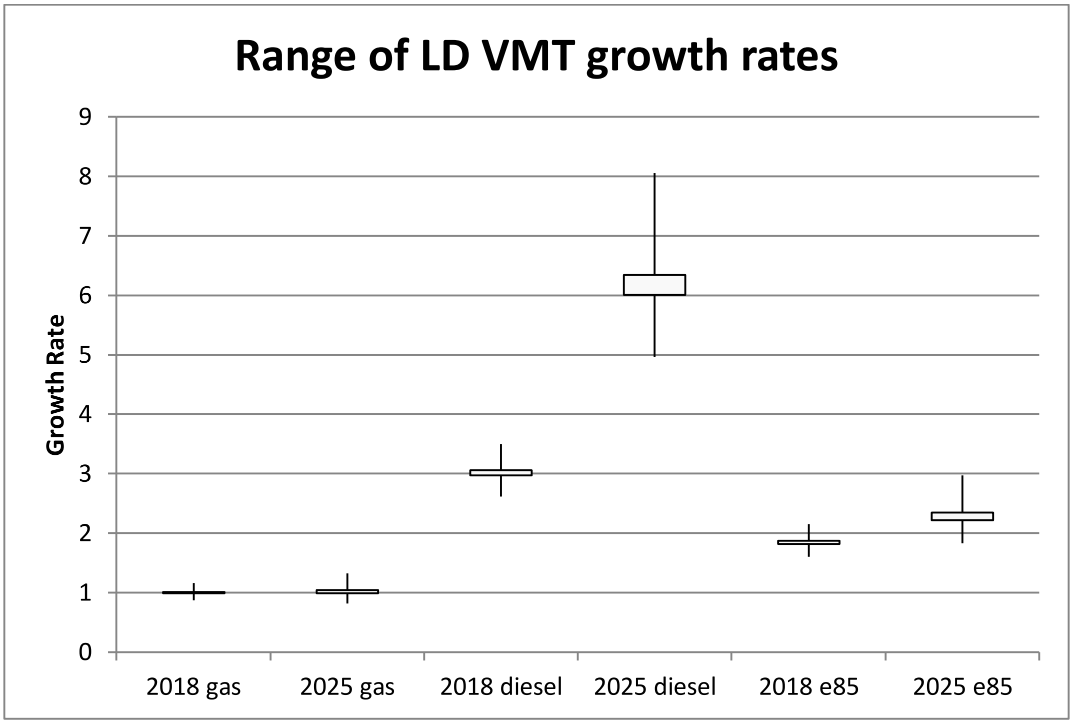
- s = source type/fuel
- c = county
- VMTprojFactor = county VMT projection factor (by source/fuel)
- AEOprojFactor = national VMT projection factor from AEO (by source/fuel)
- humanProjFactor = human projection factor for the county (year specific)
- natlhumanProjFactor = national human projection factor (year specific)
- D = damping factor, 0 = no county adjustment, 1 = full county variation

The specific value of D used for EPA projections was 0.5. This was based on an analysis of the growth of LD vehicles over time as compared to human population, which was found to be about 0.5 vehicles per person. The LD growth rates will vary by county, fuel, and year. The range of these growth rates are shown in Figure 4-4.

Vehicle population (VPOP) was developed by creating VMT/VPOP ratios from the 2011NEIv2 VMT and 2011NEIv2 VPOP at the county, fuel and vehicle type (SCC6) level. These ratios were applied to the 2018 VMT to create a 2018 VPOP. This process was repeated using the 2025 VMT to create the 2025 VPOP.

Hoteling (HOTELING) was developed by creating VMT/HOTELING ratios from the 2011 NEIv2 VMT and 2011 NEIv2 HOTELING at the county level. For these ratios, the VMT was limited to combination long-haul trucks (SCC6 220262). The HOTELING was the total of auxiliary power units (APU) and extended idle (EXT). These ratios were applied to the 2018 VMT to create a 2018 HOTELING. To get the APU split, 16% of HOTELING was assumed to be APU in all counties. This is consistent with MOVES2014 default split for APU for calendar year 2018. This process was repeated using the 2025 VMT to create the 2025 HOTELING. An APU split of 25% was used in 2025.

Figure 4-4. Light Duty VMT growth rates



4.3.1.2 Set up and Run MOVES to create EFs

Emission factor tables were created by running SMOKE-MOVES using the same procedures and models as described for 2011 (see the 2011NEIv2 TSD and Section 2.3). The same meteorology and the same representative counties were used. Changes between 2011 and future years (2018 or 2025) are predominantly activity data, fuels, national and local rules, and age distributions. Age (i.e., model year) distributions were projected forward using the methodology described in the MOVES activity report (EPA, 2015), although some states supplied age distributions in their CDBs. Fleet turnover resulted in a greater fraction of newer vehicles meeting stricter emission standards. The similarities and differences between the two runs are described in Table 4-51.

Table 4-51. Inputs for MOVES runs for 2018 and 2025

Element	**2017**	**2025**
Code	MOVES20141021cb6	MOVES20141021cb6
Default database	movesdb20141021cb6	movesdb20141021cb6
VMT and VPOP	2011 NEIv2	2011 NEIv2
Hydrocarbon speciation	Done inside MOVES	Done inside MOVES
Fuels	movesdb20141021_fuelsupply	movesdb20141021_fuelsupply
CA LEVIII	ca_standards_SS_20140903 (16 states)	ca_standards_SS_20140903 (16 states)

The following states were modeled as having adopted the California LEV III program (see Table 4-52):

Table 4-52. CA LEVIII program states

FIPS	State Name
06	California
09	Connecticut
10	Delaware
23	Maine
24	Maryland
25	Massachusetts
34	New Jersey
36	New York
41	Oregon
42	Pennsylvania
44	Rhode Island
50	Vermont
53	Washington

Fuels were projected into the future using estimates from the AEO2014 (http://www.eia.gov/forecasts/aeo/), release date May 7th 2014, as well as fuel properties changing as part of the Tier 3 Emissions and Fuel Standards Program (http://www.epa.gov/otaq/tier3.htm). The AEO2014 projection includes market shares of E10, E15, and E85 in 2018, as well as biodiesel market shares up to B5 (note that these values do not assume full implementation of the RFS2 program). The regional fuel properties and renewable volumes in 2011 were projected to 2018 in order to preserve the regional variation present in these fuel supplies, with total fuel volumes aligned to those in the AEO2014. Due to similarities between fuel volumes an in order to simplify analysis, the 2025 fuels were identical to the 2018 fuels. For details on the 2018 and 2025 speciation of onroad mobile source emissions, which is dependent on the fuels, see Section 3.2.1.4.

4.3.1.3 National and California adjustments

A set of adjustments were done in SMOKE-MOVES to create 2017 and 2025 emissions: 1) refueling, 2) California emissions, and 3) 2017 adjustments.

The first set of adjustment factors was for refueling. This uses the same approach as was used in 2011 (see the Section 2.3.1 for details) to take account of the few counties in Colorado that provided point source gas refueling emissions. These adjustments essentially zero out the MOVES-based gasoline refueling emissions (SCC 2201*62) in these counties so that the point estimates will be used instead.

The second set of adjustment factors was used to incorporate future year emissions provided by California. The same approach as was used in 2011 was used to match the emissions totals provided by CARB (see Section 2.3.1). The only differences between the 2011 approach and that applied for 2017 are that the latter uses the 2017 emissions provided by CARB and the 2018 EPA SMOKE-MOVES output to apportion and temporalize the emissions. For 2025, the process was repeated using 2025 emissions provided by CARB and the 2025 SMOKE-MOVES output for the EPA estimates. The provided CARB emissions were produced from working draft versions of EMFAC2011-LD and EMFAC2011-HD and include the following heavy duty regulations: chip reflash, extended idling, public fleet, trash trucks, drayage trucks, and trucks and buses. It does not include the GHG/smartway regulations for trucks, or the low carbon fuel standard. The California adjustment factors are by county, comparison SCC6, pollutant and impact all processes (RPD, RPV, RPH, and RPP).

The third set of adjustment factors adjusted 2018 emissions to 2017 levels. EPA ran MOVES2014 in inventory mode at the national level to create a 2017 inventory and a 2018 inventory. Each inventory was then divided by the respective year's VMT to create a 2017 emissions rate and a 2018 emissions rate. EPA calculated ratios of 2017 to 2018 by SCC and pollutant and applied them nationally at the SCC and pollutant level to adjust the SMOKE-MOVES results from 2018 to 2017. Separate ratios were calculated for the winter fuel months and the summer fuel months. The exception to this adjustment was in California, where CARB emissions were used to adjust the emissions (see above).

Because these adjustment factors are multiplicative, a single set of adjustment factors was created by multiplying the three adjustment factors together while taking care to match process (RPD, RPV, RPH, or RPP), pollutant, SCC, and county. Movesmrg applied the composite adjustment factor file (CFPRO) to compute 2017 or 2025 emissions that incorporated the appropriate adjustments for that case, county, SCC, and process.

4.4 Nonroad mobile source projections (nonroad)

The projection of locomotives and Category 1 and 2 commercial marine vessels to 2017 and 2025 is described in 4.2.3.3. The projection of the larger Category 3 commercial marine vessels is described in Section 4.2.3.4. Most of the remaining sources in the nonroad sector are projected by running the NMIM model with fuels and vehicle populations appropriate to 2018 and 2025; this section describes the projection of these sources. Similar to onroad, EPA adjusted the 2018 modeled emissions to 2017 levels.

This sector includes monthly exhaust, evaporative and refueling emissions from nonroad engines (not including commercial marine, aircraft, and locomotives) derived from NMIM for all states except California and Texas. NMIM provides nonroad emissions for VOC by three emission modes: exhaust, evaporative and refueling.

With the exception of California and Texas, U.S. emissions for the nonroad sector (defined as the equipment types covered by the NONROAD model) were created using a consistent NMIM-based approach as was used for 2011. Specifically, NMIM utilized NONROAD2008a including future-year equipment population estimates, control programs to the years 2018 and 2025, and inputs were either state-supplied as part of the 2011NEIv1 and 2011NEIv2 process or national level inputs. Fuels for 2018 and 2025 were assumed to be E10 everywhere for nonroad equipment. The fuels were developed from the MOVES fuels, which in turn were developed to be consistent with AEO2013 projections for 2018 and 2025. The AEO version is slightly older because nonroad projections were not updated for the 2011NEIv2. The databases used in the 2018 run were NMIM county database "NCD20130731_nei2018dv1" and fuels database "tier3frm2018ctrlfuels_03152013_ e10fuelsNMIM." The 2018 and 2025 emissions account for changes in activity data (based on NONROAD model default growth estimates of future-year equipment population) and changes in fuels and engines that reflect implementation of national regulations and local control programs that impact each year differently due to engine turnover. For details on the 2018 and 2025 speciation of nonroad, see Section 3.2.1.4.

The version of NONROAD used was the current public release, NR08a, which models all in-force nonroad controls. The represented rules include:

- "Clean Air Nonroad Diesel Final Rule - Tier 4", published June, 2004: http://www.epa.gov/otaq/nonroad-diesel.htm
- Control of Emissions from Nonroad Large Spark-Ignition Engines, and Recreational Engines (Marine and Land-Based), November 8, 2002 ("Pentathalon Rule").

- Small Engine Spark Ignition ("Bond") Rule, October, 2008: http://www.epa.gov/otaq/smallsi.htm

Not included are voluntary local programs such as encouraging either no refueling or evening refueling on Ozone Action Days.

To adjust 2018 emissions to 2017 levels, EPA ran NONROAD at the national level to create a 2017 inventory and a 2018 inventory. EPA calculated ratios of 2017 to 2018 by SCC and pollutant. These ratios were applied nationally at the SCC, mode, and pollutant level to adjust the NONROAD results from 2018 to 2017. Separate ratios were calculated for the winter fuel months versus the summer fuel months. The exception to this adjustment was in California, where CARB emissions were used to adjust the emissions (see below).

California and Texas nonroad emissions

Similar to the 2011 base year nonroad mobile, NMIM was not used to generate future-year nonroad emissions for California, other than for NH_3. EPA used NMIM for California future nonroad NH_3 emissions because CARB did not provide these data for any nonroad vehicle types. For the rest of the pollutants, the CARB-supplied 2017 and 2025 nonroad annual inventories were distributed to monthly emissions values by using the respective year 2018 and 2025 NMIM monthly inventories to compute monthly ratios by county, SCC7, mode and pollutant, which was consistent with the approach in 2011 (see Section 2.4.3). Some adjustments to the CARB inventory were needed to convert the provided TOG to VOC. See Section 3.2.1.3 for details on speciation of California nonroad data see Section 3.2.1.3)[43]. The CARB nonroad emissions include nonroad rules reflected in the December 2010 Rulemaking Inventory (http://www.arb.ca.gov/regact/2010/offroadlsi10/offroadisor.pdf) and those in the March 2011 Rule Inventory, the Off-Road Construction Rule Inventory for "In-Use Diesel".

For Texas, EPA combined Texas' submitted estimates for 2011 with EPA projections of nonroad emissions into 2017 and 2025. Conceptually, EPA used the trend of 2011 to 2017 or 2025 based on EPA's estimates to project Texas' submitted emissions for 2011. Specifically, projections were based on state-wide SCC7, mode, poll ratios[44] of 2017 and 2025 NMIM to 2011 NMIM. These ratios were then applied to Texas' submitted 2011 nonroad emissions, which had already been distributed to a monthly inventory (see Section 2.4.3), to create 2018 and 2025 monthly nonroad inventories.

4.5 "Other Emissions": Offshore Category 3 commercial marine vessels and drilling platforms, Canada and Mexico (othpt, othar, and othon)

As described in Section 2.5, emissions from Canada, Mexico, and non-U.S. offshore Category 3 Commercial Marine Vessels (C3 CMV) and drilling platforms are included as part of three emissions modeling sectors: othpt, othar, and othon. For oil drilling platforms, EPA used emissions from the 2011NEIv2 point source inventory for 2011 and both future years. Environment Canada did not provide any future-year emissions that were consistent with the 2010 base year emissions, therefore emissions for Canada were not projected to

[43] In addition, airport equipment was removed from CARB's inventory because these sources were modeled elsewhere.

[44] These ratios were initially attempted by county/SCC7/mode/pollutant, but due to significantly different distributions of certain source types between EPA and TCEQ's emissions, this created unreasonable growth in certain areas. The above approach was used except in the following, relatively limited conditions. If a state/SCC7/mode/pollutant was in EPA 2017 and 2025 emissions but not in EPA's 2011 emissions, 2017 and 2025 EPA emissions were used in the final inventory. If a state/SCC7/mode/pollutant was in TCEQ's 2011 emissions but was not in EPA's 2017 and 2025 emissions, then state/SCC3/mode/pollutant ratios were used to project to 2017 and 2025.

future years and are the same as those used in the 2011 base case. Emissions for Mexico are based on the Inventario Nacional de Emisiones de Mexico, 2008 projected to years 2018 and 2025 (ERG, 2014a).

As discussed in Section 2.5.1, the ECA-IMO-based C3 CMV emissions outside of U.S. state waters are processed in the othpt sector. This enables shipping lanes to be represented and for emissions to be treated as elevated sources. These C3 CMV emissions include those assigned to the Exclusive Economic Zone (defined as those emissions just beyond U.S. waters approximately 3-10 miles offshore, extending to about 200 nautical miles from the U.S. coastline), and all other offshore emissions. The projection factors for the othpt C3 CMV emissions vary by geographic and region as shown in Table 4-8.

5 Emission Summaries

The following tables summarize emissions differences between the 2011 evaluation case, the 2017 base case, and the 2025 base case. These summaries are provided at the national level by sector for the contiguous U.S. and for the portions of Canada and Mexico inside the smaller 12km domain (12US2) discussed in Section 3.1. The afdust sector emissions represent the summaries *after* application of both the land use (transport fraction) and meteorological adjustments (see Section 2.2.1); therefore, this sector is called "afdust_adj" in these summaries. The onroad sector totals are post-SMOKE-MOVES totals, representing air quality model-ready emission totals, and include CARB emissions for California. The c3marine sector includes U.S. emissions within state waters only; these extend to roughly 3-5 miles offshore and includes CMV emissions at U.S. ports. "Offshore to EEZ" represents CMV emissions that are within the (up to) 200 nautical mile Exclusive Economic Zone (EEZ) boundary but are outside of U.S. state waters along with the offshore oil platform emissions from the NEI. Finally, the "Non-US SECA C3" represents all non-U.S. and non-Canada emissions outside of the (up to) 200nm offshore boundary, including all Mexican CMV emissions. Canadian CMV emissions are included in the othar sector.

National emission totals by air quality model-ready sector are provided for all CAP emissions for the 2011 evaluation case in Table 5-1. The total of all sectors in the 2011 evaluation case are listed as "Con U.S. Total". Table 5-2 provides national emissions totals by sector for CAPs in the 2017 base case. Table 5-3 provides national emissions totals by sector for CAPs in the 2025 base case.

Table 5-4 provides national-by sector emission summaries for CO for all the cases: 2011 evaluation case, 2017 base case, and 2025 base case, with percent change from 2011 to 2017 and 2011 to 2025. Table 5-5 through Table 5-10 provide the same summaries for NH_3, NO_X, $PM_{2.5}$, PM_{10}, SO_2 and VOC, respectively. Note that the same fire emissions are used in all cases.

Table 5-1. National by-sector CAP emissions summaries for the 2011 evaluation case

Sector	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
afdust_adj				6,735,072	923,938		
ag		3,515,198					
agfire	956,243	3,321	42,767	140,728	93,959	16,224	74,783
c1c2rail	180,579	511	1,075,217	35,359	33,019	12,609	48,281
nonpt	1,645,989	94,242	720,454	491,825	404,258	275,655	3,672,249
np_oilgas	627,609	0	647,169	16,843	15,333	18,306	2,556,649
nonroad	13,951,020	2,627	1,630,301	162,417	154,657	4,031	2,024,419
onroad	26,313,827	120,805	5,719,979	367,667	194,690	29,665	2,709,470
c3marine	12,532	68	131,382	10,168	9,043	86,373	5,149
ptprescfire	10,063,500	161,999	167,599	1,060,130	900,546	83,082	2,313,404
ptwildfire	10,499,197	167,331	165,799	1,111,857	943,717	82,691	2,374,690
ptegu	777,902	24,925	2,088,233	281,614	206,884	4,662,717	36,336
ptnonipm	2,312,304	66,192	1,222,456	478,885	322,142	1,057,242	802,988
pt_oilgas	235,162	5,947	509,856	14,585	13,935	66,577	164,098
rwc	2,517,844	19,693	34,436	381,476	381,252	8,954	442,541
Con U.S. Total	**70,093,709**	**4,182,859**	**14,155,649**	**11,288,626**	**4,597,374**	**6,404,125**	**17,225,056**
Off-shore to EEZ*	175,353	185	899,986	26,247	24,544	139,169	81,602
Non-US SECA C3	17,184	0	202,432	17,206	15,828	127,579	7,294
Canada othafdust				779,674	112,523		
Canada othar	3,015,606	326,610	361,896	158,996	131,114	70,272	886,456
Canada othon	3,032,005	18,653	345,664	17,628	12,216	1,701	178,431
Canada othpt**	496,083	13,069	266,912	70,005	29,165	544,502	129,119
Mexico othar	277,810	163,040	182,869	98,812	50,158	10,679	410,734
Mexico othon	3,361,123	7,978	243,714	2,425	1,624	4,919	319,353
Mexico othpt	153,061	3,706	286,303	55,162	42,105	453,466	53,813
Non-US Total	**10,528,225**	**533,241**	**2,789,775**	**1,226,156**	**419,276**	**1,352,287**	**2,066,802**

* "Offshore to EEZ" includes both the offshore point emissions, and the "Offshore to EEZ" c3marine emissions

Table 5-2. National by-sector CAP emissions summaries for the 2017 base case

Sector	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
afdust_adj				7,093,387	964,080		
ag		3,577,123					
agfire	956,243	3,321	42,767	140,728	93,959	16,224	74,783
c1c2rail	194,109	513	915,797	25,970	24,245	1,161	34,528
nonpt	1,673,888	94,816	734,072	494,930	416,334	104,585	3,511,392
np_oilgas	677,087	0	687,307	21,112	19,420	37,505	3,164,559
nonroad	12,371,786	2,857	1,129,911	113,568	107,267	1,856	1,422,907
onroad	15,607,769	88,774	3,150,751	302,041	124,930	14,985	1,507,880
c3marine	15,600	68	131,691	1,729	1,531	3,904	6,429
ptprescfire	10,063,500	161,999	167,599	1,060,130	900,546	83,082	2,313,404
ptwildfire	10,499,197	167,331	165,799	1,111,857	943,717	82,691	2,374,690
ptegu	820,402	41,275	1,547,987	279,931	212,913	1,462,200	40,433
ptnonipm	2,357,260	66,496	1,192,297	480,114	325,400	807,093	814,400
pt_oilgas	216,480	5,887	411,055	14,013	13,379	69,034	165,559
rwc	2,504,587	19,546	35,507	384,041	383,807	8,814	437,984
Con U.S. Total	**57,957,907**	**4,230,006**	**10,312,541**	**11,523,551**	**4,531,527**	**2,693,133**	**15,868,951**
Off-shore to EEZ*	186,196	185	855,139	10,237	9,768	9,945	86,093
Non-US SECA C3	22,335	0	239,528	22,313	20,527	165,925	9,462
Canada othafdust				779,674	112,523		
Canada othar	3,015,606	326,610	361,896	158,996	131,114	70,272	886,456
Canada othon	3,032,005	18,653	345,664	17,628	12,216	1,701	178,431
Canada othpt**	496,083	13,069	266,912	70,005	29,165	544,502	129,119
Mexico othar	299,511	166,412	199,951	103,086	53,005	11,930	470,910
Mexico othon	2,068,792	10,044	164,555	2,565	1,697	1,943	218,848
Mexico othpt	186,436	4,904	348,544	64,263	49,790	363,306	68,970
Non-US Total	**9,306,964**	**539,877**	**2,782,187**	**1,228,767**	**419,805**	**1,169,524**	**2,048,288**

Table 5-3. National by-sector CAP emissions summaries for the 2025 base case

Sector	CO	NH_3	NO_X	PM_{10}	$PM_{2.5}$	SO_2	VOC
afdust_adj				7,621,008	1,023,169		
ag		3,610,283					
agfire	956,243	3,321	42,767	140,728	93,959	16,224	74,783
c1c2rail	215,196	514	679,934	17,679	16,507	888	24,498
nonpt	1,695,259	94,957	746,389	511,976	431,038	95,195	3,426,386
np_oilgas	721,546	0	717,783	25,266	22,439	38,913	3,478,495
nonroad	13,299,524	3,543	794,770	77,615	72,788	2,088	1,179,395
onroad	10,444,934	85,521	1,707,692	280,816	83,019	13,759	904,713
c3marine	20,988	68	104,503	2,335	2,075	5,272	8,687
ptprescfire	10,063,500	161,999	167,599	1,060,130	900,546	83,082	2,313,404
ptwildfire	10,499,197	167,331	165,799	1,111,857	943,717	82,691	2,374,690
ptegu	903,766	46,007	1,435,523	274,544	208,678	1,471,933	41,795
ptnonipm	2,440,880	66,698	1,229,333	487,373	333,048	800,678	826,684
pt_oilgas	254,080	5,922	464,256	16,859	16,381	69,560	190,788
rwc	2,323,717	18,150	34,722	355,849	355,599	7,606	408,336
Con U.S. Total	**53,838,831**	**4,264,314**	**8,291,070**	**11,984,034**	**4,502,962**	**2,687,889**	**15,252,654**
Off-shore to EEZ*	210,270	185	666,757	9,313	8,799	12,165	94,501
Non-US SECA C3	31,937	0	296,532	7,029	6,407	43,104	13,563
Canada othafdust				779,674	112,523		
Canada othar	3,015,606	326,610	361,896	158,996	131,114	70,272	886,456
Canada othon	3,032,005	18,653	345,664	17,628	12,216	1,701	178,431
Canada othpt**	496,083	13,069	266,912	70,005	29,165	544,502	129,119
Mexico othar	316,038	168,218	218,022	105,952	55,152	13,454	526,197
Mexico othon	2,167,729	13,338	116,490	3,196	2,104	1,351	198,850
Mexico othpt	204,038	5,975	387,578	74,454	57,000	360,401	85,703
Non-US Total	**9,473,705**	**546,048**	**2,659,850**	**1,226,247**	**414,482**	**1,046,952**	**2,112,821**

Table 5-4. National by-sector CO emissions (tons/yr) summaries and percent change

Sector	2011 CO	2017 CO	2025 CO	% change 2011 to 2017	% change 2011 to 2025
afdust_adj	0	0	0	0%	0%
ag	0	0	0	0%	0%
agfire	956,243	956,243	956,243	0%	0%
c1c2rail	180,579	194,109	215,196	7%	19%
nonpt	1,645,989	1,673,888	1,695,259	2%	3%
np_oilgas	627,609	677,087	721,546	8%	15%
nonroad	13,951,020	12,371,786	13,299,524	-11%	-5%
onroad	26,313,827	15,607,769	10,444,934	-41%	-60%
c3marine	12,532	15,600	20,988	24%	67%
ptprescfire	10,063,500	10,063,500	10,063,500	0%	0%
ptwildfire	10,499,197	10,499,197	10,499,197	0%	0%
ptegu	777,902	820,402	903,766	5%	16%
ptnonipm	2,312,304	2,357,260	2,440,880	2%	6%
pt_oilgas	235,162	216,480	254,080	-8%	8%
rwc	2,517,844	2,504,587	2,323,717	-1%	-8%
Con U.S. Total	**70,093,709**	**57,957,907**	**53,838,831**	**-17%**	**-23%**
Off-shore to EEZ*	175,353	186,196	210,270	6%	20%
Non-US SECA C3	17,184	22,335	31,937	30%	86%
Canada othafdust	0	0	0	0%	0%
Canada othar	3,015,606	3,015,606	3,015,606	0%	0%
Canada othon	3,032,005	3,032,005	3,032,005	0%	0%
Canada othpt**	496,083	496,083	496,083	0%	0%
Mexico othar	277,810	299,511	316,038	8%	14%
Mexico othon	3,361,123	2,068,792	2,167,729	-38%	-36%
Mexico othpt	153,061	186,436	204,038	22%	33%
Non-US Total	**10,528,225**	**9,306,964**	**9,473,705**	**-12%**	**-10%**

Table 5-5. National by-sector NH_3 emissions (tons/yr) summaries and percent change

Sector	**2011 NH_3**	**2017 NH_3**	**2025 NH_3**	**% change 2011 to 2017**	**% change 2011 to 2025**
afdust_adj	0	0	0	0%	0%
ag	3,515,198	3,577,123	3,610,283	2%	3%
agfire	3,321	3,321	3,321	0%	0%
c1c2rail	511	513	514	0%	1%
nonpt	94,242	94,816	94,957	1%	1%
np_oilgas	0	0	0	0%	0%
nonroad	2,627	2,857	3,543	9%	35%
onroad	120,805	88,774	85,521	-27%	-29%
c3marine	68	68	68	0%	0%
ptprescfire	161,999	161,999	161,999	0%	0%
ptwildfire	167,331	167,331	167,331	0%	0%
ptegu	24,925	41,275	46,007	66%	85%
ptnonipm	66,192	66,496	66,698	0%	1%
pt_oilgas	5,947	5,887	5,922	-1%	0%
rwc	19,693	19,546	18,150	-1%	-8%
Con U.S. Total	**4,182,859**	**4,230,006**	**4,264,314**	**1%**	**2%**
Off-shore to EEZ*	185	185	185	0%	0%
Non-US SECA C3	0	0	0	0%	0%
Canada othafdust	0	0	0	0%	0%
Canada othar	326,610	326,610	326,610	0%	0%
Canada othon	18,653	18,653	18,653	0%	0%
Canada othpt**	13,069	13,069	13,069	0%	0%
Mexico othar	163,040	166,412	168,218	2%	3%
Mexico othon	7,978	10,044	13,338	26%	67%
Mexico othpt	3,706	4,904	5,975	32%	61%
Non-US Total	**533,241**	**539,877**	**546,048**	**1%**	**2%**

Table 5-6. National by-sector NO_x emissions (tons/yr) summaries and percent change

Sector	**2011 NO_X**	**2017 NO_X**	**2025 NO_X**	**% change 2011 to 2017**	**% change 2011 to 2025**
afdust_adj	0	0	0	0%	0%
ag	0	0	0	0%	0%
agfire	42,767	42,767	42,767	0%	0%
c1c2rail	1,075,217	915,797	679,934	-15%	-37%
nonpt	720,454	734,072	746,389	2%	4%
np_oilgas	647,169	687,307	717,783	6%	11%
nonroad	1,630,301	1,129,911	794,770	-31%	-51%
onroad	5,719,979	3,150,751	1,707,692	-45%	-70%
c3marine	131,382	131,691	104,503	0%	-20%
ptprescfire	167,599	167,599	167,599	0%	0%
ptwildfire	165,799	165,799	165,799	0%	0%
ptegu	2,088,233	1,547,987	1,435,523	-26%	-31%
ptnonipm	1,222,456	1,192,297	1,229,333	-2%	1%
pt_oilgas	509,856	411,055	464,256	-19%	-9%
rwc	34,436	35,507	34,722	3%	1%
Con U.S. Total	**14,155,649**	**10,312,541**	**8,291,070**	**-27%**	**-41%**
Off-shore to EEZ*	899,986	855,139	666,757	-5%	-26%
Non-US SECA C3	202,432	239,528	296,532	18%	46%
Canada othafdust	0	0	0	0%	0%
Canada othar	361,896	361,896	361,896	0%	0%
Canada othon	345,664	345,664	345,664	0%	0%
Canada othpt**	266,912	266,912	266,912	0%	0%
Mexico othar	182,869	199,951	218,022	9%	19%
Mexico othon	243,714	164,555	116,490	-32%	-52%
Mexico othpt	286,303	348,544	387,578	22%	35%
Non-US Total	**2,789,775**	**2,782,187**	**2,659,850**	**0%**	**-5%**

Table 5-7. National by-sector $PM_{2.5}$ emissions (tons/yr) summaries and percent change

Sector	2011 $PM_{2.5}$	2017 $PM_{2.5}$	2025 $PM_{2.5}$	% change 2011 to 2017	% change 2011 to 2025
afdust_adj	923,938	964,080	1,023,169	4%	11%
ag	0	0	0	0%	0%
agfire	93,959	93,959	93,959	0%	0%
c1c2rail	33,019	24,245	16,507	-27%	-50%
nonpt	404,258	416,334	431,038	3%	7%
np_oilgas	15,333	19,420	22,439	27%	46%
nonroad	154,657	107,267	72,788	-31%	-53%
onroad	194,690	124,930	83,019	-36%	-57%
c3marine	9,043	1,531	2,075	-83%	-77%
ptprescfire	900,546	900,546	900,546	0%	0%
ptwildfire	943,717	943,717	943,717	0%	0%
ptegu	206,884	212,913	208,678	3%	1%
ptnonipm	322,142	325,400	333,048	1%	3%
pt_oilgas	13,935	13,379	16,381	-4%	18%
rwc	381,252	383,807	355,599	1%	-7%
Con U.S. Total	**4,597,374**	**4,531,527**	**4,502,962**	**-1%**	**-2%**
Off-shore to EEZ*	24,544	9,768	8,799	-60%	-64%
Non-US SECA C3	15,828	20,527	6,407	30%	-60%
Canada othafdust	112,523	112,523	112,523	0%	0%
Canada othar	131,114	131,114	131,114	0%	0%
Canada othon	12,216	12,216	12,216	0%	0%
Canada othpt**	29,165	29,165	29,165	0%	0%
Mexico othar	50,158	53,005	55,152	6%	10%
Mexico othon	1,624	1,697	2,104	5%	30%
Mexico othpt	42,105	49,790	57,000	18%	35%
Non-US Total	**419,276**	**419,805**	**414,482**	**0%**	**-1%**

Table 5-8. National by-sector PM_{10} emissions (tons/yr) summaries and percent change

Sector	2011 PM_{10}	2017 PM_{10}	2025 PM_{10}	% change 2011 to 2017	% change 2011 to 2025
afdust_adj	6,735,072	7,093,387	7,621,008	5%	13%
ag	0	0	0	0%	0%
agfire	140,728	140,728	140,728	0%	0%
c1c2rail	35,359	25,970	17,679	-27%	-50%
nonpt	491,825	494,930	511,976	1%	4%
np_oilgas	16,843	21,112	25,266	25%	50%
nonroad	162,417	113,568	77,615	-30%	-52%
onroad	367,667	302,041	280,816	-18%	-24%
c3marine	10,168	1,729	2,335	-83%	-77%
ptprescfire	1,060,130	1,060,130	1,060,130	0%	0%
ptwildfire	1,111,857	1,111,857	1,111,857	0%	0%
ptegu	281,614	279,931	274,544	-1%	-3%
ptnonipm	478,885	480,114	487,373	0%	2%
pt_oilgas	14,585	14,013	16,859	-4%	16%
rwc	381,476	384,041	355,849	1%	-7%
Con U.S. Total	**11,288,626**	**11,523,551**	**11,984,034**	**2%**	**6%**
Off-shore to EEZ*	26,247	10,237	9,313	-61%	-65%
Non-US SECA C3	17,206	22,313	7,029	30%	-59%
Canada othafdust	779,674	779,674	779,674	0%	0%
Canada othar	158,996	158,996	158,996	0%	0%
Canada othon	17,628	17,628	17,628	0%	0%
Canada othpt**	70,005	70,005	70,005	0%	0%
Mexico othar	98,812	103,086	105,952	4%	7%
Mexico othon	2,425	2,565	3,196	6%	32%
Mexico othpt	55,162	64,263	74,454	16%	35%
Non-US Total	**1,226,156**	**1,228,767**	**1,226,247**	**0%**	**0%**

Table 5-9. National by-sector SO_2 emissions (tons/yr) summaries and percent change

Sector	2011 SO_2	2017 SO_2	2025 SO_2	% change 2011 to 2017	% change 2011 to 2025
afdust_adj	0	0	0	0%	0%
ag	0	0	0	0%	0%
agfire	16,224	16,224	16,224	0%	0%
c1c2rail	12,609	1,161	888	-91%	-93%
nonpt	275,655	104,585	95,195	-62%	-65%
np_oilgas	18,306	37,505	38,913	105%	113%
nonroad	4,031	1,856	2,088	-54%	-48%
onroad	29,665	14,985	13,759	-49%	-54%
c3marine	86,373	3,904	5,272	-95%	-94%
ptprescfire	83,082	83,082	83,082	0%	0%
ptwildfire	82,691	82,691	82,691	0%	0%
ptegu	4,662,717	1,462,200	1,471,933	-69%	-68%
ptnonipm	1,057,242	807,093	800,678	-24%	-24%
pt_oilgas	66,577	69,034	69,560	4%	4%
rwc	8,954	8,814	7,606	-2%	-15%
Con U.S. Total	**6,404,125**	**2,693,133**	**2,687,889**	**-58%**	**-58%**
Off-shore to EEZ*	139,169	9,945	12,165	-93%	-91%
Non-US SECA C3	127,579	165,925	43,104	30%	-66%
Canada othafdust	0	0	0	0%	0%
Canada othar	70,272	70,272	70,272	0%	0%
Canada othon	1,701	1,701	1,701	0%	0%
Canada othpt**	544,502	544,502	544,502	0%	0%
Mexico othar	10,679	11,930	13,454	12%	26%
Mexico othon	4,919	1,943	1,351	-61%	-73%
Mexico othpt	453,466	363,306	360,401	-20%	-21%
Non-US Total	**1,352,287**	**1,169,524**	**1,046,952**	**-14%**	**-23%**

Table 5-10. National by-sector VOC emissions (tons/yr) summaries and percent change

Sector	2011 VOC	2017 VOC	2025 VOC	% change 2011 to 2017	% change 2011 to 2025
afdust_adj	0	0	0	0%	0%
ag	0	0	0	0%	0%
agfire	74,783	74,783	74,783	0%	0%
c1c2rail	48,281	34,528	24,498	-28%	-49%
nonpt	3,672,249	3,511,392	3,426,386	-4%	-7%
np_oilgas	2,556,649	3,164,559	3,478,495	24%	36%
nonroad	2,024,419	1,422,907	1,179,395	-30%	-42%
onroad	2,709,470	1,507,880	904,713	-44%	-67%
c3marine	5,149	6,429	8,687	25%	69%
ptprescfire	2,313,404	2,313,404	2,313,404	0%	0%
ptwildfire	2,374,690	2,374,690	2,374,690	0%	0%
ptegu	36,336	40,433	41,795	11%	15%
ptnonipm	802,988	814,400	826,684	1%	3%
pt_oilgas	164,098	165,559	190,788	1%	16%
rwc	442,541	437,984	408,336	-1%	-8%
Con U.S. Total	**17,225,056**	**15,868,951**	**15,252,654**	**-8%**	**-11%**
Off-shore to EEZ*	81,602	86,093	94,501	6%	16%
Non-US SECA C3	7,294	9,462	13,563	30%	86%
Canada othafdust	0	0	0	0%	0%
Canada othar	886,456	886,456	886,456	0%	0%
Canada othon	178,431	178,431	178,431	0%	0%
Canada othpt**	129,119	129,119	129,119	0%	0%
Mexico othar	410,734	470,910	526,197	15%	28%
Mexico othon	319,353	218,848	198,850	-31%	-38%
Mexico othpt	53,813	68,970	85,703	28%	59%
Non-US Total	**2,066,802**	**2,048,288**	**2,112,821**	**-1%**	**2%**

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Appendix A: Nonpoint Oil and Gas (np_oilgas) SCCs

The table below shows the SCCs in the nonpoint oil and gas sector (np_oilgas).

SCC	SCC description
2310000000	Industrial Processes;Oil and Gas Production: SIC 13;All Processes;Total: All Processes
2310000220	Industrial Processes;Oil and Gas Production: SIC 13; Drill rigs
2310000230	Industrial Processes;Oil and Gas Exploration and Production;All Processes;Workover Rigs
2310000330	Industrial Processes;Oil and Gas Production: SIC 13; Artificial lift
2310000550	Industrial Processes;Oil and Gas Exploration and Production;All Processes;Produced Water
2310000660	Industrial Processes;Oil and Gas Exploration and Production;All Processes;Hydraulic Fracturing Engines
2310002000	Industrial Processes;Oil and Gas Production: SIC 13;All Processes : Off-shore;Total: All Processes
2310002301	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil And Gas Production;Flares: Continuous Pilot Light
2310002305	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil And Gas Production;Flares: Flaring Operations
2310002401	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil And Gas Production;Pneumatic Pumps: Gas And Oil Wells
2310002411	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil And Gas Production;Pressure/Level Controllers
2310002421	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil And Gas Production;Cold Vents
2310010000	Industrial Processes;Oil and Gas Production: SIC 13;Crude Petroleum;Total: All Processes
2310010100	Industrial Processes;Oil and Gas Production: SIC 13;Crude Petroleum; Oil well heaters
2310010200	Industrial Processes;Oil and Gas Production: SIC 13;Crude Petroleum; Oil well tanks - flashing & standing/working/breathing
2310010300	Industrial Processes;Oil and Gas Production: SIC 13;Crude Petroleum; Oil well pneumatic devices
2310010700	Industrial Processes;Oil and Gas Production: SIC 13;Crude Petroleum; Oil well fugitives
2310010800	Industrial Processes;Oil and Gas Production: SIC 13;Crude Petroleum; Oil well truck loading
2310011000	Industrial Processes;Oil and Gas Production: SIC 13;Crude Petroleum : On-shore;Total: All Processes
2310011020	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Storage Tanks: Crude Oil
2310011100	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Heater Treater
2310011201	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Tank Truck/Railcar Loading: Crude Oil
2310011450	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Wellhead
2310011500	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Fugitives: All Processes
2310011501	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Fugitives: Connectors
2310011502	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Fugitives: Flanges

SCC	SCC description
2310011503	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Fugitives: Open Ended Lines
2310011504	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Fugitives: Pumps
2310011505	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Fugitives: Valves
2310011506	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Fugitives: Other
2310011600	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Production;Artificial Lift Engines
2310012000	Industrial Processes;Oil and Gas Production: SIC 13;Crude Petroleum : Off-shore;Total: All Processes
2310012020	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil Production;Storage Tanks: Crude Oil
2310012511	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil Production;Fugitives; Connectors: Oil Streams
2310012512	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil Production;Fugitives; Flanges: Oil
2310012515	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil Production;Fugitives; Valves: Oil
2310012516	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil Production;Fugitives; Other: Oil
2310012521	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil Production;Fugitives; Connectors: Oil/Water Streams
2310012522	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil Production;Fugitives; Flanges: Oil/Water
2310012526	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil Production;Fugitives; Other: Oil/Water
2310020000	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas;Total: All Processes
2310020600	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas; Compressor engines
2310020700	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas; Gas well fugitives
2310020800	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas; Gas well truck loading
2310021010	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Storage Tanks: Condensate
2310021011	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Condensate Tank Flaring
2310021030	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Tank Truck/Railcar Loading: Condensate
2310021100	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas; Gas well heaters
2310021101	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Natural Gas Fired 2Cycle Lean Burn Compressor Engines < 50 HP
2310021102	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Natural Gas Fired 2Cycle Lean Burn Compressor Engines 50 To 499 HP
2310021103	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Natural Gas Fired 2Cycle Lean Burn Compressor Engines 500+ HP
2310021201	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Natural Gas Fired 4Cycle Lean Burn Compressor Engines <50 HP
2310021202	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Natural Gas Fired 4Cycle Lean Burn Compressor Engines 50 To 499 HP
2310021203	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Natural Gas Fired 4Cycle Lean Burn Compressor Engines 500+ HP

SCC	SCC description
2310021209	
2310021251	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Lateral Compressors 4 Cycle Lean Burn
2310021300	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas; Gas well pneumatic devices
2310021301	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Natural Gas Fired 4Cycle Rich Burn Compressor Engines <50 HP
2310021302	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Natural Gas Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP
2310021303	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Natural Gas Fired 4Cycle Rich Burn Compressor Engines 500+ HP
2310021309	
2310021310	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Gas Well Pneumatic Pumps
2310021351	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Lateral Compressors 4 Cycle Rich Burn
2310021400	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas; Gas well dehydrators
2310021401	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Nat Gas Fired 4Cycle Rich Burn Compressor Engines <50 HP w/NSCR
2310021402	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Nat Gas Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP w/NSCR
2310021403	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Nat Gas Fired 4Cycle Rich Burn Compressor Engines 500+ HP w/NSCR
2310021411	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Gas Well Dehydrators - Flaring
2310021500	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas; Gas well completion - flaring and venting
2310021501	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Fugitives: Connectors
2310021502	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Fugitives: Flanges
2310021503	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Fugitives: Open Ended Lines
2310021504	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Fugitives: Pumps
2310021505	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Fugitives: Valves
2310021506	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Fugitives: Other
2310021509	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Fugitives: All Processes
2310021600	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas; Gas well venting
2310021601	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Gas Well Venting - Initial Completions
2310021602	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Gas Well Venting - Recompletions
2310021603	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Gas Well Venting - Blowdowns
2310021604	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Gas Well Venting - Compressor Startups
2310021605	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Gas Well Venting - Compressor Shutdowns

SCC	SCC description
2310021700	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Production;Miscellaneous Engines
2310022000	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas : Off-shore;Total: All Processes
2310022010	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Gas Production;Storage Tanks: Condensate
2310022051	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Gas Production;Turbines: Natural Gas
2310022090	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Gas Production;Boilers/Heaters: Natural Gas
2310022105	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Gas Production;Diesel Engines
2310022410	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Gas Production;Amine Unit
2310022420	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Gas Production;Dehydrator
2310022501	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Gas Production;Fugitives; Connectors: Gas Streams
2310022502	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Gas Production;Fugitives; Flanges: Gas Streams
2310022505	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Gas Production;Fugitives; Valves: Gas
2310022506	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Gas Production;Fugitives; Other: Gas
2310023010	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Storage Tanks: Condensate
2310023030	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Tank Truck/Railcar Loading: Condensate
2310023100	Industrial Processes; Oil and Gas Production; CBM; Dehydrators
2310023102	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;CBM Fired 2Cycle Lean Burn Compressor Engines 50 To 499 HP
2310023202	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;CBM Fired 4Cycle Lean Burn Compressor Engines 50 To 499 HP
2310023251	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Lateral Compressors 4 Cycle Lean Burn
2310023300	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Pneumatic Devices Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Pneumatic Devices
2310023302	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;CBM Fired 4Cycle Rich Burn Compressor Engines 50 To 499 HP
2310023310	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Pneumatic Pumps
2310023351	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Lateral Compressors 4 Cycle Rich Burn
2310023400	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Dehydrators
2310023509	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Fugitives
2310023511	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Fugitives: Connectors
2310023512	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Fugitives: Flanges
2310023513	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Fugitives: Open Ended Lines
2310023515	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Fugitives: Valves
2310023516	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Fugitives: Other

SCC	SCC description
2310023600	Industrial Processes; Oil and Gas Production; CBM; Venting - Compressor Shutdown
2310023601	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Venting - Initial Completions
2310023602	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Venting - Recompletions
2310023603	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Venting - Blowdowns
2310023606	Industrial Processes;Oil and Gas Exploration and Production;Coal Bed Methane Natural Gas;Mud Degassing
2310030000	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas Liquids;Total: All Processes
2310030210	Industrial Processes;Oil and Gas Production: SIC 13;Natural Gas Liquids; Gas well tanks - Flashing & Standing/Working/Breathing
2310030300	Industrial Processes;Oil and Gas Exploration and Production;Natural Gas Liquids;Gas Well Water Tank Losses
2310030401	Industrial Processes;Oil and Gas Exploration and Production;Natural Gas Liquids;Gas Plant Truck Loading
2310111100	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Exploration;Mud Degassing
2310111401	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Exploration;Oil Well Pneumatic Pumps
2310111700	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Oil Exploration;Oil Well Completion: All Processes
2310112401	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil Exploration;Oil Well Pneumatic Pumps
2310121100	Industrial Processes;Oil and Gas Exploration and Production;On-Shore Gas Exploration;Mud Degassing
2310121401	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil Exploration;Oil Well Pneumatic Pumps
2310121700	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Oil Exploration;Oil Well Completion: All Processes
2310122100	Industrial Processes;Oil and Gas Exploration and Production;Off-Shore Gas Exploration;Mud Degassing

Appendix B: Mapping of Fuel Distribution SCCs to BTP, BPS and RBT

The table below provides a crosswalk between fuel distribution SCCs and classification type for portable fuel containers (PFC), fuel distribution operations associated with the bulk-plant-to-pump (BTP), refinery to bulk terminal (RBT) and bulk plant storage (BPS).

SCC	Type	Description
40301001	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Fixed Roof Tanks (Varying Sizes); Gasoline RVP 13: Breathing Loss (67000 Bbl. Tank Size)
40301002	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Fixed Roof Tanks (Varying Sizes); Gasoline RVP 10: Breathing Loss (67000 Bbl. Tank Size)
40301003	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Fixed Roof Tanks (Varying Sizes); Gasoline RVP 7: Breathing Loss (67000 Bbl. Tank Size)
40301004	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Fixed Roof Tanks (Varying Sizes); Gasoline RVP 13: Breathing Loss (250000 Bbl. Tank Size)
40301006	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Fixed Roof Tanks (Varying Sizes); Gasoline RVP 7: Breathing Loss (250000 Bbl. Tank Size)
40301007	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Fixed Roof Tanks (Varying Sizes); Gasoline RVP 13: Working Loss (Tank Diameter Independent)
40301101	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Floating Roof Tanks (Varying Sizes); Gasoline RVP 13: Standing Loss (67000 Bbl. Tank Size)
40301102	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Floating Roof Tanks (Varying Sizes); Gasoline RVP 10: Standing Loss (67000 Bbl. Tank Size)
40301103	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Floating Roof Tanks (Varying Sizes); Gasoline RVP 7: Standing Loss (67000 Bbl. Tank Size)
40301105	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Floating Roof Tanks (Varying Sizes); Gasoline RVP 10: Standing Loss (250000 Bbl. Tank Size)
40301151	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Floating Roof Tanks (Varying Sizes); Gasoline: Standing Loss - Internal
40301202	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Variable Vapor Space; Gasoline RVP 10: Filling Loss
40301203	RBT	Petroleum and Solvent Evaporation; Petroleum Product Storage at Refineries; Variable Vapor Space; Gasoline RVP 7: Filling Loss
40400101	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Breathing Loss (67000 Bbl Capacity) - Fixed Roof Tank
40400102	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Breathing Loss (67000 Bbl Capacity) - Fixed Roof Tank
40400103	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Breathing Loss (67000 Bbl. Capacity) - Fixed Roof Tank
40400104	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Breathing Loss (250000 Bbl Capacity)-Fixed Roof Tank
40400105	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Breathing Loss (250000 Bbl Capacity)-Fixed Roof Tank

SCC	Type	Description
40400106	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Breathing Loss (250000 Bbl Capacity) - Fixed Roof Tank
40400107	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Working Loss (Diam. Independent) - Fixed Roof Tank
40400108	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Working Loss (Diameter Independent) - Fixed Roof Tank
40400109	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Working Loss (Diameter Independent) - Fixed Roof Tank
40400110	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss (67000 Bbl Capacity)-Floating Roof Tank
40400111	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss (67000 Bbl Capacity)-Floating Roof Tank
40400112	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Standing Loss (67000 Bbl Capacity)- Floating Roof Tank
40400113	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss (250000 Bbl Cap.) - Floating Roof Tank
40400114	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss (250000 Bbl Cap.) - Floating Roof Tank
40400115	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Standing Loss (250000 Bbl Cap.) - Floating Roof Tank
40400116	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13/10/7: Withdrawal Loss (67000 Bbl Cap.) - Float Rf Tnk
40400117	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13/10/7: Withdrawal Loss (250000 Bbl Cap.) - Float Rf Tnk
40400118	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Filling Loss (10500 Bbl Cap.) - Variable Vapor Space
40400119	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Filling Loss (10500 Bbl Cap.) - Variable Vapor Space
40400120	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Filling Loss (10500 Bbl Cap.) - Variable Vapor Space
40400130	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Specify Liquid: Standing Loss - External Floating Roof w/ Primary Seal
40400131	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss - Ext. Floating Roof w/ Primary Seal
40400132	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss - Ext. Floating Roof w/ Primary Seal
40400133	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Standing Loss - External Floating Roof w/ Primary Seal
40400140	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Specify Liquid: Standing Loss - Ext. Float Roof Tank w/ Secondy Seal

SCC	Type	Description
40400141	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss - Ext. Floating Roof w/ Secondary Seal
40400142	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss - Ext. Floating Roof w/ Secondary Seal
40400143	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Standing Loss - Ext. Floating Roof w/ Secondary Seal
40400148	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13/10/7: Withdrawal Loss - Ext. Float Roof (Pri/Sec Seal)
40400149	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Specify Liquid: External Floating Roof (Primary/Secondary Seal)
40400150	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Miscellaneous Losses/Leaks: Loading Racks
40400151	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Valves, Flanges, and Pumps
40400152	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Vapor Collection Losses
40400153	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Vapor Control Unit Losses
40400160	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Specify Liquid: Standing Loss - Internal Floating Roof w/ Primary Seal
40400161	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss - Int. Floating Roof w/ Primary Seal
40400162	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss - Int. Floating Roof w/ Primary Seal
40400163	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Standing Loss - Internal Floating Roof w/ Primary Seal
40400170	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Specify Liquid: Standing Loss - Int. Floating Roof w/ Secondary Seal
40400171	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13: Standing Loss - Int. Floating Roof w/ Secondary Seal
40400172	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 10: Standing Loss - Int. Floating Roof w/ Secondary Seal
40400173	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 7: Standing Loss - Int. Floating Roof w/ Secondary Seal
40400178	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Gasoline RVP 13/10/7: Withdrawal Loss - Int. Float Roof (Pri/Sec Seal)
40400179	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; Specify Liquid: Internal Floating Roof (Primary/Secondary Seal)
40400199	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Terminals; See Comment **
40400201	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Breathing Loss (67000 Bbl Capacity) - Fixed Roof Tank
40400202	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Breathing Loss (67000 Bbl Capacity) - Fixed Roof Tank

SCC	Type	Description
40400203	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 7: Breathing Loss (67000 Bbl. Capacity) - Fixed Roof Tank
40400204	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Working Loss (67000 Bbl. Capacity) - Fixed Roof Tank
40400205	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Working Loss (67000 Bbl. Capacity) - Fixed Roof Tank
40400206	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 7: Working Loss (67000 Bbl. Capacity) - Fixed Roof Tank
40400207	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Standing Loss (67000 Bbl Cap.) - Floating Roof Tank
40400208	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Standing Loss (67000 Bbl Cap.) - Floating Roof Tank
40400210	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13/10/7: Withdrawal Loss (67000 Bbl Cap.) - Float Rf Tnk
40400211	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Filling Loss (10500 Bbl Cap.) - Variable Vapor Space
40400212	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Filling Loss (10500 Bbl Cap.) - Variable Vapor Space
40400213	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 7: Filling Loss (10500 Bbl Cap.) - Variable Vapor Space
40400230	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Specify Liquid: Standing Loss - External Floating Roof w/ Primary Seal
40400231	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Standing Loss - Ext. Floating Roof w/ Primary Seal
40400232	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Standing Loss - Ext. Floating Roof w/ Primary Seal
40400233	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 7: Standing Loss - External Floating Roof w/ Primary Seal
40400240	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Specify Liquid: Standing Loss - Ext. Floating Roof w/ Secondary Seal
40400241	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Standing Loss - Ext. Floating Roof w/ Secondary Seal
40400248	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10/13/7: Withdrawal Loss - Ext. Float Roof (Pri/Sec Seal)
40400249	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Specify Liquid: External Floating Roof (Primary/Secondary Seal)
40400250	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Loading Racks
40400251	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Valves, Flanges, and Pumps
40400252	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Miscellaneous Losses/Leaks: Vapor Collection Losses

SCC	Type	Description
40400253	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Miscellaneous Losses/Leaks: Vapor Control Unit Losses
40400260	RBT	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Specify Liquid: Standing Loss - Internal Floating Roof w/ Primary Seal
40400261	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Standing Loss - Int. Floating Roof w/ Primary Seal
40400262	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Standing Loss - Int. Floating Roof w/ Primary Seal
40400263	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 7: Standing Loss - Internal Floating Roof w/ Primary Seal
40400270	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Specify Liquid: Standing Loss - Int. Floating Roof w/ Secondary Seal
40400271	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 13: Standing Loss - Int. Floating Roof w/ Secondary Seal
40400272	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10: Standing Loss - Int. Floating Roof w/ Secondary Seal
40400273	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 7: Standing Loss - Int. Floating Roof w/ Secondary Seal
40400278	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Gasoline RVP 10/13/7: Withdrawal Loss - Int. Float Roof (Pri/Sec Seal)
40400279	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Bulk Plants; Specify Liquid: Internal Floating Roof (Primary/Secondary Seal)
40400401	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 13: Breathing Loss
40400402	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 13: Working Loss
40400403	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 10: Breathing Loss
40400404	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 10: Working Loss
40400405	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 7: Breathing Loss
40400406	BTP/BPS	Petroleum and Solvent Evaporation; Petroleum Liquids Storage (non-Refinery); Petroleum Products - Underground Tanks; Gasoline RVP 7: Working Loss
40600101	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Splash Loading **
40600126	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Submerged Loading **
40600131	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Submerged Loading (Normal Service)

SCC	Type	Description
40600136	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Splash Loading (Normal Service)
40600141	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Submerged Loading (Balanced Service)
40600144	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Splash Loading (Balanced Service)
40600147	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Submerged Loading (Clean Tanks)
40600162	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Loaded with Fuel (Transit Losses)
40600163	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Gasoline: Return with Vapor (Transit Losses)
40600199	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Tank Cars and Trucks; Not Classified **
40600231	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Loading Tankers: Cleaned and Vapor Free Tanks
40600232	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Loading Tankers
40600233	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Loading Barges: Cleaned and Vapor Free Tanks
40600234	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Loading Tankers: Ballasted Tank
40600235	BTP/BPS	Petroleum and Solvent Evaporation;Transportation and Marketing of Petroleum Products;Marine Vessels;Gasoline: Ocean Barges Loading - Ballasted Tank
40600236	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Loading Tankers: Uncleaned Tanks
40600237	RBT	Petroleum and Solvent Evaporation;Transportation and Marketing of Petroleum Products;Marine Vessels;Gasoline: Ocean Barges Loading - Uncleaned Tanks
40600238	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Loading Barges: Uncleaned Tanks
40600239	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Tankers: Ballasted Tank
40600240	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Loading Barges: Average Tank Condition
40600241	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Gasoline: Tanker Ballasting
40600299	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Marine Vessels; Not Classified **
40600301	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Splash Filling
40600302	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Submerged Filling w/o Controls
40600305	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Unloading **

SCC	Type	Description
40600306	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Balanced Submerged Filling
40600307	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Underground Tank Breathing and Emptying
40600399	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Gasoline Retail Operations - Stage I; Not Classified **
40600401	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Filling Vehicle Gas Tanks - Stage II; Vapor Loss w/o Controls
40600501	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Pipeline Petroleum Transport - General - All Products; Pipeline Leaks
40600502	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Pipeline Petroleum Transport - General - All Products; Pipeline Venting
40600503	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Pipeline Petroleum Transport - General - All Products; Pump Station
40600504	RBT	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Pipeline Petroleum Transport - General - All Products; Pump Station Leaks
40600602	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Consumer (Corporate) Fleet Refueling - Stage II; Liquid Spill Loss w/o Controls
40600701	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Consumer (Corporate) Fleet Refueling - Stage I; Splash Filling
40600702	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Consumer (Corporate) Fleet Refueling - Stage I; Submerged Filling w/o Controls
40600706	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Consumer (Corporate) Fleet Refueling - Stage I; Balanced Submerged Filling
40600707	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Consumer (Corporate) Fleet Refueling - Stage I; Underground Tank Breathing and Emptying
40688801	BTP/BPS	Petroleum and Solvent Evaporation; Transportation and Marketing of Petroleum Products; Fugitive Emissions; Specify in Comments Field
2501050120	RBT	Storage and Transport; Petroleum and Petroleum Product Storage; Bulk Terminals: All Evaporative Losses; Gasoline
2501055120	BTP/BPS	Storage and Transport; Petroleum and Petroleum Product Storage; Bulk Plants: All Evaporative Losses; Gasoline
2501060050	BTP/BPS	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Total
2501060051	BTP/BPS	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Submerged Filling
2501060052	BTP/BPS	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Splash Filling
2501060053	BTP/BPS	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Stage 1: Balanced Submerged Filling
2501060200	BTP/BPS	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Underground Tank: Total
2501060201	BTP/BPS	Storage and Transport; Petroleum and Petroleum Product Storage; Gasoline Service Stations; Underground Tank: Breathing and Emptying
2501995000	BTP/BPS	Storage and Transport; Petroleum and Petroleum Product Storage; All Storage Types: Working Loss; Total: All Products
2505000120	RBT	Storage and Transport; Petroleum and Petroleum Product Transport; All Transport Types; Gasoline
2505020120	RBT	Storage and Transport; Petroleum and Petroleum Product Transport; Marine Vessel; Gasoline

SCC	Type	Description
2505020121	RBT	Storage and Transport; Petroleum and Petroleum Product Transport; Marine Vessel; Gasoline - Barge
2505030120	BTP/BPS	Storage and Transport; Petroleum and Petroleum Product Transport; Truck; Gasoline
2505040120	RBT	Storage and Transport; Petroleum and Petroleum Product Transport; Pipeline; Gasoline
2660000000	BTP/BPS	Waste Disposal, Treatment, and Recovery; Leaking Underground Storage Tanks; Leaking Underground Storage Tanks; Total: All Storage Types

Appendix C: Future Animal Population Projection Methodology, Updated 07/24/12

In the EPA's ammonia inventory for animal agricultural operations (National Emission Inventory - Ammonia Emissions from Animal Agricultural Operations; Revised Draft Report; April 22, 2005), population projections for the beef, dairy, swine, and poultry animal sectors were developed and used to estimate future ammonia emissions from these animal sectors. To develop the 2005 population projections, EPA used inventory data from the U.S. Department of Agriculture (USDA) and the Food and Agriculture Policy and Research Institute (FAPRI).

Since completion of the 2005 ammonia emissions inventory, USDA and FAPRI have released updated reports that contain animal population data and projections. These data were used to update the 2005 animal inventory projections. The data sources and the methodology used to develop the population projections for each animal type are discussed below. These future projections do not account for any changes in animal populations or regional dislocations associated with EPA's revised effluent limitations guidelines and standards for concentrated animal feeding operations promulgated in December 2002 (68 FR 7176, February 12, 2003). Due to insufficient data, animal population projections and future emission estimates were not developed for sheep, goats, and horses.

Dairy Cattle. The 2010 FAPRI *U.S. and World Agricultural Outlook* (FAPRI 2010) report provides estimated national milk cow inventory data and projections from 2009 through 2019 and shows an overall decline in U.S. dairy cow populations. The FAPRI projections depict an essentially linear relationship between 2001 milk cow populations and subsequent years. The EPA estimated future dairy cattle populations using a linear regression analysis of the national population data available from the FAPRI report, covering 1982 through 2019. Figure C-1 illustrates the linear projection of the U.S. dairy cow population and trend line.

Beef Cattle. The USDA *Agricultural Projections to 2021* (USDAa) provides estimated national cattle inventory data and projections from 2010 through 2021. Beef production has a clear cycle generated by producers' expectations about future prices, grain market cycles, and other economic conditions. The pace of the cycle is limited by the reproductive capacity of the animal. Cattle inventories can expand only as fast as cows can reproduce. This has historically resulted in a 7- to 12-year cycle, from peak to peak (Kohls, 1998). Peaks and troughs of the cycle are 5 to 6 percent higher or lower than the general trend in cattle populations so the stage of the cycle can make a significant difference in population at any given future date.

The EPA decomposed the beef cow inventory time series into a trend line, a cyclical component, and a random error component (Bowerman, 1987). The trend line was estimated by linear regression of the inventory data from 1990 to 2015 on a time variable. The cyclical component was then estimated as the percentage deviation from the trend line in the historical data. A graph of that information appeared to show a cyclic trend (trough to peak). The robust U.S. economy of the 1990s may explain the longer than average cycle. With so little data, EPA assumed the down side of the cycle was symmetrical with the up side, so the data set would contain three values for each stage of the cycle. The average of the absolute value of the three observations represents the cyclical component. The EPA forecasted the trend line out to 2030 and adjusted it by the average percentage deviation from the trend for that stage of the cycle, as illustrated in Figure C-2.

The projection data for the beef cattle inventory show some difference in growth cycle of beef cows versus other beef cattle (e.g., steers, bulls). The EPA conducted a separate analysis of these animal populations. Other beef cattle populations appear to follow similar cycles and were forecasted using the same technique as beef cows (see Figure C-3).

Figure C-1. Dairy Cow Inventory Projections

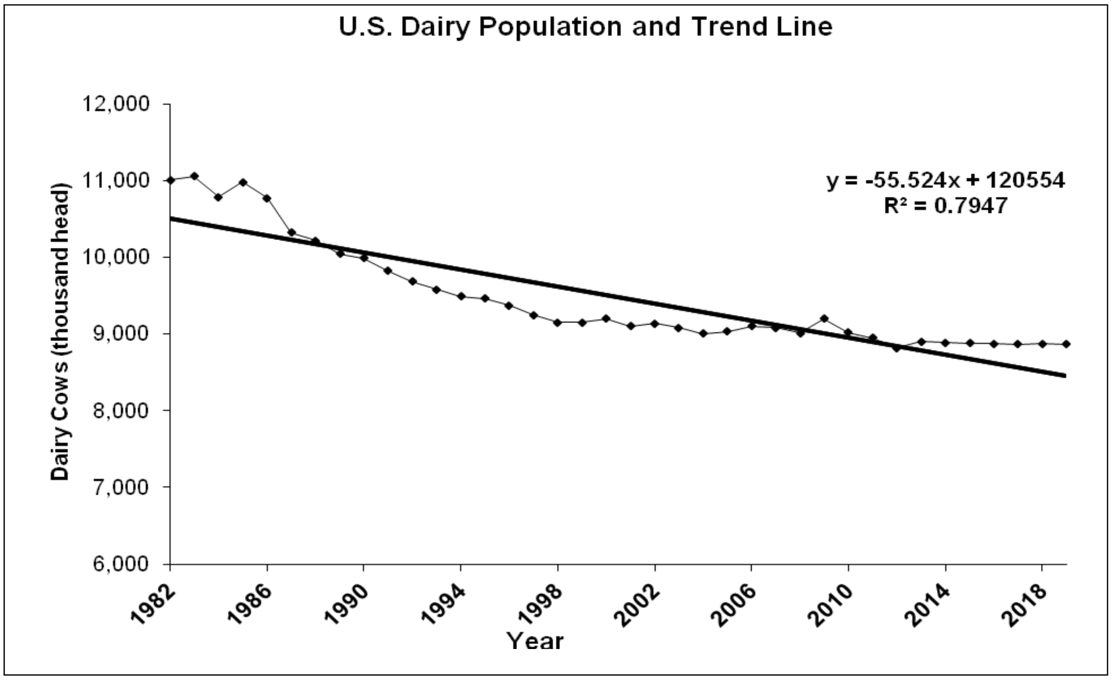


Figure C-2. Beef Cow Inventory Projections

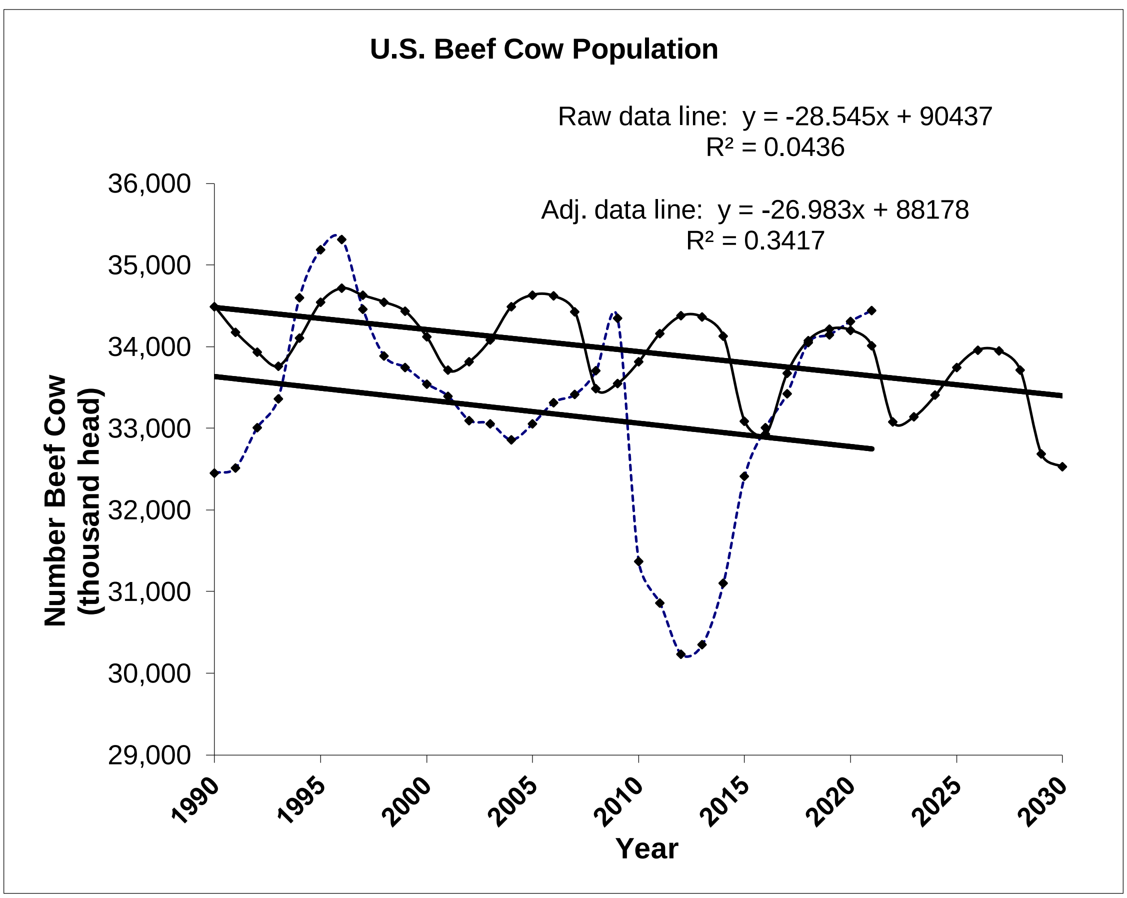
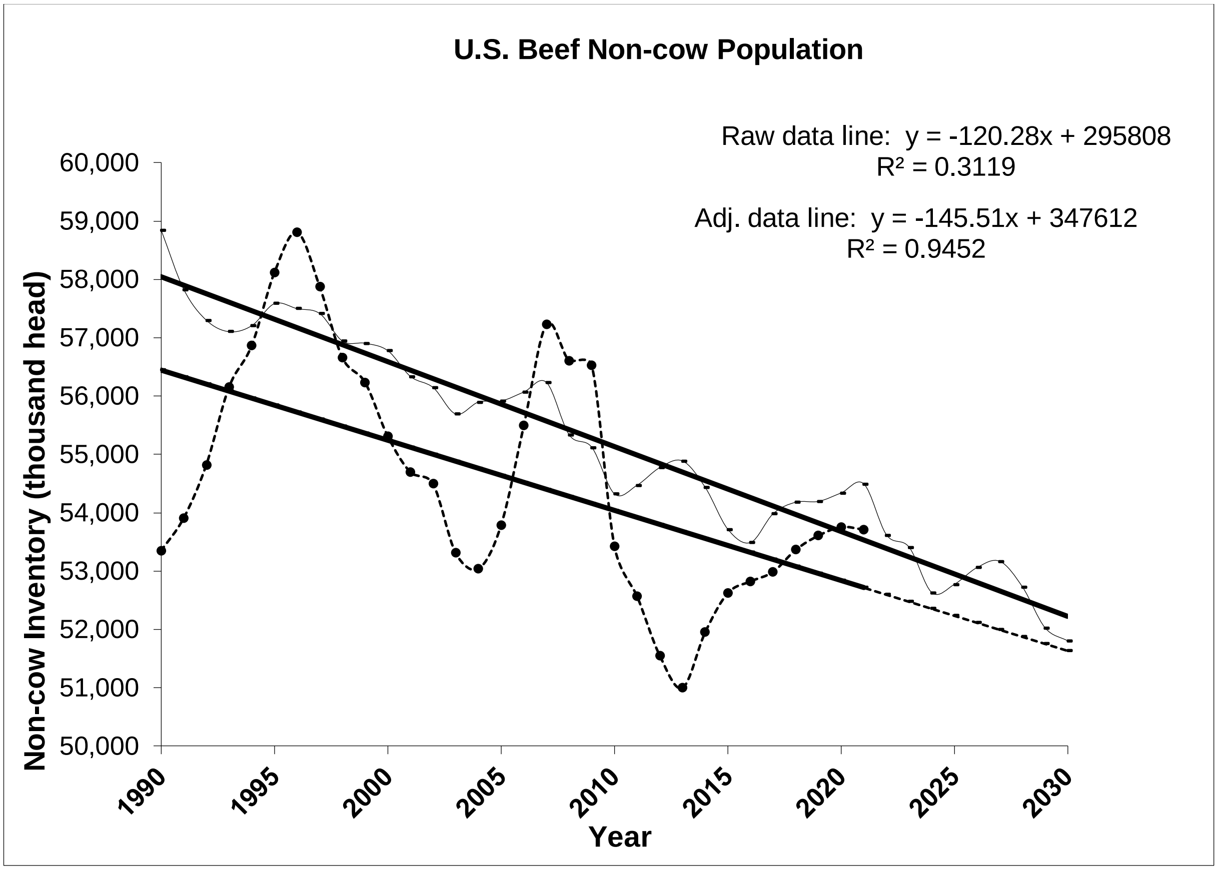


Figure C-3. Non-cow Beef Inventory Projections



Swine. Annual swine populations are categorized by breeding and market swine. The 2010 FAPRI *U.S. and World Agricultural Outlook* (FAPRI 2010) report presents annual inventory data and projections from 2009 through 2019 for breeding swine and market swine inventories (rather than a combined total). The FAPRI data show an overall increase in swine production over time. Due to increasing productivity (i.e., increased number of pigs per litter), the population of breeding swine is expected to decline over the long term.

The EPA estimated future swine populations using a cycle and trend decomposition analysis. Breeding and market swine population projections and inventory data from the FAPRI report capture the variability of the swine production cycle. Changes in the pork industry in the 1990's have made recent data atypical and inconsistent. For example, EPA replaced the 1996 market hog cyclical deviation with the average of all of the other data because they were so far out of line with the hog cycle.

The EPA estimated the trend and deviations from the trend as in the beef cattle analysis. However, it was not possible to apply the identical technique from the beef cattle industry to the hog industry because a well-defined periodic cycle was not evident in the annual data. The EPA evaluated a 3-year moving average of the deviation to further reduce the random component. As the smoothed cycle continued to appear irregular, EPA assumed that the 2010's will repeat the pattern of the 1990's. Breeding hog populations were estimated using a similar approach. See Figures C-4 and C-5 for an illustration of the swine projections for the market hog and breeding hog inventories, respectively.

Poultry. Annual poultry populations in the EPA's ammonia emissions inventory for animal agriculture are presented for broilers, turkeys, and layers. To project poultry populations, EPA used population and projection data from the annual summary of the USDA/NASS *Poultry – Production and Value* reports (USDAb) for broilers and turkeys, and the *Chickens and Eggs* reports (USDAc). With these data, EPA used a linear regression analysis to predict the number of birds produced in the U.S. for years beyond 2011. Figures C-6 and C-7 present the population projections for broilers and turkeys, respectively. Figure C-8 shows the population projections for egg layers.

Figure C-4. Market Hog Inventory Projections

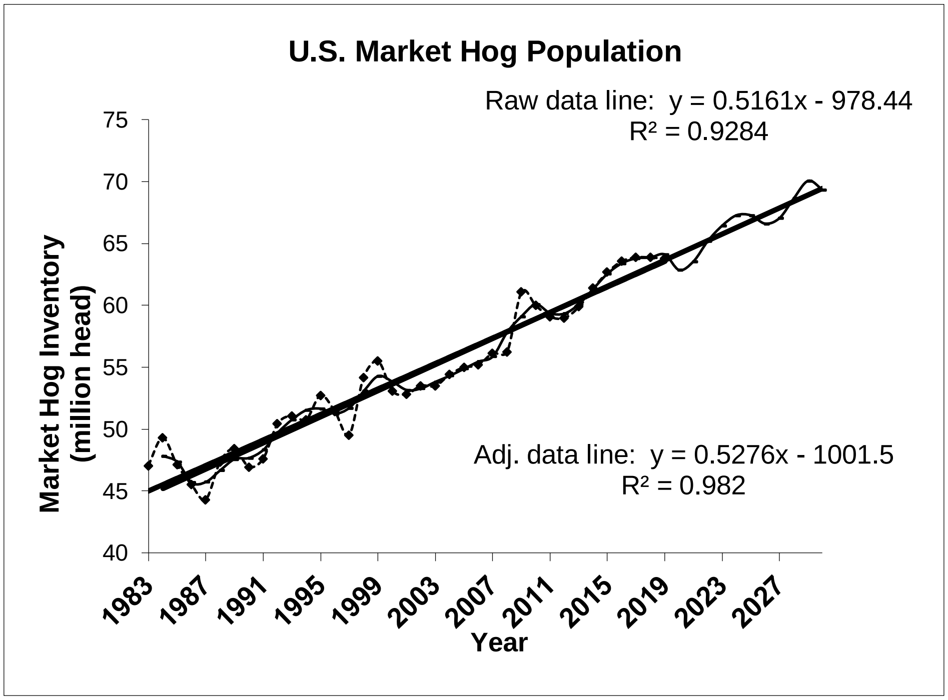


Figure C-5. Breeding Hog Inventory Projections

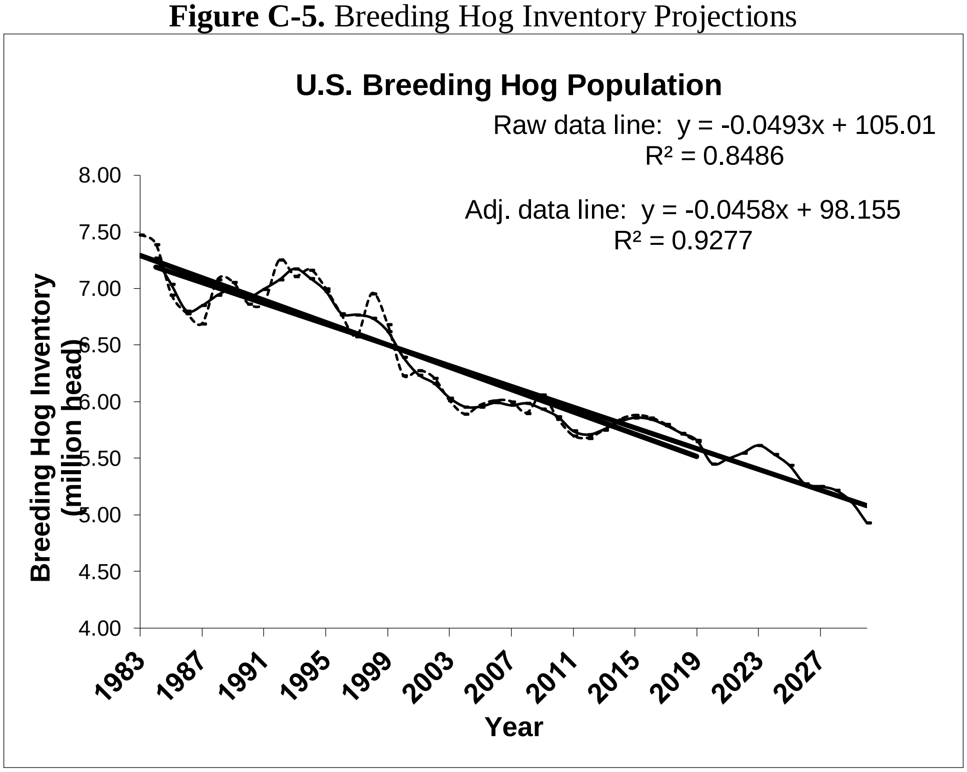


Figure C-6. Broiler Inventory Projection

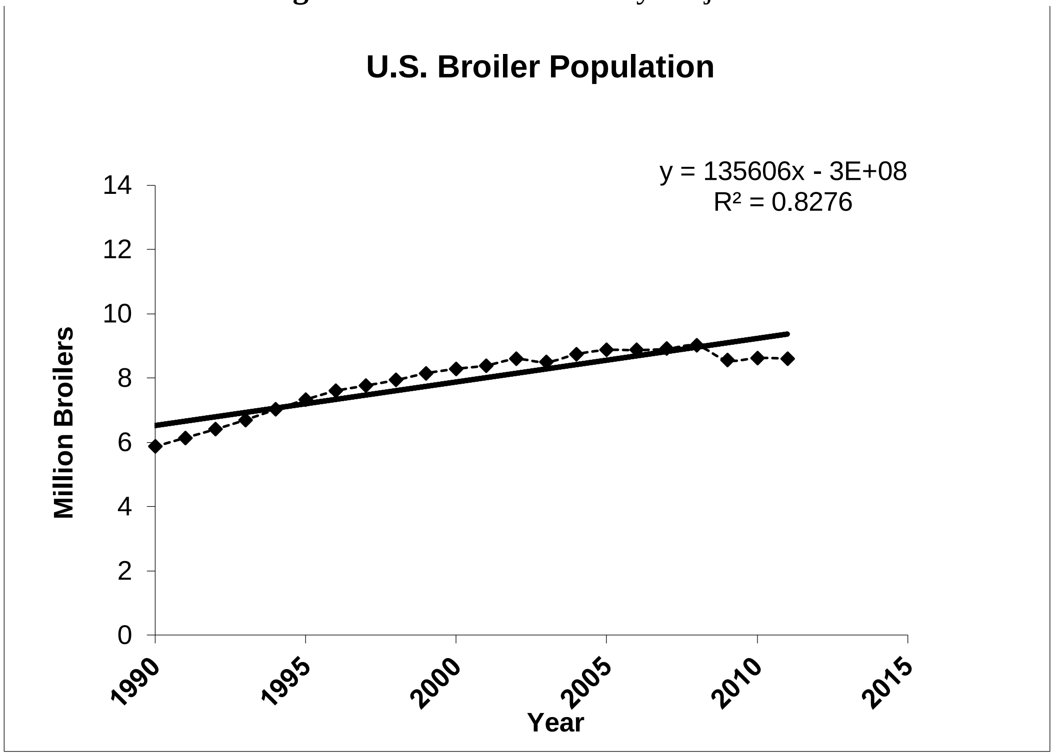


Figure C-7. Turkey Inventory Projection

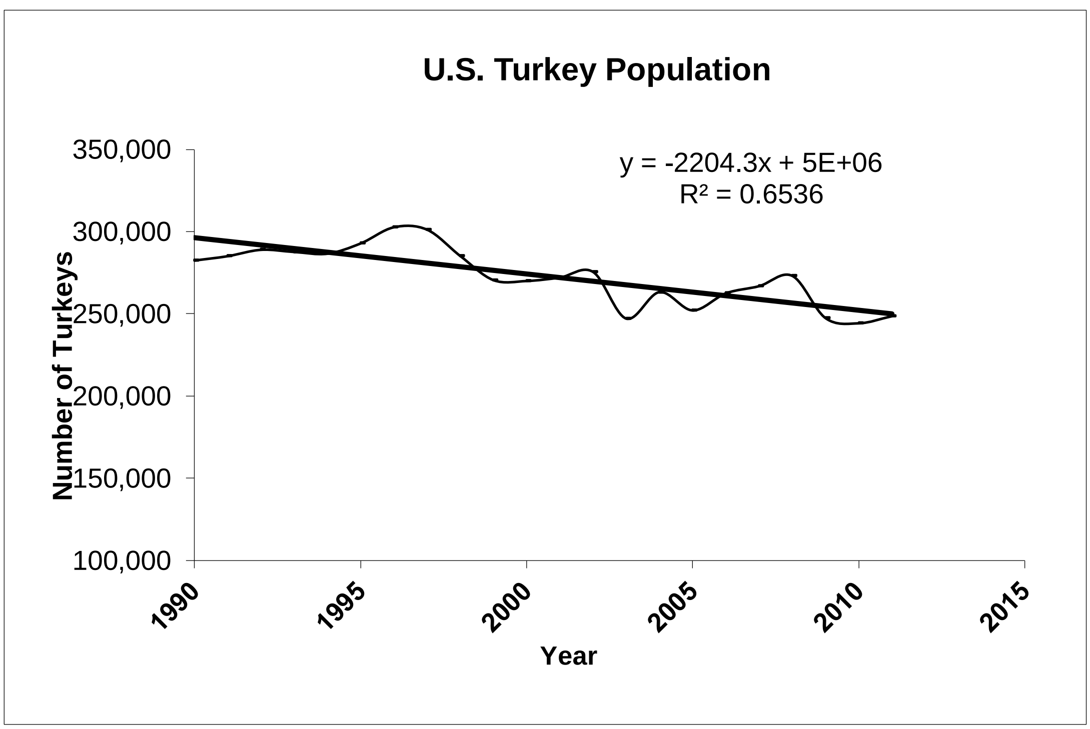
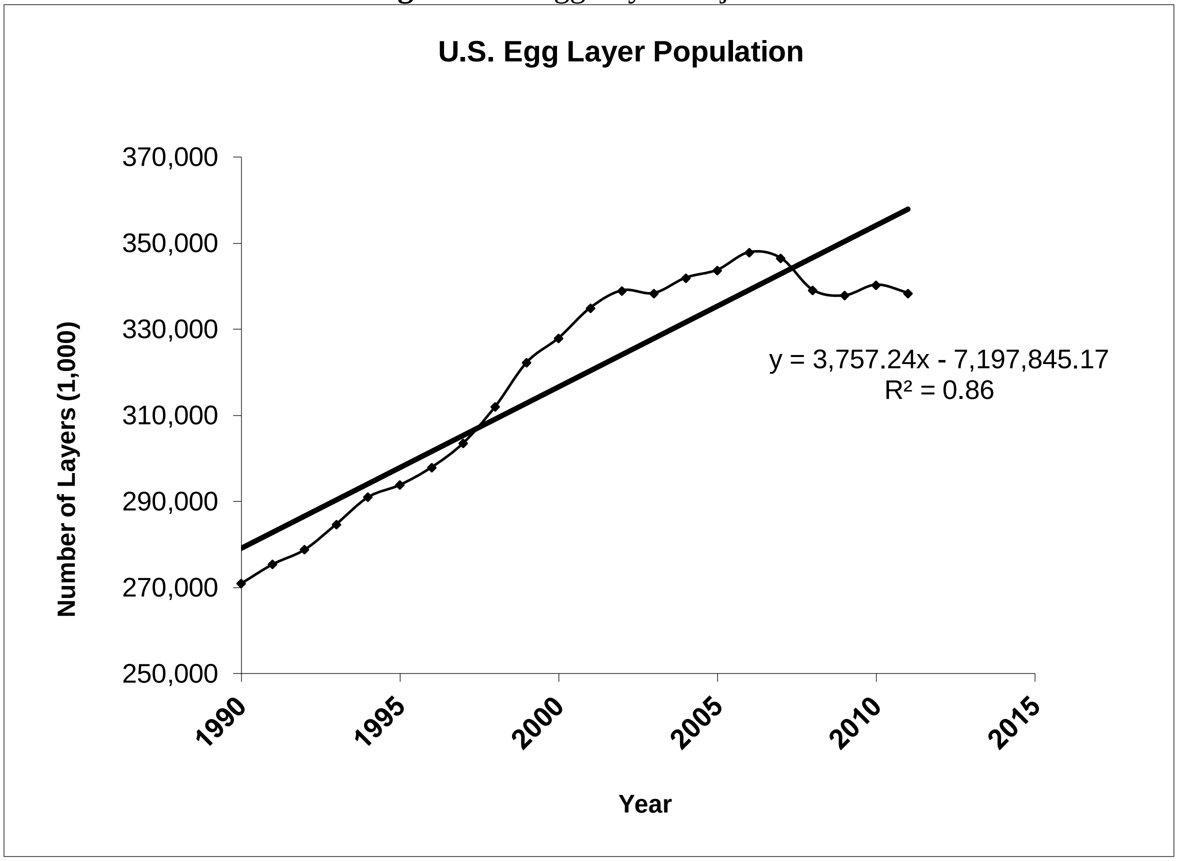


Figure C-8. Egg Layer Projection



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http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do;jsessionid=0AFEA5A73F0092B7498ACB64B7CABBED?documentID=1509