

**TECHNICAL SUPPORT DOCUMENT  
EMISSION INVENTORY DEVELOPMENT  
FOR 2011 AND 2017  
FOR THE NORTHEASTERN U.S.  
BETA2 VERSION**

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## ACRONYMS

AEO	Annual Energy Outlook
APU	Auxiliary Power Unit
CAMD	EPA Clean Air Markets Division
CAP	Criteria Air Pollutant
CDB	County Database
CEM	Continuous Emission Monitoring
CMV	Commercial Marine Vessel
CO	Carbon Monoxide
CoST	Control Strategy Tool
CSAPR	Cross-state Air Pollution Rule
EGU	Electric Generating Unit
EIA	Energy Information Agency
EIS	Emission Inventory System
EMF	Emission Modeling Framework
EPA	Environmental Protection Agency
ERTAC	Eastern Regional Technical Advisory Committee
FAA	Federal Aviation Administration
GSE	Ground Support Equipment
HAP	Hazardous Air Pollutant
ICI	Industrial/commercial/institutional
IPM	Integrated Planning Model
LTO	Landing Takeoff
MACT	Maximum Achievable Control Technology
MANE-VU	Mid-Atlantic/Northeast Visibility Union
MARAMA	Mid-Atlantic Regional Air Management Association
mmBtu	Million British Thermal Units
NAAQS	National Ambient Air Quality Standard
NAICS	North American Industrial Classification System
NCD	National County Database
NEI	National Emission Inventory
NEI2011v1	Version 1 of the 2011 National Emission Inventory
NEI2011v2	Version 2 of the 2011 National Emission Inventory
NEMS	National Energy Modeling System
NERC	North American Electric Reliability Corporation
NH <sub>3</sub>	Ammonia
NMIM	National Mobile Inventory Model
NO <sub>x</sub>	Oxides of Nitrogen
OTC	Ozone Transport Commission
PM <sub>10</sub>	Particles with diameter less than or equal to 10 micrometers

PM2.5	Particles with diameter less than or equal to 2.5 micrometers
RICE	Reciprocating Internal Combustion Engines
RWC	Residential Wood Combustion
S/L/T	State/local/tribal
SCC	Source Classification Code
SIP	State Implementation Plan
SMOKE	Sparse Matrix Operator Kernel Emissions
SO2	Sulfur Dioxide
TAF	Terminal Area Forecast
TSD	Technical Support Document
UAF	Unit Availability File
VMT	Vehicle Miles Travelled
VOC	Volatile Organic Compound

## 1. INTRODUCTION

The Mid-Atlantic Regional Air Management Association (MARAMA) is coordinating the development of Northeastern regional emissions inventories for air quality modeling. This Technical Support Document (TSD) describes the development of a comprehensive Northeastern regional emission inventory for 2011 and emission projections for 2017. State, Local, and Tribal (S/L/T) air agencies may use this inventory to address State Implementation Plan (SIP) requirements for attaining national ambient air quality standards (NAAQS) for ozone and fine particles, to evaluate progress towards long-term regional haze goals, and to support a single integrated, one-atmosphere air quality modeling platform.

Key inventory attributes include:

- **Base Year:** 2011
- **Projection Years:** 2017 – complete inventory development. 2023 – growth factors prepared and provided to USEPA for use in their October, 2016 ek modeling inventory.
- **Source Category Sectors:** electric generating unit (EGU) point sources, other point sources, nonpoint sources, nonroad mobile sources included in the NONROAD model, other nonroad sources (aircraft, locomotives, commercial marine vessels), onroad mobile sources included in the MOVES model, fire events, and biogenic sources.
- **Pollutants:** ammonia (NH<sub>3</sub>), carbon monoxide (CO), oxides of nitrogen (NO<sub>x</sub>), filterable plus condensable particles with diameter less than or equal to 10 and 2.5 micrometers (PM<sub>10</sub> and PM<sub>25</sub>), sulfur dioxide (SO<sub>2</sub>), and volatile organic compounds (VOC).
- **Temporal Resolution:** Variable by source sector. Most sectors are annual, however nonroad emissions are monthly and biogenic, onroad and EGU emissions are hourly. Summaries provided in this TSD are annual.
- **Geographic Area:** 15 jurisdictions in the Northeastern U.S. (CT, DC, DE, MA, MD, ME, NC, NH, NJ, NY, PA, RI, VA, VT, WV); additional states, Canadian provinces, and off-shore sources are included in the complete modeling inventory for the Northeastern domain, however, this detailed documentation is only for the states in the Northeastern US. A brief summary of the projection methodology for emissions from other states and Canadian within the modeling domain is included in Section 6.8.

The guiding philosophy behind the development of both the MARAMA BETA2 2011 and future projection inventories was, where possible, to rely on the collaborative work of the S/L/T air agencies and the U.S. Environmental Protection Agency (EPA) in developing the 2011 National Emissions Inventory (NEI) (EPA2015a) and the USEPA 2011 modeling platform (EPA2015b). This TSD does not attempt to duplicate the documentation available in EPA 2011 NEI and modeling reports. Rather, it provides a brief summary of existing EPA documentation with references to appropriate EPA documents. Copies of referenced documents are available on the MARAMA website (<http://www.marama.org/technical-center/emissions-inventory/2011-inventory-and-projections>).

This TSD contains the following Sections:

- **Section 1** is an introduction to the TSD
- **Section 2** documents the development of the 2011 inventory for each source sectors

- **Section 3** documents the development of the 2017 inventories for each source sectors
- **Section 4** summarizes the quality assurance and quality control (QA/QC) activities
- **Section 5** identifies the data files that make up the inventory which are stored on the MARAMA Emission Modeling Framework (EMF)
- **Section 6** provides emissions data summaries by pollutant

The following provides a summary of the inventories that preceded the MARAMA BETA2 inventory and were used as resources in development of this inventory.

**The EPA 2011 v6.3 Modeling Platform** (EPA2016) xxx provided the emission factors used in calculating mobile emissions in the MARAMA BETA2 2011 and 2017 inventory. The v6.3 is also termed the ‘ek’ version. The “e” stands for evaluation, meaning that year-specific data for fires and electric generating units (EGUs) are used, and the “k” represents that this was the eleventh set of emissions modeled for a 2011-based modeling platform. At the time of this TSD preparation, the EPA 2011 v6.3 platform is released to the public. However, EPA provided a pre-release of the mobile emission factors for use by Northeast states in preparing this BETA2 inventory. When released, the ‘ek’ inventory datasets will provide further improvements to the ‘eh’ inventory. Except for mobile emission, the MARAMA BETA2 datasets rely on the ‘eh’ inventory, described below, as a starting point.

**The EPA 2011 v6.2 Modeling Platform** (EPA2015b) was a key resource in preparing the MARAMA BETA2 2011 base year inventory. The v6.2 is also termed the ‘eh’ version. 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. The EPA 2011 v6.2 platform integrates numerous datasets into a form useful for air quality modeling. The platform was released in August 2015, and was used to support ozone transport modeling for the 2008 National Ambient Air Quality Standards (NAAQS), the 2015 ozone NAAQS, along with other special studies. The inventory datasets include the 2011 NEI v2 emissions inventory updated and corrected as a result of EPA QA and state input, as well as meteorological data, and other supporting data. MARAMA and states have further improved the ‘eh’ datasets as a result of QA checks and adjustments to account for improved interpretation of existing rules, or application of state specific rules and controls not included in the national inventory. These changes are described in detail in this TSD.

**The 2011 National Emissions Inventory (NEI)** (EPA2015a) underlies all versions of the EPA MARAMA 2011 modeling inventories. The triannual NEI is prepared by the EPA based primarily upon emission estimates and model inputs provided by S/L/T air agencies for sources in their jurisdictions. To build the NEI, S/L/T submit their data to the EPA Emissions Inventory System (EIS). The EIS stores the S/L/T data in a common format and performs hundreds of automated QA checks to improve data quality. S/L/T agencies collaborate extensively with EPA to avoid duplication of effort, use consistent data and methodologies, avoid duplication between categories, ensure completeness and improve data quality. EPA reviews the S/L/T submittals and provides feedback on data quality such as suspected outliers and missing data by comparing to previously established emissions ranges and past inventories. EPA also augments the S/L/T data to fill gaps. Data used for gap filling comes from other emission reporting programs including the Acid Rain Program, the CAMD CEM database under 40 CFR Part 75 and from EPA’s regulatory development projects. In addition, EPA executes various emission estimation

models (EPA2015c) and blends data from these multiple sources, and performs quality assurance steps that further enhance and augment the S/L/T data.

The development of both the USEPA and the regional MARAMA 2011 modeling inventory and emission projections is an iterative process with multiple versions released as files are corrected and refined. For example, the MARAMA Alpha2 replaced the Alpha inventory correcting duplication and faulty spatial distribution of the marine inventory. Figure 1 shows the parallel progression of USEPA and regional inventory creation for the 2011 base inventory and future projection suites.

**Figure 1: Iterative development of the USEPA and MARAMA Inventories**

USEPA Inventory Development			MARAMA Inventory Development	
November 27, 2013	USEPA 2011 Modeling Platform V1	2011NEIv1		
January 2014	USEPA 2018 Modeling Platform V1	2018NEIv1	April 2014	V1 growth factors created based on NEIv1
October 2014	USEPA 2011/2018 Modeling Platform V2 (Preliminary)	2011NEIv2 (Preliminary)		
March 2015	USEPA 2011/2018 Modeling Platform V2 (Final)	2011NEIv2 (Final)	March 2015	MARAMA Alpha 2011/2018
			July 2015	MARAMA Alpha2 2011/2018
August 2015	USEPA 2011/2017 Modeling Platform V6.2	2011NEIv6.2		
			December 2015	MARAMA Alpha2 2011/2018/2028
			January 2016	MARAMA Beta 2011
			June 2016	MARAMA Beta 2017

**The MARAMA ALPHA2 2011/2018/2028 inventory** (MARAMA2015), was based on the USEPA 2011 V2 platform, as released by EPA in October 2014. Growth factors used to create future years 2018 and 2028 were based on EPA 2011/2018v1 and ERTAC EGU V2.3. Detailed documentation of the ALPHA2 inventory can be found in the Technical Support Document prepared in association with that inventory (MARAMA2015). The ALPHA2 inventory is intended for Northeast regional visibility attainment demonstration modeling and preliminary modeling to identify ozone control strategies.

**The MARAMA BETA2 2011 inventory**, described in this document, is primarily based on the emission files contained in the EPA Version 6.2 2011 Modeling Platform inventory, released for public comment in August 2015 (EPA2015b). The exception is mobile emissions for both 2011 and 2017 which rely on EPA Version 6.3 or ‘ek’ inventory. The V6.2 platform inventory, which is also termed the ‘eh’ inventory, includes some improvements over the 2011 NEIv2, including elimination of some double counted sources. Figure 2 summarizes the data sources used for each source sector of the BETA2 inventory. Any EPA updates to the files after that access date are not reflected in this inventory. MARAMA has creating the BETA2 projection to 2017 based on this BETA2 inventory.

There are numerous refinements of the inventory datasets obtained from the V6.2 EPA platform that have been incorporated into the Northeast regional 2011 BETA2 inventory. One of the most

important of these is the use of the ERTAC EGU methodology to estimate emissions from electricity generation. More detail on ERTAC EGU is provided in Section 2.1.2.1 of this document.

Updates in the MARAMA BETA2 2011 from the ALPHA2 2011 inventory include the following:

- Replacement of updated files from the EPA V6.2 platform including:
  - Point Non-IPM– An updated version of this file was incorporated that included many S/L/T comments.
  - Non-Road – ALPHA2 relied on EPA 2011 NEI V1 for this sector. BETA2 incorporates EPA 2011 NEI V2 which includes corrections by Delaware to and incorporated by EPA.
  - Replacement of updated biogenic emissions
  - Ethanol plants – Incorporated an updated version from EPA V6.2 platform
  - Point Oil and Gas – Incorporated an updated version from EPA V6.2 platform
  - Refueling – Incorporated an updated version from EPA V6.2 platform
  - Agricultural ammonia – Incorporated an updated version from EPA V6.2 platform
  - Residential Wood – Incorporated an updated version from EPA V6.2 platform
  - Non-point – Incorporated an updated version from EPA V6.2 platform
  - New 2014a MOVES emission factors using CB05 chemistry
- Improvements beyond inclusion of the EPA V6.2 platform files performed by MARAMA including:
  - Mobile emissions prepared using the new 2014a MOVES emission factors using CB05 chemistry. The MOVES emission factors were provided by EPA in Spring 2017 and are an improvement on the factors used in the V6.2 platform. The SMOKE MOVES runs, which generate gridded emissions, were completed by New Jersey DEP.
  - Units found to be missing in the non-IPM and non-egu point source files were added. These sources were included in the MARAMA Alpha2 inventory, but had been eliminated by EPA as duplicate sources in IPM. These were added back as they were determined by states not to be duplicates in the MARAMA inventory.
  - NY and CT corrected emissions for non-point combustion sources.
  - Replacement of updated ERTAC EGU files for both 2011 and 2017. ALPHA2 relied on ERTAC EGU v2.3. In the BETA2 inventory, these are replaced with ERTAC EGU v2.5L2
  - Correction of the 2011 onroad emissions in 15 New Jersey counties.

**The MARAMA BETA2 2017 inventory**, for the covered states, as described in this document, is not based on the 2017 emission files contained in USEPA platform. Rather it has been developed by projecting from the MARAMA BETA2 2011. Thus, the improvements made to BETA2 2011, as described above, will be carried forward into 2017.

The MARAMA projection approach is distinct and more refined than the approach taken by USEPA. EPA in their first draft used a “no-growth” approach that flat-lines future year emissions for many non-EGU point and nonpoint stationary source categories. They then remove emissions from units that have been shutdown and apply control factors that represent new federal rules. For the V6.2 platform EPA has now adopted the MARAMA state-supplied growth factors for the covered region for most categories and these are included in the v6.2 inventory.<sup>1</sup>

In the V6.2 platform EPA included some state rules for covered states that were provided to them as comments on the inventory.

Northeastern S/L/T agencies prefer to use factors developed by MARAMA in consultation with states to project emissions as a better representation of future year emissions. In some cases, “growth” is positive, resulting in increased future emissions. In others, “growth” is negative, resulting in a reduction in future emissions. Development of the northeast regional projection factors is described in detail in Section 3.1 of this document.

The grown emissions are first adjusted to reflect unit shutdowns, and then to represent installation of control devices or other changes to source emissions. Where emissions from shutdowns are preserved as offsets for future growth some states have elected to move these emissions to offset files, rather than removing them from the inventory. Emissions are then further adjusted to represent both federal and state rules that limit emissions. This approach is further described in Section 3.1 of this document.

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<sup>1</sup> One exception is Oil and Gas sources where USEPA used a uniform approach across all states.



**Figure 2: Data Sources for 2011 and 2017 Inventories by Source Sector**

MARAMA Sector	Source for 2011 Inventory	Source for 2017 Inventory
Point - ERTAC EGUs	ERTAC V2.5 with growth factors set at 1.0 for NOx and SO2. State provided emission rates for other pollutants	ERTAC V2.5L2 for NOx and SO2, with state provided emission rates for other pollutants
Point – Small EGUs	EPA 2011 v6.2 platform ('eh') subset of EGU sector	Projected and controlled using v2 factors within the EMF tool
Point – Aircraft Engines, Ground Support Equipment, Auxiliary Power Units	EPA 2011 v6.2 ('eh') platform	Projected and controlled using v2 factors within the EMF tool
Point - Other Sources	EPA 2011 v6.2 ('eh') platform subset of point sector	Projected and controlled using v2 factors within the EMF tool
Nonpoint – Area Sources	EPA 2011 v6.2 ('eh') platform	Projected and controlled using v2 factors within the EMF tool
Nonroad – Commercial Marine Vessels and Railroad Locomotives	EPA 2011 v6.2 ('eh') platform	Projected and controlled using v2 factors within the EMF tool
Nonroad – NONROAD Model	EPA 2011 v6.2 ('eh') platform NONROAD Model	EPA 2017 v6.2 ('eh') platform NONROAD Model
Onroad – MOVES Model	EPA 2011 v6.3 ('ek') platform MOVES Model with updated New Jersey data for 13 counties.	EPA 2017 v6.3 ('ek') platform MOVES2014a emission factors prepared for CBO5 chemistry applied to EPA v6.2 platform county level activity data.
Fire Events	EPA 2011 v6.2 ('eh') platform	EPA 2011 v6.2 ('eh') platform (using 2011 inventory for 2017)
Biogenic	EPA BEIS 3.61	EPA BEIS 3.61 (using 2011 inventory for 2017)
Other states in the modeling domain	EPA 2011 v6.2 ('eh') platform	EPA 2017 v6.2 ('eh') platform and EPA closure, control and projection factors.
Canadian Sources	Canada 2010	Applied the average change in emissions that is expected to occur in the Eastern modeling domain between 2011 and 2017 by pollutant and sector

Note: the specific files used for each sector and year are provided in Section 5



## 2. 2011 BASE YEAR INVENTORY DEVELOPMENT

The Northeastern regional emission inventory categorizes all air pollution sources into eight sectors. MARAMA defined these sectors to be consistent with the historical way in which the Northeast S/L/T agencies have organized past inventories and to allow consistent comparison of base and future year inventories. These sectors include:

- **Point Sources.** This sector includes source for which specific geographic coordinates (e.g., latitude/longitude) are specified, as in the case of an individual facility. A unit may have multiple emission release points such as boilers, furnaces, spray booths, kilns, etc. In addition, a unit may have multiple processes (e.g., a boiler that sometimes burns residual oil and sometimes burns natural gas). The MARAMA BETA2 point source sector is further partitioned into several subsectors to facilitate emission projection, comparison with the USEPA inventory, and summarization. These include:
  - Electric Generation Units (EGU)
  - Non-ERTAC IPM sources (termed “Small EGUs” in the ALPHA2 inventory)
  - Oil & Gas points (Onshore and Offshore)
  - Ethanol Plants
  - Portable Sources
  - Other Point Sources

Three of these subsectors are directly analogous subsectors in the EPA ‘eh’ inventory including:

- Oil & Gas points (Onshore and Offshore)
  - Ethanol Plants
  - Portable Sources
- **Aircraft/GSE/APU Point Sources.** This sector includes emissions from aircraft engines, ground support equipment (GSE) and auxiliary power units (APUs) that are identified as point sources (e.g., emissions are located at specific airport locations).
- **Nonpoint Sources.** This sector includes sources which individually are too small in magnitude or too numerous to inventory as individual point sources. Nonpoint sources include smaller industrial, commercial and institutional facilities, as well as residential sources. S/L/T agencies and EPA estimate nonpoint emissions at the county level. This sector does not include locomotive emissions outside of the rail yards and commercial marine vessel emissions, which are included in the nonroad sector described below. The MARAMA BETA2 nonpoint source sector is further partitioned into several subsectors to facilitate emission projection, comparison with the USEPA inventory, and summarization. These include:
  - Agriculture - nonpoint livestock and fertilizer application
  - Fugitive dust - building construction, road construction, agricultural dust, and road dust
  - Nonpoint oil and gas-related processes
  - Portable fuel containers
  - Remaining nonpoint - nonpoint sources not included in other subsectors

- Residential wood combustion
  - Stage 1 vehicle refueling
- **Nonroad Sources in the NONROAD Model.** This sector contains mobile sources included in NONROAD model within the National Mobile Inventory Model (NMIM). Nonroad emissions result from the use of fuel in a diverse collection of vehicles and equipment such as construction equipment, recreational vehicles, and landscaping equipment.
- **Rail/CMV Nonroad Sources.** This sector includes internal combustion engines used to propel commercial marine vessels (CMV) and locomotives.
- **Onroad Sources.** This sector contains mobile sources included in the MOVES model. Onroad emissions result from the combustion and evaporation of fuel used by motorized vehicles that are normally operated on public roadways. This includes passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy-duty trucks, and buses.
- **Fire Sources.** This sector includes sources of pollution caused by the inadvertent or intentional burning of biomass including forest, rangeland (e.g., grasses and shrubs), and agricultural vegetative residue.
- **Biogenic Sources.** This sector includes emissions from vegetation and soils that are computed via a model that utilizes spatial information on vegetation and land use, and environmental conditions of temperature and solar radiation.

See Section 5 of this TSD for a discussion of how these sectors relate to the individual inventory datasets included in the EMF.

## 2.1. POINT SOURCES

S/L/T agencies are primarily responsible for developing the point source inventory for the triannual NEI. S/L/T agencies obtain this data from the annual emissions statement reports submitted by the owners of the source of air pollution. Individual S/L/T agencies compile and quality assure the industry submittals, and maintain substantial databases of both small and large air emission sources. Furthermore, they maintain full documentation on point sources and emissions located in their jurisdictions. Individual S/L/T agency staff and websites should be consulted for detailed documentation on how each agency develops their point source emission inventories.

### 2.1.1. EPA Pollutant Augmentation

USEPA augmented the S/L/T point source submissions to the NEI to ensure data completeness and consistency across the national inventory. Augmentation occurred for PM<sub>2.5</sub>, PM<sub>10</sub> and HAP sources. This is more fully described in the USEPA NEI documentation.

### 2.1.2. Point Source Sub-Sectors

This section provides more detail concerning each point source sub-sector in the MARAMA BETA2 inventory.

#### 2.1.2.1. Electric Generation Units (EGU )

This subsector includes boilers, combustion gas turbines, combined cycle units, and reciprocating engines used to power an electrical generator that is connected to the electrical grid. The specific sources in the EGU subsector are listed in the Unit Availability File (UAF)

contained in Appendix B to this document. Northeastern S/L/T agencies use the ERTAC tool to estimate base and future year EGU emissions. These estimates replace the estimates in the EPA modeling platform that are IPM-based forecasts. This is the major difference between the MARAMA BETA2 and USEPA inventories.

Incorporation of ERTAC EGU into the inventory requires reworking of several other inventory sectors to ensure completeness and avoid double counting. Further detail on the ERTAC EGU Tool is provided in Section 3.2 of this document.

#### **2.1.2.2. Non-ERTAC IPM Sources (Small EGUs)**

The Non-ERTAC IPM file contains sources that are included in EPA's IPM modeling but not included in the ERTAC forecasting tool. Many sources in this sector are small EGUs including those fueled by wood or landfill gas and municipal waste combustors. In addition, the sub-sector includes some non-EGUs such as other combustion units, some of which feed some power into the grid, located at smelters, paper mills, and petroleum refineries that are included in the USEPA IPM files. This sub-sector was created so that an "apples-to-apples" comparison could be made between the IPM and ERTAC projections. This subsector was termed the "Small EGUs" in the ALPHA2 inventory.

#### **2.1.2.3. Point On-Shore Oil & Gas Production Facilities**

Larger oil and gas production facilities, including pipeline compressor stations, are included in the point source inventories. Where these point source emissions units are double counted in the area source file states have subtracted from emissions calculated using the nonpoint Oil and Gas tool. EPA created the Point Oil and Gas subsector to assist the S/L/T agencies to identify source to subtraction out of area source calculations. See Section 2.1.2 of the EPA 2011 Modeling Platform TSD (EPA, 2015b) for additional documentation of the on-shore oil and gas production point source inventory.

#### **2.1.2.4. Offshore Oil & Gas Drilling Platforms**

EPA augments the point source sector by including point source offshore oil and gas drilling platforms that are beyond U.S. state-county boundaries in the Gulf of Mexico. These sources are not in the 15 Northeast states in this regional emission inventory, no further discussion of EPA's augmentation procedures is presented here.

#### **2.1.2.5. Ethanol Production Facilities**

As part of its rule development work, EPA developed a list of corn ethanol facilities for 2011. Many of these ethanol facilities were included in the 2011NEIv6.2. EPA believes that some of these sources were not included in the NEI as point sources because they did not meet the 100 ton/year potential-to-emit threshold for NEI point sources. EPA added these sources to the 2011NEIv6.2. While most of these additional corn ethanol facilities were located in the Midwestern states, two were located in New York (Western New York Energy LLC and Sunoco Fulton Ethanol Plant). See Section 2.1.3 of the EPA 2011 Modeling Platform TSD (EPA, 2015b) for further documentation.

#### **2.1.2.6. Portable Point Sources**

Some S/L/T agencies include portable equipment used primarily in the construction industry in their point source inventories. This includes processes such as portable aggregate crushers and asphalt hot mix plants. These sources tend to move throughout the year and S/L/T agencies cannot precisely locate them by latitude/longitude or county. Emissions from these sources are

assigned to “777” counties since their precise location changes through the year. All emissions from “777” counties were outside of the 15 Northeast states in this regional emissions inventory and were very small compared to the emissions from other point sources.

#### 2.1.2.7. Other Point Sources

This subsector includes the point sources that remain after the redistribution to the other point subsectors described above. Sources in this subsector include industrial/commercial/institutional boilers and engines; industrial processes such as cement manufacturing and petroleum refining; surface coating facilities; organic liquids storage and transfer; and waste disposal facilities. The inventory for these sources primarily uses data collected from the affected sources by the applicable S/L/T agencies. However, this subsector is not completely analogous to the USEPA subsector of the same name as a result of additional quality assurance checks undertaken by the region in preparation for the BETA2 inventory that removed additional double counting in the subsector.

EPA includes certain mobile sources located at airports and rail yards as point sources in order to locate them geographically by latitude and longitude. Later sections of this document describe the methodology for estimating emissions from airports and rail yards.

#### 2.1.3. Partitioning of Point Sources to Sub-Sectors

**For the MARAMA ALPHA2 inventory**, two EPA point source subsectors: 1) IPM and 2) Non-EGU were combined and then split into three subsectors as follows:

- ERTAC Electric Generation Units (EGU)
- Non-ERTAC IPM sources (this subsector was termed “Small EGUs” in the Alpha2 inventory)
- Other Point Sources

A cross-reference file for jurisdictions in the Northeast regional emissions inventory was prepared to facilitate the split. The cross-reference matches records in the ERTAC UAF (see Appendix B) with analogous records in the both the 2011 NEI and EPA modeling platform. ORIS facility and boiler identifiers are used to match units across the three data systems. Facility names and county assignments, as well as the magnitudes of the SO<sub>2</sub> and NO<sub>x</sub> emissions were checked to confirm preliminary matches. Note that although the ERTAC UAF contains units flagged as either EGU or nonEGU, only the units flagged as EGU are included in the EGU forecasting tool projections. Units flagged as nonEGU in the UAF were not included in the EGU subsector. S/L/T agencies reviewed and corrected the cross-reference. This cross-reference file was further refined and extended to the continental United States by a coordinated inter-regional and USEPA combined effort. The final cross-reference used to perform the split is provided in Appendix A.

**For the MARAMA BETA2 inventory**, the “Small EGU” subsector file was retained, but renamed “Non-ERTAC IPM sources”, to more clearly indicate the genesis of that subsector.

The ALPHA2 “Other Point Source” file was replaced with the “Other Point Source” file from the EPA ‘eh’ modeling inventory and an EMF compare dataset query was run between the ALPHA2 and USEPA ‘eh’ “Other Point Source” datasets to identify non-matching units. This comparison found numerous sources that were included in the ALPHA2 were now missing from the USEPA ‘eh’ “Other Point Source” dataset. S/L/T were provided a list of these discrepancies

for review. S/L/T feedback was used by MARAMA to determine to which dataset each non-matching unit should be assigned as follows:

- **Double counted** - elsewhere in the inventory, and MARAMA removed them from consideration, or
- **Missing** - added back to Non-ERTAC IPM, Other Point, or Onshore Oil and Gas datasets.

Appendix CC indicates the assignments made by S/L/T. MARAMA then revised the datasets as indicated by states.

## 2.2. NONPOINT SOURCES

Nonpoint sources are small stationary sources that may not individually emit significant amounts of air pollution, but when aggregated can make an appreciable contribution to the emission inventory. The main reason not to treat them as point sources is that the effort required to gather data and estimate emissions for each individual source is great although emissions per source are generally small. S/L/T agencies and EPA group emissions from these sources into broad categories, such as residential fuel combustion or consumer solvent usage. Each of these broad groups of processes contains a number of more specific subgroups that share similar emission processes and emission estimation methods. There are literally hundreds of area source processes included in the nonpoint source inventory.

For the 2011 NEI, S/L/T agencies collaborated with EPA to develop best practices for estimating nonpoint source emissions estimates. The collaboration, referred to as the ERTAC “Area Source Comparability” project, facilitated agreement on emission estimation methodologies, data source, emission factors, and SCCs for a number of important nonpoint sectors, allowing EPA to prepare the emissions estimates for all states using the group’s final approaches. During the 2011 NEI inventory development cycle, S/L/T agencies could accept the ERTAC/EPA estimates to fulfill their nonpoint emissions reporting requirements. EPA encouraged S/L/T agencies that did not use EPA’s estimates or tools to improve upon these “default” methodologies and submit further improved data.

Nonpoint emissions are frequently estimated using detailed calculation tools that have been developed for that purpose. EPA has provided the detailed activity data and emissions factors on its Nonpoint Emissions Tools and Methods ftp site (EPA, 2015c).

As a starting point, the BETA2 Version of the Northeast regional emission inventory relies upon EPA v6.2 modeling platform as provided in August 2015. Documentation of the nonpoint source inventory in the EPA v6.2 platform is provided in Section 3.1.7 and 3.2 through 3.30 of the NEIv2 2011 TSD (EPA, 2015a). Section 3.1.7 outlines the general approach used in developing the nonpoint source inventory, while Sections 3.2 through 3.30 provide additional details.

For emission modeling and summarization purposes, the nonpoint inventory is sub-divided into several subsectors, as described in the following subsections. Although EPA V6.2 modeling platform includes locomotives and commercial marine vessels in the nonpoint inventory, in the BETA2 inventory these sources are considered nonroad mobile sources that are described later in this document as part of the nonroad sector. In addition, refinements were made by CT and NY for this BETA2 inventory. These refinements are described in more detail below.

See Section 5 for a discussion of how the individual inventory files are associated with the MARAMA emission summary sectors.

### **2.2.1. Fugitive Dust**

The nonpoint source fugitive dust inventory contains PM<sub>10</sub> and PM<sub>2.5</sub> emission estimates for certain nonpoint categories including paved roads, unpaved roads and airstrips, construction (residential, industrial, road and total), agriculture production, and mining and quarrying. The sector 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 fugitive dust sector is separated from other nonpoint sectors to allow for the application of a “transport fraction” and meteorological/precipitation reductions. Emission modelers apply these adjustments 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. The purpose of applying the transport fraction and meteorological adjustments is to reduce the overestimation of fugitive dust in the grid modeling as compared to ambient observations.

Refer to section 2.2.1 of the 2011 Modeling Platform TSD (EPA, 2015b) for further information.

### **2.2.2. Agricultural Ammonia**

The nonpoint source agricultural ammonia inventory contains NH<sub>3</sub> emission estimates for nonpoint SCCs identified by EPA staff. This sector includes fertilizer - any nitrogen-based compound or mixture - that is applied to land to improve plant fitness. This category also accounts for emissions from livestock waste from domesticated animals intentionally reared for the production of food, fiber, or other goods or for the use of their labor. The livestock included in the EPA-estimated emissions include beef cattle, dairy cattle, ducks, geese, goats, horses, poultry, sheep, and swine. Refer to sections 3.3 and 3.4 of the 2011 NEIv2 TSD (EPA, 2015a) and section 2.2.2 of the 2011 Modeling Platform TSD (EPA, 2015b) for further information.

### **2.2.3. Oil and Gas Production**

The nonpoint oil and gas sector contains emission estimates for onshore and offshore oil and gas production processes. Offshore emissions for all states and regions in this inventory are identical to the USEPA V2 estimate.

Onshore nonpoint oil and gas emissions were estimated using the USEPA Oil and Gas ACCESS database tool. The tool is designed estimate nonpoint emissions associated with the exploration and drilling at oil and gas wells including the equipment used at the well sites to extract the product and deliver it to a central collection point or processing facility. 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. 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.

In some cases, states replaced the tool estimates with their own state estimates. In the 15 state region covered by this TSD both Pennsylvania and West Virginia used their own state estimates. These state specific estimates were also provided to USEPA for the 2011 NEI. Pennsylvania



replaced most tool emissions with source reported data. West Virginia collected improved West Virginia input data and re-ran the tool for their state and submitted that data.

For more information on the development of the oil and gas emissions in the 2011 NEI, see Section 3.21 of the TSD (EPA, 2015a).

#### **2.2.4. Portable Fuel Containers**

EPA developed emission estimates for portable fuel containers using the ERTAC “Area Source Comparability” methodology. It appears that the EPA/ERTAC methodology accounts for state control programs that were enacted prior to the Federal rule adoption in 2007. EPA extracted the portable fuel container segment of the nonpoint inventory into a separate file because of their methodology for projecting emissions. Refer to section 3.1.7 of the 2011 NEIv2 TSD (EPA, 2015a) for further information.

#### **2.2.5. Gasoline Unloading and Refueling**

EPA developed emission estimates for gasoline service station Stage 1 fuel transfers (e.g., transferring fuel from tanker trucks into underground storage tanks) and underground storage tank breathing evaporative losses using the ERTAC “Area Source Comparability” methodology. EPA extracted the Stage 1 and underground tank breathing segment of the nonpoint inventory into a separate file to facilitate review of this segment of the inventory by S/L/T agencies. Refer to section 3.1.7 of the 2011 NEIv2 TSD (EPA, 2015a) for further information. Note that Stage 2 refueling (e.g., transfer of gasoline into the vehicles’ fuel tank) is included in the onroad inventory since the emissions are calculated using the MOVES model.

#### **2.2.6. Residential Wood Combustion**

The residential wood combustion 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 chimeneas. 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. EPA has developed a tool for calculating residential wood combustion emissions. For more information on the development of the residential wood combustion emissions, see Section 3.14 of the 2011 NEIv2 TSD (EPA, 2015a).

#### **2.2.7. Other Nonpoint Sources**

This sector includes all stationary nonpoint sources that were not subdivided into the nonpoint sectors discussed above. Locomotives and commercial marine vessel (CMV) mobile sources included in the 2011 NEIv2 nonpoint inventory were moved out of the EPA nonpoint sector and put into their own files for the BETA inventory as described later in this document. There are hundreds of individual processes in this category that are grouped into the following categories:

- Industrial and commercial fuel combustion not included in the point source sector
- Residential fuel combustion other than wood combustion;
- Chemical manufacturing not included in the point source sector

- Industrial processes not included in the point source sector, 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, industrial maintenance, autobody refinishing, traffic marking, textile production, furniture finishing, and coating of paper, plastic, metal, appliances, and new motor vehicles.
- Solvent utilization for degreasing of parts and equipment used in manufacturing processes such as for furniture, metals, auto repair and electronics.
- Solvent utilization for dry cleaning, graphic arts, plastics, industrial processes
- Solvent utilization for consumer products such as personal care products, household products, adhesives and sealants
- Solvent utilization for asphalt application and roofing, industrial and commercial adhesive and sealants and pesticide application
- Waste disposal, treatment, and recovery via incineration, open burning, landfills, and composting
- Miscellaneous area sources such as cremation, hospitals, lamp breakage, and automotive repair shops

Refer to section 3.2 through 3.30 of the 2011 NEIv2 TSD (EPA, 2015a) and section 2.2.6 of the 2011 Modeling Platform TSD (EPA, 2015b) for further information.

#### 2.2.7.1. State refinements to the nonpoint inventory

New York provided refinements to the nonpoint inventory using DEC preferred emission factors. New York performed the calculations and submitted replacement emissions for the county record for each of the following SCC and pollutant.

- Industrial wood combustion (SCC: 2102008000) - PM<sub>10</sub>
- Commercial combustion - distillate-fired boilers (SCC: 2103004001) - PM<sub>10</sub>
- Commercial combustion - distillate-fired engines (SCC: 2103004002) - PM<sub>10</sub>
- Commercial combustion – natural gas (SCC: 2103006000) - PM<sub>10</sub> and VOC
- Residential – distillate (SCC: 2104004000) PM<sub>10</sub> and PM<sub>2.5</sub>
- Residential – natural gas (SCC: 2104006010) PM<sub>10</sub> and VOC
- Residential – (SCC: 2104007000) PM<sub>10</sub> and PM<sub>2.5</sub>

Connecticut provided refinements to the nonpoint inventory. Connecticut performed the calculations and submitted replacement emissions for the county record for each of the following SCC and pollutant.

SCC	SCC description	Pollutant
2102004001	Fuel Comb - Industrial Boilers, ICEs - Distillate Oil	SO <sub>2</sub>
2103004001	Fuel Comb - Comm/Institutional - Distillate Oil	SO <sub>2</sub>
2102005000	Fuel Comb - Industrial Boilers, ICEs - Residual Oil	SO <sub>2</sub>
2103005000	Fuel Comb - Comm/Institutional -Residual Oil	SO <sub>2</sub>



## 2.3. AIRCRAFT, LOCOMOTIVES, AND COMMERCIAL MARINE VESSELS (MARINE/AIR/RAIL – MAR)

In previous inventories (2002 and 2007), the Northeastern S/L/T agencies have included emissions from aircraft, locomotives and commercial marine vessels as a separate inventory section called Marine/Air/Rail or MAR, since the NONROAD model does not estimate emissions from these sources. To remain consistent with those inventories, MARAMA continues to segregate locomotive and commercial marine vessels in the MARAMA BETA2. This is different than the approach taken in the USEPA ‘eh’ inventory where these sources are sorted differently into either the point source inventory or the nonpoint source inventory. The following sections described how emissions for these sources were estimated and the inventory files in which they are located for the MARAMA BETA2 inventory.

### 2.3.1. MAR - Aircraft and Related Equipment

This sector only includes exhaust emissions from aircraft exhaust, auxiliary power units (APUs) and ground support equipment (GSE). This sector does not include other emission sources located at airports such as fuel combustion for airport heating or solvent use for aircraft maintenance. Both of these are included in the point source inventory. The sector also does not include emissions from jet fuel storage or aircraft refueling.

EPA, in consultation with S/L/T agencies, estimated emissions related to aircraft activity for U.S. airports, including seaplane ports and heliports. As part of the development process, S/L/T agencies had the opportunity to provide both activity data and emissions to the NEI. Where provided, S/L/T data was preferred over the national defaults in calculations using the Federal Aviation Administration’s Emissions and Dispersion Modeling System.

See Section 4.2 of EPA’s 2011 NEIv2 TSD (EPA, 2015a) for further information on how aircraft, GSE and APU emissions were calculated.

#### 2.3.1.1. Aircraft fuel combustion

Fuel combustion data was collected for four types of aircraft:

- **Commercial aircraft** tend to be larger aircraft powered with jet engines and are used for transporting passengers, freight, or both.
- **Air Taxi aircraft** carry passengers, freight, or both, but usually are smaller aircraft and operate on a more limited basis than the commercial aircraft; aircraft in this category are further sub-categorized as is turbine- or piston-driven, which allows the emissions estimation model to assign the fuel used, jet fuel or aviation gas, respectively; also, activity data is determined by the fraction of turbine- and piston-driven aircraft.
- **General Aviation aircraft** includes most other aircraft used for recreational flying and personal transportation. Aircraft in this category are further sub-categorized as is turbine- or piston-driven, which allows the emissions estimation model to assign the fuel used, jet fuel or aviation gas, respectively; also, activity data is determined by the fraction of turbine- and piston-driven aircraft.
- **Military aircraft** are associated with military installations, but they sometimes have activity at non-military airports.

Since EPA calculated emissions for specific airports, the emissions from aircraft engines are included in the point source inventory since the precise location of the airport is known. In

earlier inventories, aircraft emissions were typically calculated at the county level instead of the airport level. EPA developed emissions estimates associated with aircrafts' landing and takeoff (LTO) cycle. The cycle begins when the aircraft approaches the airport on its descent from cruising altitude, lands, taxis to the gate, and idles during passenger deplaning. It continues as the aircraft idles during passenger boarding, taxis back out onto the runway for subsequent takeoff, and ascent (climb out) to cruising altitude. Thus, the five specific operating modes in an LTO are (1) Approach, (2) Taxi/idle-in, (3) Taxi/idle-out, (4) Takeoff, and (5) Climbout.

EPA used the FAA's Emissions and Dispersion Modeling System (EDMS, Version 5.1). EDMS calculates emissions by aircraft type using actual LTO activity data by airport and the latest aircraft engine emission factors from the International Civil Aviation Organization (ICAO) Engine Exhaust Emissions Data Bank.

#### 2.3.1.2. Aircraft Auxiliary power units (APU) and ground support equipment (GSE)

The 2011v6.2 EPA modeling platform also includes emission estimates for aircraft auxiliary power units (APUs) and aircraft ground support equipment (GSE) typically found at airports, such as aircraft refueling vehicles, baggage handling vehicles, and equipment, aircraft towing vehicles, and passenger buses. These sources are located at specific airport facilities and are characterized as point sources in the NEI because they are geographically located by latitude/longitude. Emissions for GSE and APUs associated with aircraft-specific activity were also estimated by EDMS, using the assumptions and defaults incorporated in the model.

#### 2.3.2. Locomotives and Rail Yards

The locomotive sector includes railroad locomotives powered by diesel-electric engines. A diesel-electric locomotive uses 2-stroke or 4-stroke diesel engines and an alternator or a generator to produce the electricity required to power its traction motors. The locomotive source category is sub-divided into sub-categories based on railroad revenues and type of service:

- **Class I** line haul locomotives carry freight long distances and are operated by national railroad companies with large carrier operating revenues. There were seven Class I freight operators in 2008.
- **Class II/III** line haul locomotives are operated by companies with smaller revenues. Class II railroads operate on a regional basis. Class III railroads are typically local short-line railroads serving a small number of towns and industries. In 2008, there were about 12 Class II and 530 Class III Railroads.
- **Passenger railroads** operated by AMTRAK providing intercity passenger train service in the United States.
- **Commuter railroads** operate locomotives that provide a passenger rail transport service that primarily operates between a city center and the middle to outer suburbs.
- **Rail yards** include switcher locomotives engaged in splitting and joining rail cars.

EPA based the 2011 NEIv2 rail inventory on the recommendations of the ERTAC Rail Subcommittee for a methodology that (1) standardized S/L/T agencies' inventory development methods, (2) improved the quality of data received and the resulting emission inventories, and (3) reduced the administrative burden on railroad companies of providing data. EPA, in consultation with ERTAC, developed a comprehensive rail inventory for the 2008 NEI.

For the 2011 NEIv2, EPA developed 2011 national rail estimates by applying growth factors to the 2008 NEI values based on railroad freight traffic data from the 2008 and 2011 submitted by all Class I rail lines to the Surface Transportation Board and employment statistics from the American Short Lines and Regional Railroad Association for class II and III. EPA identified 95 rail yard locations in the Northeastern region for inclusion in the point source inventory using a database from the Federal Railroad Administration. EPA estimated CAP emissions using yard-specific emission factors and on national fuel values allocated to rail yards using an approximation of line haul activity within the yard. EPA allocated the emissions to line haul shape IDs and yard locations based on 2008 allocations. Emissions from specific rail yards are included in the point source inventory; all other emissions from locomotives are stored in the nonpoint inventory. EPA allocated the nonpoint emissions to line haul shape IDs and yard locations based on 2008 allocations.

See Section 4.4 of EPA's 2011 NEIv2 TSD (EPA, 2015a) for further information on how locomotive emissions were calculated.

### 2.3.3. Commercial Marine Vessels

The commercial marine vessel (CMV) sector includes boats and ships used either directly or indirectly in the conduct of commerce or military activity. The majority of vessels in this category are powered by diesel engines that are fueled either with distillate or residual fuel oil blends. The CMV inventory is divided into sub-sectors:

- **Category 1 and 2 (C1/C2) marine diesel engines** typically range in size from about 700 to 11,000 horsepower (hp). These engines are used to provide propulsion power on many kinds of vessels including tugboats, pushboats, supply vessels, fishing vessels, and other commercial vessels in and around ports. C1/C2 vessels (C1 and C2) typically use distillate fuels.
- **Category 3 (C3) marine engines** includes vessels with engines having displacement above 30 liters per cylinder. C3 vessels typically use residual oil. There are two parts to the C3 marine inventory. The near shore emissions, such as occurs in coastal waterways like the Chesapeake Bay or Long Island Sound are treated as area sources while emissions in the shipping lane emissions are treated as point sources. Emissions are equally distributed to pseudo-stacks that are positioned along the shipping lanes modelled to mimic ship boiler stacks.

The CMV source category does not include recreational marine vessels, which are generally less than 100 feet in length, most being less than 30 feet, and powered by either inboard or outboard engines. These emissions are included in those calculated by the NONROAD model and are accounted for there.

EPA estimated CMV emission as a collaborative effort between the Office of Transportation and Air Quality (OTAQ) and Office of Air Quality Planning and Standards (OAQPS). For C1/C2 marine diesel engines, the emission estimates were consistent with the 2011 Locomotive and Marine federal rule making. For C3 engines in the shipping lanes, EPA estimated 2011 emission by applying regional adjustment factors to account for growth to the previously developed emission estimates for a base year of 2002. In addition, EPA developed and applied NO<sub>x</sub> adjustment factors to account for implementation of the NO<sub>x</sub> Tier 1 standard.

Geographically, the inventories include port and inter-port emissions that occur within the area that extends 200 nautical miles (nm) from the official U.S. shoreline, which is roughly equivalent to the border of the U.S. Exclusive Economic Zone.

EPA allocates the portion of the CMV emissions that are estimated to occur within 3 miles of the shore to individual counties. These near-shore emissions are treated as area sources. EPA allocates these emissions to individual GIS polygons using methods that vary by operating mode (i.e., in-port hoteling, maneuvering, reduced speed zone, and underway). For example, port emissions appear only in port polygons, federal water emissions in federal waters. Northeast states typically develop their own estimates of near-shore CMV emissions that then replace the EPA national top down estimates.

See Section 4.3 of EPA's 2011 NEIv2 TSD (EPA, 2015a) for further information on how CMV emissions were calculated and geographically allocated.

## **2.4. NONROAD EQUIPMENT**

This sector includes non-highway vehicles, equipment and emissions processes that are included in EPA's NONROAD model. NONROAD calculates emissions for a diverse collection of equipment, including:

- Recreational
- Construction
- Industrial and Commercial
- Logging
- Underground Mining
- Pleasure Craft (excludes commercial marine vessels)
- Railroad Equipment (excludes locomotives).

NONROAD estimates emissions from these sources for four fuel types: gasoline, diesel, compressed natural gas, and liquefied petroleum gas.

The NONROAD model is embedded in EPA's National Mobile Inventory Model (NMIM) and allows EPA to produce nonroad mobile emissions in a consistent and automated way for the entire country. The primary input to the NONROAD model is the National County Database (NCD), which contains all the county-specific information needed to run NONROAD. EPA initially populates the NCD with default inputs and distributes the NCD to S/L/T agencies who are able to update the data within the NCD to create emissions estimates that accurately reflect local conditions and equipment usage. Some S/L/T agencies in the Northeast accepted the EPA NCD defaults and NONROAD modeling results. Others provided updates to the NCD that EPA used in its national NONROAD model run. Still other states executed the NONROAD model on their own and provided NONROAD results to EPA to replace the EPA-generated NONROAD model results.

See Section 4.5 of EPA's 2011 NEIv2 TSD (EPA2015a) for further information regarding the S/L/T agency inputs to the NONROAD model and other information on how EPA executed the NONROAD model.

## 2.5. ONROAD VEHICLES

The onroad mobile source sector includes emissions from gasoline and diesel vehicles that are normally operated on public roadways. This includes passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy-duty trucks, and buses. EPA also included Stage II vapor recovery gasoline refueling emissions in their onroad modeling platform, which has historically been treated as an area source emission.

EPA generated emissions using the latest publically released version of the EPA highway emissions model, MOVES2014a. The primary input to the MOVES model is the MOVES County Database (CDB), which contains all the county-specific information needed to run MOVES, such as vehicle miles travelled, vehicle type and age distributions, fuel types, emission inspection and maintenance programs, and many other parameters. EPA initially populates the CDB with default inputs and distributes the CDB to S/L/T agencies who update the data within the CDB to create emissions estimates that accurately reflect local conditions. Most of the Northeastern S/L/T agencies submitted a subset of state specific CDB inputs (for example, only data related to inspection/maintenance programs, or population data for a subset of source types); EPA used national defaults as CDB data not provided by states.

EPA used the county-specific inputs and tools that integrated the MOVES model with the SMOKE emission inventory model to take advantage of the gridded hourly temperature information available from meteorology modeling used for air quality modeling. This “SMOKE-MOVES” tool requires emission rate “lookup” tables generated by MOVES that differentiate emissions by process (running, start, vapor venting, etc.), vehicle type, road type, temperature, speed, hour of day, etc. EPA used an automated process to run MOVES to produce emission factors by temperature and speed for “representative counties” to which every other county could be mapped. Using the MOVES emission rates, SMOKE selected appropriate emissions rates for each county, hourly temperature, SCC, and speed bin and multiplied the emission rate by activity (VMT or vehicle population) to produce emissions. EPA performed these calculations for every county, grid cell, and hour in the continental U.S.

See Section 4.6 of EPA’s 2011 v6.2 modeling platform TSD (EPA, 2015b) for further information on how onroad emissions were calculated and geographically allocated.

New Jersey provided updated 2011 activity data for 15 counties. New 2011 onroad emissions were estimated based on the revised 2011 activity data using the EMF SMOKE MOVES tool. The USEPA representative county emissions factors were unchanged.

## 2.6. FIRES

Fire sources in this section are sources of pollution caused by the inadvertent or intentional burning of biomass including forest, rangeland (e.g., grasses and shrubs), and agricultural vegetative residue. This sector is specifically categorized into three sub-sectors: wildfires, prescribed burning, and agricultural burning. Other types of fires, such as residential wood combustion and yard waste/refuse burning, are included in the nonpoint sector.

EPA uses the SMARTFIRE2 system together with local activity data (acres burned, types of fuels, fuel consumption values, etc.) to make emission estimates for both wild and prescribed

fires. All S/L/T agencies in the Northeast relied upon EPA's SMARTFIRE methodology for estimating emissions for wild and prescribed fires.

Most of the S/L/T agencies in the Northeast relied upon EPA's methodology for calculating emissions from agricultural burning activities. The EPA method relies mainly on satellite-based methods to develop the burned area and then uses an assigned crop type to estimate final emissions.

See Section 5 of EPA's 2011 NEIv2 TSD (EPA, 2015a) for further information on how emissions were calculated and geographically allocated.

## **2.7. BIOGENIC SOURCES**

Biogenic emission sources are emissions that come from natural sources. They must be accounted for in photochemical grid models, as most types are widespread and ubiquitous contributors to background air chemistry. Biogenic emissions from vegetation and soils are computed using a model that utilizes spatial information on vegetation, land use and environmental conditions of temperature and solar radiation. The model inputs are typically horizontally allocated (gridded) data, and the outputs are gridded biogenic emissions that can be speciated and utilized as input to photochemical grid models.

BETA2 has Biogenic emissions from BEIS 3.61 (2011 v6.3 modeling platform); this is an update from 2011NEIv2 which uses 3.60.

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. The 12-kilometer gridded hourly data are summed to monthly and annual level, and are mapped from 12-kilometer grid cells to counties using a standard mapping file.

See Section 6 of EPA's 2011 NEIv2 TSD (EPA, 2015a) for further information on how emissions were calculated and geographically allocated.



### 3. FUTURE YEAR INVENTORY DEVELOPMENT

#### 3.1. Overview of Inventory Projection Methodology

Projection of emissions to future years is key to air quality technical and policy support work. S/L/T agencies consult with MARAMA, ERTAC, and EPA to prepare emission projections reflecting anticipated changes in future activities such as energy use, employment, population growth, VMT and new air pollution control measures. The future year projection methodologies vary by inventory sector. Figure 3 provides an overview of the emission projection methodology used for each source sector.

**Figure 3: Overview of Emission Projection Methodology for Each Source Sector**

MARAMA Sector	Emission Projection Methodology
ERTAC EGUs (Section 3.2)	Uses ERTAC EGU Forecasting Tool: <ul style="list-style-type: none"> <li>• Uses 2011 hourly emissions as the starting point</li> <li>• Applies regional projections of electric generation growth using Annual Energy Outlook 2015 and North American Reliability Council growth rates</li> <li>• Accounts for known future shutdowns, new units, emission controls, and fuel switches</li> <li>• Ensures available capacity is matched to projected demand</li> <li>• Ensures unit capacity is never exceeded</li> <li>• Uses base year activity as the profile for future activity</li> <li>• Calculates hourly future year emissions for each unit</li> </ul>
Other Point Sources (Section 3.3)	Uses MARAMA-developed projection and control factors within the Emission Modeling Framework tool: <ul style="list-style-type: none"> <li>• Uses 2011 annual emissions as the starting point</li> <li>• Applies national, regional, or local projections of surrogate activity parameters (fuel use, employment, population, etc.)</li> <li>• Accounts for emission reductions from national rules</li> <li>• Accounts for emission reductions from Ozone Transport Commission model rules that have been implemented by the States</li> <li>• Accounts for emission reductions from consent decrees and settlements</li> <li>• Accounts for emission reductions from other State-specific emission control programs</li> <li>• Calculates annual future year emissions</li> </ul>
Nonpoint Sources (Section 3.4)	
Other Nonroad Sources (Section 3.5)	
Nonroad – NONROAD Model (Section 3.6)	Uses EPA's NONROAD model: <ul style="list-style-type: none"> <li>• Uses USEPA v6.2 files for 2017</li> <li>• Accounts for increases in activity (based on NONROAD model default growth estimates of future-year equipment population)</li> <li>• Accounts for changes in fuels and engines that reflect implementation of national regulations that impact each year differently due to engine turnover</li> <li>• Accounts for local control programs and other parameters</li> <li>• Calculates monthly exhaust, evaporative and refueling emissions by county</li> </ul>
Onroad – MOVES Model (Section 3.7)	Uses EPA's SMOKE-MOVES model: <ul style="list-style-type: none"> <li>• Uses 2014a MOVES CB05 chemistry emission factors developed by USEPA in Spring 2016</li> <li>• Activity data was updated to include corrections to 15 New Jersey counties</li> <li>• Accounts for increases in vehicle miles travelled as projected by USEPA v6.2</li> <li>• Accounts for changes in fuels and engines that reflect implementation of national regulations that impact each year differently due to engine turnover and fuel requirements</li> <li>• Accounts for local control programs and other parameters</li> <li>• Calculates hourly exhaust, evaporative and refueling emissions by grid cell</li> </ul>
Fire Events	Uses NEI2011v2 inventory for all future projections, including 2017 (e.g., assumes no change from

MARAMA Sector	Emission Projection Methodology
(Section 3.8)	the base year)
Biogenic (Section 3.9)	Uses BEIS v3.6.1 2011 inventory for all future projections including 2017 (e.g., assumes no change from the base year)

S/L/T agencies, in consultation with ERTAC and MARAMA, developed two new and innovative emission projection methodologies and tools for this round of inventory projections. The first is the ERTAC EGU Forecasting Tool. The second is a set of growth and control factors used within the Emission Modeling Framework (EMF) to project emissions for most source sectors.

MARAMA uses the **ERTAC EGU Forecasting Tool** (ERTAC, 2015) to project electricity generation and emissions from EGUs. Development of the Tool was a collaborative effort among the Northeastern, Mid-Atlantic, Southeastern, and Lake Michigan area states; other member states; industry representatives; and multi-jurisdictional planning organization representatives. The methodology calculates future emissions of NO<sub>x</sub> and SO<sub>2</sub> based on projections of future generation, the 2011 base year emission rates, and known future year emission controls, fuel switches, retirements, and new units. The future year emissions for other pollutants (CO, NH<sub>3</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, and VOC) are calculated using generation projections from the ERTAC tool and a file of emission factors for each unit. Section 3.2.1 describes the ERTAC forecasting tool, while Section 3.2.2 documents how emission factors were established for pollutants other than NO<sub>x</sub> and SO<sub>2</sub>.

MARAMA is using the **Emissions Modeling Framework (EMF)** software system to manage and assure the quality of emissions inventories and emissions modeling-related data. One of the modules within the EMF system is the Control Strategy Tool (CoST) module (UNC, 2013), which is used to project emissions for future years using growth and control factors developed specifically for this effort. The CoST module required the following inputs needed to project a base-year inventory to a future-year inventory:

- A set of parameters that control how the strategy is run
- One or more emissions inventory datasets
- Projection Packet(s) to specify growth factors or other inventory adjustments
- Plant Closure Packet(s) to identify facilities, emission units or processes to close
- Control Packet(s) to specify specific emission control factors

The EMF CoST module applies the projection and control factors to the base year emission estimates to create the projected inventory.

To facilitate S/L/T agency review of the factors contained in the EMF Projection Packets, **User-Friendly Multi-Year Projection Factor Calculation Spreadsheets** were developed to provide surrogate growth parameters, match growth parameters to inventory records, and configure growth factors into the required EMF format. The spreadsheets flexibly allow users to select base or future years other than 2011 and 2017. The spreadsheets then compute the projection factors for the selected combination.

There are multiple projection spreadsheets, one for each nonpoint and nonEGU point subsectors. The spreadsheets allow the user to create a projection packet for any combination of base year and future year for the 2007 to 2040 period. Each spreadsheet contains four tabs:



- The “**General Methodology**” tab outlines the general data sources and methodology used and defines the individual columns of the remaining three tabs.
- The “**Growth Raw Data**” tab provides the surrogate growth parameter data for all years from 2007 to 2040, along with code that uniquely defines each surrogate parameter and a brief description of the source of the surrogate data.
- The “**NEI to Growth Factor XWALK**” tab maps a specific facility or emission process to one of the surrogate growth parameters. We obtained the list of facilities and emission processes from the NEI2011v2. Since the states may be using a base year inventory other than 2011 or doing projections for future years other than 2017, there is a function that allows users to select the base year and the future year to compute the projection factor for that combination of years. There is also a function to cap the growth factor to prevent unreasonably low or high growth.
- The “**EMF Projection Packet**” tab re-configures the previous tab into the EMF *Table Format for Projection Packet Extended Dataset Type*. The user must export this tab to a comma-separated-value (.csv) file for input to the CoST module.

Sections 3.3, 3.4, and 3.5 provide a detailed discussion of the surrogate parameters used to project emissions for the other point, nonpoint, and other nonroad sectors.

In addition to the EMF Projection packets created from the projection spreadsheets, we also assembled **EMF Closure and Control packets**. The Closure packet identifies facilities and/or emission processes scheduled to close sometime after 2011. The packet also includes the date of the closure. Except where a state elected to retain a source's closure emissions for offsets emissions from closed facilities and/or emission processes are set to zero after the effective date of the closure. A detailed discussion of closure packets and offset files is provided in Section 3.3.2.

Control packets include the effect on emissions of a variety of national, regional, and state rules, regulations, consent decrees and settlements obtained from the EPA control packets as well controls and rules specific to the 15 states covered by this inventory. States reviewed and revised the EPA control packets and made adjustments. Sections 3.3.3 provide a detailed discussion of the modifications made to the EPA federal measures control packets rules.

In addition to the EPA control factors, we developed control factors to account for state implementation of OTC and MANE-VU emission control recommendations as well as for state-specific rules. Section 3.3.5 provide a detailed discussion of the OTC, MANE-VU and state-specific rules.

### 3.2. ERTAC EGU Emissions

The ERTAC projection tool was developed by S/L/T agencies under the direction of the Eastern Regional Technical Advisory Committee (ERTAC) as an alternative EGU modeling approach that is more appropriate for use in SIP modeling.

The Tool uses base EPA Clean Air Markets Division (CAMD) data and fuel specific growth rates developed from primarily Energy Information Agency (EIA) and National Energy Reliability Corporation (NERC) data to estimate future activity and emissions. The tool uses base year activity as contained in the CAMD files as a pattern for future activity, so that the

future year temporal activity profiles match the modeled meteorology. Generation and emissions are collected by continuous emission monitors (CEM) located at facilities and electronically reported to CAMD. Seasonally averaged base year emission rates for SO<sub>2</sub> and NO<sub>x</sub> (lb/mmBtu) are calculated from this data. Future emission rates are developed from base year emission rates adjusted to account for state knowledge of known future year emission controls, fuel switches, retirements, and new units.

Expected changes in generation are estimated based on EIA Annual Energy Outlook (AEO) projections of future regional generation and the National Energy Reliability Corporation (NERC) regional peak growth rates. This information is available by region and fuel type. Future generation by unit is estimated by combining these data files with a table of state knowledge of unit changes. Hourly future emissions of NO<sub>x</sub> and SO<sub>2</sub> are calculated by multiplying hourly projected future generation by future emission rates.

Future unit generation rates, NO<sub>x</sub> and SO<sub>2</sub> emissions are estimated directly by the ERTAC tool. This output is then post-processed to develop emissions estimates for other pollutants needed for air quality modeling. Section 3.2.1 provides background on inputs, Section 3.2.2 describes the model runs used for this BETA2 inventory, while Section 3.2.3 documents how the ERTAC tool results were used in air quality modeling.

### 3.2.1. ERTAC EGU Inputs

The ERTAC EGU Tool input files are built by the ERTAC committee from a wide variety of existing data. The Tool uses the base year CEM data as a starting point. The CEM data includes hourly emissions variability resulting from a number of factors, including variability in **emission rate** due to changes in fuel quality, control device performance, and other site specific factors as well as variability in **emissions due to change in load**. Emission rate changes are not preserved in the final modeling files. Rather an average Ozone Season and Non-Ozone season rate are used. Therefore, to estimate base year 2011 emissions on the same basis as future year emissions, the ERTAC tool was run where Future Year = Base Year = 2011 to estimate 2011 emissions. For the base year run growth factors were set to 1 and retirements and fuel switches were removed. This allowed the code to project a “future” year that is aligned with the base year (2011).

Input files are subject to periodic quality assurance and updating by S/L/T agency staff. In addition, S/L/T agencies provide information on new units, new controls, fuel switches, shutdowns and other unit-specific changes. Periodic updates of these input files drives creation of new run versions.

ERTAC EGU Tool input files are as follows:

- **Base Year Hourly CEM data** – This file contains hourly generation and emissions data extracted from EPA’s CAMD database. In unit-specific situations where base year hourly data needs modification, the tool allows the user to provide a nonCAMD hourly file, which may be used to adjust or add data to the base year hourly CEM file.
- **Unit Availability File (UAF)** – This file is a table of base year unit specific information derived from CAMD NEEDS database, state input, EIA Form 860, and NERC data. This file is maintained by the ERTAC committee and provides information on changes to specific units from the base year to the future year. For example, the UAF captures actual or planned

changes to utilization fractions, unit efficiency, capacity, or fuels. S/L/T agencies have also added information on actual and planned new units and shutdowns.

- **Control File** – This file contains a table of known future unit specific changes to SO<sub>2</sub> or NO<sub>x</sub> emission rates (in terms of lbs/mmBtu) or control efficiencies (for example, addition of a scrubber or selective catalytic reduction system). This information is provided by S/L/T agency staff. This file also provides emission rates for units that did not operate in the base year. Controls can be differentiated seasonally, monthly, weekly, or using other time spans. For example, a unit may employ more effective controls during the ozone season.
- **Seasonal Controls File** – This optional file may be used by S/L/T agencies to enter seasonal or periodic future year emissions rates for specific units such that the information is used in all future year runs. This file may be used in addition to, or as an alternative to, the Control File.
- **Input Variables File** – A table of variables used in the modeling run. Regions and fuels are not hardwired into the model. Rather, the regions and their characteristics are specified in the Input Variables File. This file allows the S/L/T agencies to specify variables such as the size, fuel type and location for new units. In addition, the regional scheme and fuel types are specified in this file.
- **Growth Factor File** – A table of growth factors developed from the EIA Annual Energy Outlook (AEO) and NERC estimates. Electrical generation growth is delineated by geographic region and generating unit type.

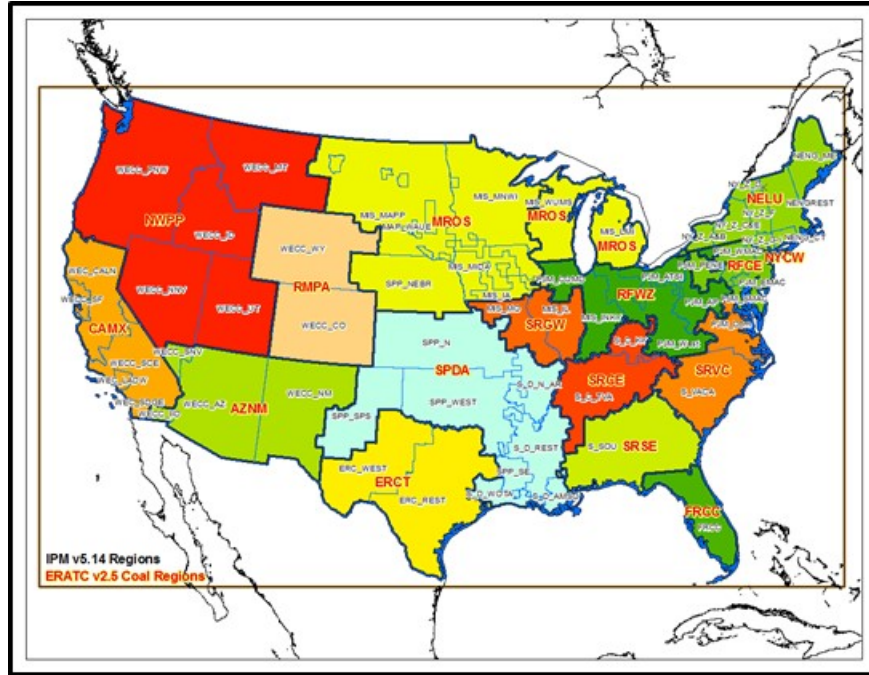
### 3.2.2. ERTAC EGU Tool Background

Each electricity generating unit included in the model is assigned to a geographic region and fuel type bin in the Unit Availability File. The five fuel types in current use are as follows:

- Coal;
- Oil;
- Natural Gas – Combined Cycle;
- Natural Gas – Single Cycle;
- Natural Gas – Boiler gas.

The geographic regional system currently in use is a modified version of the EIA Electricity Market Module (EMM) regional system. The regional system in use for coal is shown in Figure 4. Slightly different boundaries are used for other fuel types.

**Figure 4: Regional boundaries for coal generation, CONUSv2.5L2 which are based on the Electricity Market Module (EMM) Regions**



The EIA and NERC regional systems are not identical, so an adjustment is required to align these regional systems to develop annual and peak growth rates. To match EIA and NERC, a “best fit” NERC regional growth factor is assigned to each EMM region. In the simplest case, where a clear match between EIA and NERC regional schemes exists, for example NPCC-New England, the NERC peak growth rate is assigned to the corresponding EMM region. In more complicated cases, where multiple NERC regions corresponded to a single EMM region, or where regions were organized along substantially different geographic boundaries, the NERC peak growth factors were averaged to generate a growth factor for the (usually larger) corresponding EMM region. As an example, the EIA CAMx region corresponds to two NERC regions, WECC-CALN and WECC-CALS. In this case, the WECC-CALN and WECC-CALS growth factors TTTTT were averaged and applied to the EIA-CAMx region. The resulting assignments are shown in Figure 5.

**Figure 5: EMM to NERC Crosswalk – ERTAC EGU V2.5L2**

EMM Region Number	Fuel	EMM Region Name	ERTAC Regional Code	Single "Best-Fit" NERC Subregion Peak Growth Code
1	Coal, NG, Oil	Texas Regional Entity (ERCT)	ERCT	ERCOT
2	Coal, NG, Oil	Florida Reliability Coordinating Council (FRCC)	FRCC	FRCC
3+4+10	Coal, NG, Oil	MROW (3), MROZ (4) & RFCM (10) from previous runs were combined to form MROS.	MROS	MRO-MAPP / MISO /SPP
5+7+8	Coal, NG, Oil	Northeast Power Coordinating Council / Northeast (NEWE), Upstate New York (NYUP), and Long Island (NYLI) combined to form NELU	NELU	NPCC - NE
6	Coal, NG, Oil	Northeast Power Coordinating Council / NYC Westchester (NYCW)	NEWW	NPCC - NY
9	Coal, NG, Oil	Reliability First Corporation / East (RFCE)	RFCE	PJM / SERC - E
11 (adjusted)	Coal, NG, Oil	Reliability First Corporation / West (RFCW adjusted to move Michigan plants to MROS)	RFWZ	PJM / SERC - E
12	NG, Oil	SERC Reliability Corporation / Delta (SRDA)	SRDA	MRO-MAPP / MISO /SPP
13	Coal, NG, Oil	SERC Reliability Corporation / Gateway (SRGW)	SRGW	MRO-MAPP / MISO /SPP
14	Coal, NG, Oil	SERC Reliability Corporation / Southeastern (SRSE)	SRSE	SERC - SE
15	Coal, NG, Oil	SERC Reliability Corporation / Central (SRCE)	SRCE	MRO-MAPP / MISO /SPP
16	Coal, NG, Oil	SERC Reliability Corporation / Virginia Carolina (SRVC)	SRVC	PJM / SERC - E

EMM Region Number	Fuel	EMM Region Name	ERTAC Regional Code	Single "Best-Fit" NERC Subregion Peak Growth Code
17+18	Coal, NG, Oil	Southwest Power Pool / North (SPNO) + South (SPSO)	SPPR	MRO-MAPP / MISO /SPP
12+17+18	Coal	Southwest Power Pool / North (SPNO) + South (SPSO) + Delta (SRDA)	SPDA	MRO-MAPP / MISO /SPP
19	Coal, NG, Oil	Western Electricity Coordinating Council / Southwest (AZNM)	AZNM	WECC-WECC-SWSG
20	Coal, NG, Oil	Western Electricity Coordinating Council / California (CAMX)	CAMX	WECC-CAMX US
21	Coal, NG, Oil	Western Electricity Coordinating Council / Northwest Power Pool Area (NWPP)	NWPP	WECC-NWPP US
22	Coal, NG, Oil	Western Electricity Coordinating Council / Rockies (RMPA)	RMPA	WECC-WECC-RMRG

Expected future generation by fuel type are provided by EIA in their annual energy outlook (AEO). Annual average regional growth factors are calculated by dividing AEO future year by base year generation. The NERC peak growth rates are not delineated by fuel so each fuel has the same peak growth factor. The tool uses these growth files to estimate hourly growth factors for each region and fuel type which account for regional average and peak growth and unit shutdowns. The tool then applies the hourly growth factors to the hourly base year hourly generation data to estimate hourly future generation.

The tool confirms that unit capacity is never exceeded. Future generation is assigned to units as long as they have capacity available. New units are created if future demand exceeds known unit capacity for a region. These new units are termed Generation Deficit Units (GDU). Adjustments to a variety of inputs are made, in consultation with state agency staff, to avoid GDU creation.

**NO<sub>x</sub> and SO<sub>2</sub> Emissions** - Base year emission rates for existing units are adjusted to account for new control equipment or other changes provided in the input files. New unit emissions, for which states do not provide emission rate data, are estimated based on the 90th percentile best performing existing unit for that fuel type and region. These rates are applied to each unit's future generation to calculate NO<sub>x</sub> and SO<sub>2</sub> emissions.

**Output** – The ERTAC tool generates files of hourly generation and emissions for each unit included in the system. In addition, summary files of this hourly data are generated, to facilitate review of the results, as follows:



- Base and future year annual generation (MW-hrs) and heat input (mmbtu)
- Base and future year ozone season generation and heat input
- Base and future year annual NO<sub>x</sub> emission (tons) and average emission rate (lbs/mmbtu)
- Base and future year ozone season NO<sub>x</sub> emission and average emission rate
- Base and future year annual SO<sub>2</sub> emissions and average emission rate

**Run Documentation** - The ERTAC EGU committee maintains and distributes reference runs for the continental United States (CONUS), including the hourly input and output files, summary files, and a documentation file for each run. These reference runs and complete documentation of the ERTAC Forecast Tool is located on the MARAMA web site. (ERTAC, 2015)

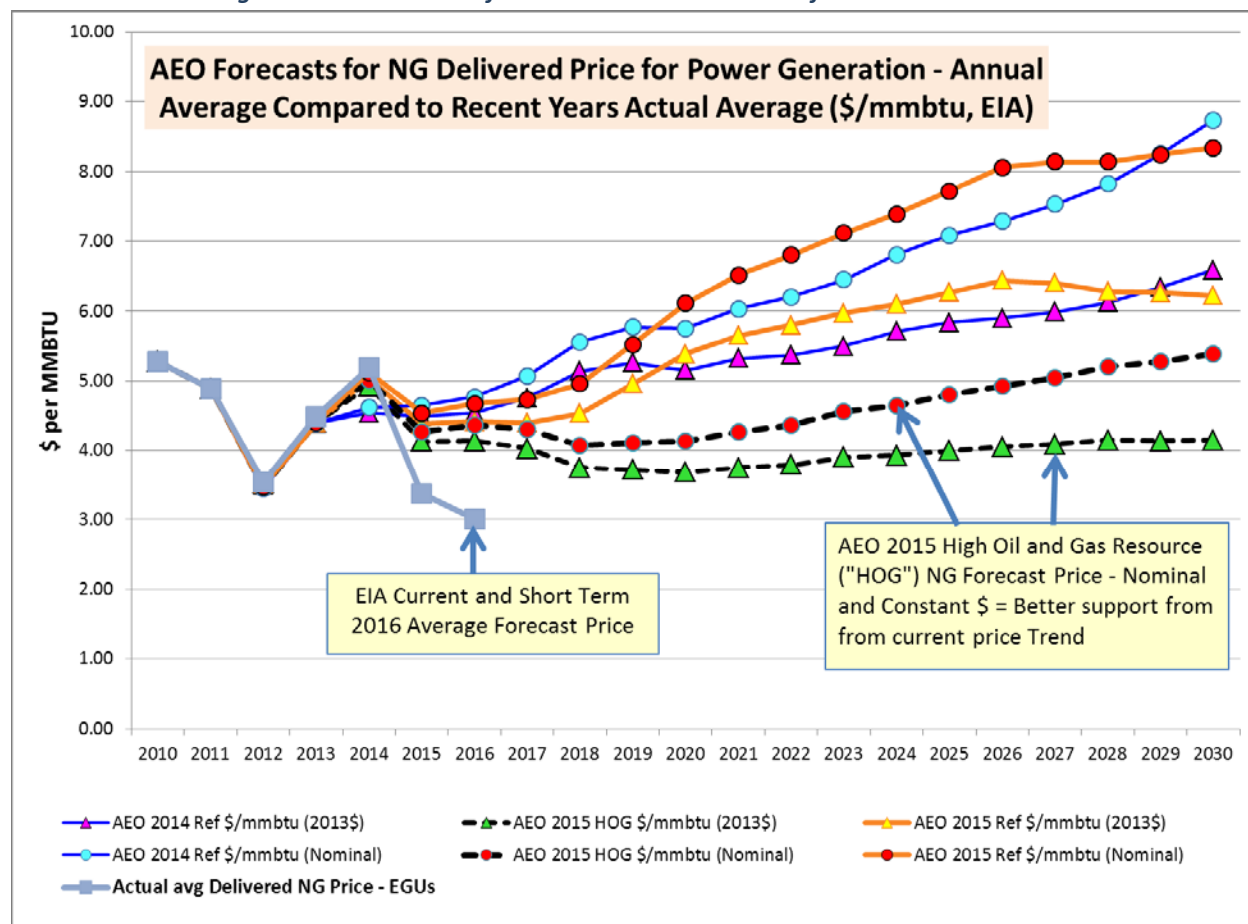
While both ERTAC EGU and IPM project emissions from EGUs, the units included in each model are not identical. The ERTAC EGU tool includes units that report their emissions to CAMD at an hourly resolution. These are generally fossil fuel fired units serving a generator of at least 25 MW. The IPM model starts with units in the NEEDS database, which is a larger universe of sources that use fossil fuels including many fossil fuel units smaller than 25 MW, as well as renewable fuels and includes non-emitting power sources such as nuclear and hydro-electric generating units. Therefore, to use the ERTAC EGU tool in the context of the other USEPA inventory files, the point source inventory must be re-partitioned to avoid either double counting or gaps in the inventory.

### **3.2.3. ERTAC EGU Tool –Continental United States (CONUS) V2.5L2**

This BETA2 inventory used EGU estimates from the ERTAC EGU CONUS v2.5L2 runs complete in August, 2016 using input file updates for northeast states current as of August 2016. When building the growth factors, the ERTAC Growth committee typically uses the EIA AEO reference case, as EIA considers the reference case to be the most likely projection. However, for v2.5L2 the ERTAC Growth committee chose to use AEO2015 High Oil and Gas Scenario.

**3.2.3.1. Rational for the Selection of the High Oil and Gas Resource Scenario for AEO2015**  
The ERTAC EGU Growth committee evaluated the AEO2015 reference case forecasts and found that it projected higher use of coal than AEO2014 across the entire projection period (2016-2040). This at a time when shorter term macro forecasts (including EIA's) indicate continued transition toward natural gas generation. An important assumption which drives fuel choice is fuel price. In the AEO2015 reference higher coal usage was driven by a forecast of higher natural gas prices for electric generation than AEO2014. The predicted price is more than double the recent actual price pattern and is a reversal of the generally declining prices noted for the power sector since 2008. Figure 6 shows the current price of natural gas, (bold blue line) which is lower than either the AEO 2014 or 2015 reference case or the High Oil and Gas Scenario.

Figure 6: AEO Forecast of Natural Gas Delivered Price for Power Generation



The ERTAC growth committee created test runs based on the AEO2015 reference case. Included in these tests were the 65,000 MW of planned coal unit retirements from 2011-2018 that stakeholders have reported via the ERTAC feedback process. These tests resulted in the creation of 12,000 MW of new coal capacity by 2023 which were unidentified and unplanned by stakeholders. This result occurred because after planned retirements of coal capacity there is no longer expected to be enough coal capacity in 2023 to produce the power predicted by the AEO2015 reference case. New coal units would have to be built to produce the power. This coal capacity shortfall showed up in both regions with coordinated ISO planning/markets as well as regions with less competitive wholesale supply. The ERTAC Growth and Implementation Committee feels that a major expansion of coal generation capacity is unlikely in the current power system environment. We attempted to mitigate the “model creation” of new coal capacity by adjusting specific region peak vs. non-peak growth rates and unit operating profiles. This did not resolve the problem.

Test runs using the High Oil and Gas growth factors revealed a better match to the expected fleet of available electric generating units. After working with both the reference and high oil and gas projection, the committee concluded that the High Oil and Gas projection was more realistic considering the fleet of generation units projected to be available now and in the future.



### 3.2.3.2. Region and fuel specific Growth Factor Adjustments

Adjustments to the EIA/NERC annual and peak growth factors were made for specific regions and fuel types as follows:

- EIA provides a single natural gas growth rate for each region. Because most growth in natural gas usage is combined cycle units, this factor was allocated to apply the growth to natural gas combined cycle unit types and “no growth” to single cycle and boiler gas unit types.
- Selected small regions were combined to allow generation growth to flow to units in the combined regions as follows:
  - **MROZ** is a region created by combining MROE with some units formerly in RFWZ. The units from RFWZ are WE Energies facilities located in the Upper Peninsula of WI and MI which participate in the MISO wholesale market. These units are integral to the WI utility system even though they were formally part of the Reliability First Council. The remaining RFCW units are renamed **RFWZ**. This change affects all fuels. Capacity in MROZ is nearly doubled which reduces levels of gas shortfall in future years and subsequent GDU formation and provides more realistic coal forecasts.
  - **SPDA** - Three AEO regions, **SRDA**, **SPPN** and **SPPS**, were aggregated for the coal fuel type only. These regions comprise Southwest Power Pool and SERC Delta (aka SERC West). Much of the aggregated region is linked or at least coordinated for reliability and power wholesaling into MISO and is referred to as MISO South. The primary utility causing the regional footprint adjustments is Entergy. It has one controlled grid connection with the rest of MISO and much better integration with SPP (OK and KS). Growth factors for the combined SPDA region were derived from a capacity weighted average of the three subregion.
  - **NELU** is a region created by combining all fuel unit types in NYUP, NYLI, NEWE and NYCWE. For clarification, NYWC remains a separate region. Peak forecasts from the two involved ISOs [NY-ISO and NE-ISO] are very similar and are relatively straightforward to allocate. The purpose of this consolidation is to deal with the very small coal facility growth patterns and to address gas and oil boiler GDU issues.

In general, local data is preferred. Therefore, EIA/NERC projections were replaced with factors based on Independent System Operators (ISO) or state data in the following regions within the states covered by the modeling inventory:

- **NYCW** – EIA/NERC growth projections for the NYCW region were replaced with factors provided by NYSDEC. These factors were developed based on NYISO projections.
- **SRVC** - For SRVC, EIA/NERC growth projections were replaced by those provided by a combined study approved by the air directors of SC, NC, VA, and WV. The Transition Points for combined cycle were set at 200 and 5000 to reflect the base load nature of combined cycle. The Transition Points were set at 10/2000 for boiler gas to push the huge increase into the middle range of the hours.

- **RFCM** - Boiler Gas, Combined Cycle, and Single Cycle annual and peak growth rates were updated.
- **SRSE** - Peak growth rates and transition were updated with local data.
- **MROS and RFWZ** - Growth based on a weighted average of combined sub-regional growth. Peak rates were limited to a maximum of 1.3.
- **CAMX** – Peak rates for Combined Cycle were set equal to the annual rates.
- **SRGW** - Peak growth rate for oil set to 2.0 to ameliorate an extreme value.
- **MROS, CAM, NWPP, RFWZ, SRCE, SRGW** - Combined Cycle peak growth rates were set to 1.3 to reduce the number of GDUs created solely for peak hour demand deficits based on LADCO, Wisconsin, and Michigan input.

**Figure 7: Summary of Inputs to ERTAC EGU v2.5L2 Model Run**

ERTAC File Name	Description	Run Notes
<b>OVERVIEW</b>	Version: 2.5	Run by ERTAC EGU leadership. Completed May 2016
	Code: 1.01	
	Base Year: 2011	Major update to UAF & Controls. State and stakeholder feedback. Submittal deadline: March 2016.
	Future Years: 2017, 2018, 2019, 2021, 2023, 2028, 2030	Major update to annual growth factors from EIA2014 to EIA2015, High Oil and Gas scenario (HOG). Peak growth based on NERC 2013
camd_hourly_base.csv	Hourly CAMD CEM data	No changes to the ertac_hourly_noncamd.csv file between 2.4 and 2.5.
ertac_hourly_noncamd.csv	Hourly CEM data replacing data in CAMD	CONUSv2.5_05052016_ertac_hourly_noncamd.csv
ertac_initial_uaf.csv	Unit Availability File	CONUSv2.5ref_20XX_05052016_ertac_initial_uaf.csv
ertac_control_emissions.csv	Annual Control File	CONUSv2.5ref_20XX_05052016_ertac_control_emissions.csv
ertac_seasonal_control_emissions.csv	Seasonal Control File	C1.01CONUSv2.5_20XX_ertac_seasonal_control_emissions.csv
	Seasonal controls provided by GA and PA (Brunner Island Units 1, 2 & 3 have lower NOX and SO2 rates during the ozone season to represent NG firing.)	
ertac_growth_rates.csv	Growth Files (XX denotes year, example 17 = 2017)	CONUSv2.5ref_20XX_05052016_ertac_growth_rates.csv
	<b>ANNUAL GROWTH</b> rates spreadsheet supplied by T. Shanley of MI DEQ called AEO2015 ESD2015 GRs.xlsx. Adjustments to AEO Growth Rates for specific regions are as follows:	
		<b>MROS and RFWZ</b> annual growth rates provided by Bob Lopez (MI) as shown in spreadsheet FullTranslationWI_Regions_AdjustmentAEO2014.xlsx,
		<b>SRVC</b> - Peak and annual growth rates supplied by NC in 6/30/2015 memo from SC, NC, VA and WV air directors to LADCO.
		<b>NYCW</b> - 2017 GRs supplied by NY in memo to MARAMA dated 2-11-2016. 2018, 2019, 2021, 2023, 2028, and 2030 GRs supplied by NY in memo to MARARA dated 3-31-2016.
	<b>PEAK GROWTH</b> Rate spreadsheet supplied by T. Shanley (MI) called Gas_Adj_AEO2014_NERC2013 Growth Rates v4 method 1 and method2.xlsx, tab Gas-Adj Ref 2014 M1. Exceptions to NERC2013:	
		<b>SRGW</b> peak growth rate for oil was set to 2.0 to ameliorate an extremely high peak rate, per LADCO.
		<b>SRSE</b> peak GRs and transition hours adjusted for Coal, CC, SC, BG as in Lopez (MI) email to Byeong Kim (GA) 7/20/2017 with subject "SRSE Peak Growth Rate Adjustments"
		<b>COMBINED CYCLE GAS</b> Amelioration of GDUs created solely for Peak hour demand deficits
		<b>MROS</b> combined cycle peak growth rate set to 1.3 and transition hours peak->formula set to 200, formula-> nonpeak set to 2000 based on LADCO, WI, and MI input. All other transition hours remain at default levels.
		<b>CAMX ; NWPP; RFWZ; SRCE; SRGW</b> Combined cycle gas peak 2028 GR set to 1.3 and transition hours set to 200 and 2000.
Regional Scheme	EMM to NERC Crosswalk	Version1
ertac_input_variables.csv	Input Variables File (XX denotes year, example 17 = 2017)	CONUSv2.5_20XX_05052016_ertac_input_variables.csv
group_total_listing.csv	Aggregation scheme for multi-state caps	C1.01CONUSv2.5_20XX_05052016_group_total_listing.csv
state_total_listing.csv	Aggregation scheme for state level caps	C1.01CONUSv2.5_20XX_05052016_state_total_listing.csv

#### 3.2.4. ERTAC to SMOKE Conversion

The outputs from the ERTAC EGU tool are converted to FF10 model inputs suitable for air quality modeling using the ERTAC to SMOKE tool. The tool adds hourly emissions for pollutants other than NO<sub>x</sub> and SO<sub>2</sub> and stack characteristics. We used the following data sources to develop emission factors for other pollutants for the ERTAC sources:

- The NEI2011v2 2011 annual emissions for criteria air pollutants and NH<sub>3</sub>.
- As described earlier, we and the S/L/T agencies developed a cross-reference file (Appendix A) to match units in the ERTAC UAF (Appendix B) with records in the NEI2011v2 for each of the jurisdictions covered by the Northeast regional emissions inventory.
- The EPA CAMD unit level file (Appendix C) contains data collected as part of EPA's emission trading programs. It contains descriptive information about emission units and period totals for heat input and CO<sub>2</sub>, NO<sub>x</sub> and SO<sub>2</sub> mass emissions. This inventory is referred to as CAMD2011. Most units are required to report data for the entire year, so that the period totals are annual totals. Other units reported data for less than 12 months, depending on when the unit began or ceased operation during 2011.
- The EPA AP-42 emission factor documents for natural gas, coal, fuel oil, and stationary gas turbines (Appendices D-G) which contains uncontrolled and controlled emission factors for criteria air pollutants for various types and sizes of combustion devices and fuel types.

The NEI2011v2 includes emission unit identifiers to link the units to the units in the CAMD2011 database and the units in the ERTAC UAF. Data elements from these three data sources were merged into a spreadsheet. States reviewed and improved these linkages and CSRA updated the linkages to redistribute the units in the NEI2011v2 into two groups: units included in the ERTAC methodology and all other units.

The methodology for calculating the emission factors varied depending on the availability of annual heat input:

- Full year reporters that have annual generation, heat input and SO<sub>2</sub>/NO<sub>x</sub> emissions available from the CAMD2011 database
- Partial year reporters that have less than 12-months of generation, heat input and SO<sub>2</sub>/NO<sub>x</sub> emissions data available in the CAMD2011 database
- New/proposed units and existing units that did not operate in 2011 (e.g., no heat input reported in CAMD2011)

Note that we did not calculate emission factors for units identified as "nonEGU" in the UAF since these units are not included in the ERTAC projections.

For full year reporters, we extracted the 2011 annual emissions of CO, NH<sub>3</sub>, PM<sub>10</sub>, PM<sub>2.5</sub> and VOC from the NEI2011v2. We also extracted the annual heat input from the CAMD2011 database. We calculated the emission factors using the following formulas:

$$EF_i \text{ (lbs/mmBtu)} = \text{TONS}_{2011_i} \text{ (tons)} * (2000 \text{ lbs/ton}) / \text{HI}_{2011\_CAMD} \text{ (mmBtu)}$$

Where:  $EF_i$  = Emission factor for pollutant  $i$

$\text{TONS}_{2011_i}$  = Annual 2011 emissions for pollutant  $i$  from NEI2011v2

$\text{HI}_{2011\_CAMD}$  = Annual 2011 heat input from CAMD2011

We used this formula when there was a one-to-one correspondence between a NEI2011v2 unit and a CAMD2011 unit. In a few cases, multiple CAMD2011 units were associated with a single NEI2011v2 unit. For example, CAMD2011 may have multiple identical combustion turbines listed individually with annual heat input for each turbine, whereas the NEI2011v2 has these same turbines grouped as a single emission unit with annual emissions representing the total emissions for all turbines in the group. For these cases, we calculated the term HI2011\_CAMD in the above equation as the sum of the heat input for all CAMD2011 units associated with the NEI2011v2 unit.

For partial full year reporters, the annual heat input was not available since the CAMD2011 only has heat input for the period that was reported. Most of these units either began operation in 2011 or ceased operation in 2011, so that the heat input for these units in effect represents the “annual” heat input. We extracted the 2011 annual emissions of CO, NH<sub>3</sub>, PM<sub>10</sub>, PM<sub>2.5</sub> and VOC from the NEI2011v2 annual emission inventory. We calculated the emission factors using the following formulas:

$$EF_i \text{ (lbs/mmBtu)} = \text{TONS2011}_i \text{ (tons)} * (2000 \text{ lbs/ton}) / \text{HI2011\_CAMD (mmBtu)}$$

Where:  $EF_i$  = Emission factor for pollutant  $i$   
 $\text{TONS2011}_i$  = Annual 2011 emissions for pollutant  $i$  from NEI2011v2  
 $\text{HI2011\_CAMD}$  = Period 2011 heat input from CAMD2011

For both existing and new units that did not operate in 2011, there is no heat input available to calculate emission factors. We extracted emission factors from AP-42 for the appropriate fuel type and combustion type, as shown in Figure 8. For three facilities that have experienced post-2011 fuel switches (BL England, Bremono Power Station, and Clinch River), we obtained unit-specific emission factors from the responsible state agency. For new facilities, we also solicited emission factors and stack parameters from states. For example, Virginia provided emission factors and stack characteristics for the combined cycle units at Warren and the coal-fired Virginia City Energy Center.

Figure 8: EPA Emission Factors from AP-42

Fuel / Unit Type	AP42 Reference	Pollutant	Emission Factor (lbs/mmBtu)
Coal – Dry-bottom Wall-fired	Table 1.1-3	CO	0.019
	Table 1.1-20	CO <sub>2</sub>	232
	n/a	NH <sub>3</sub>	n/a
	Table 1.1-6 (with cyclones)	PM <sub>10</sub> -PRI	0.388
	Table 1.1-6 (with cyclones)	PM <sub>25</sub> -PRI	0.023
	Table 1.1-19	VOC	0.0023
Diesel or Distillate Oil – Combustion Turbine	Table 3.1-1	CO	0.076
	Table 3.1-2a	CO <sub>2</sub>	157
	n/a	NH <sub>3</sub>	n/a
	Table 3.1-2a (assume all PM<2.5)	PM <sub>10</sub> -PRI	0.012
	Table 3.1-2a (assume all PM<2.5)	PM <sub>25</sub> -PRI	0.012
	Table 3.1-2a	VOC	0.0004
Natural Gas – Dry Bottom Wall-fired Boiler	Table 1.4-1 (controlled)	CO	0.082
	Table 1.4-2	CO <sub>2</sub>	118
	n/a	NH <sub>3</sub>	n/a
	Table 1.4-2 (assume all PM<2.5)	PM <sub>10</sub> -PRI	0.0075
	Table 1.4-2 (assume all PM<2.5)	PM <sub>25</sub> -PRI	0.0075

Fuel / Unit Type	AP42 Reference	Pollutant	Emission Factor (lbs/mmBtu)
	Table 1.4-2	VOC	0.0054
Natural Gas – Tangentially Fired Boiler	Table 1.4-1 (controlled)	CO	0.096
	Table 1.4-2	CO <sub>2</sub>	118
	n/a	NH <sub>3</sub>	n/a
	Table 1.4-2 (assume all PM<2.5)	PM <sub>10</sub> -PRI	0.0075
	Table 1.4-2 (assume all PM<2.5)	PM <sub>25</sub> -PRI	0.0075
	Table 1.4-2	VOC	0.0054
Natural Gas – Combustion Turbine and Combined Cycle	Table 3.1-1	CO	0.030
	Table 3.1-2a	CO <sub>2</sub>	110
	n/a	NH <sub>3</sub>	n/a
	Table 3.1-2a (assume all PM<2.5)	PM <sub>10</sub> -PRI	0.0066
	Table 3.1-2a (assume all PM<2.5)	PM <sub>25</sub> -PRI	0.0066
	Table 3.1-2a	VOC	0.0021

Emission factors for each unit and pollutant were reviewed to assess the reasonableness of each factor by comparing the calculated emission factors for each combustion/fuel type (e.g., simple cycle gas, tangentially coal-fired boiler). A few emission factors that were egregiously out-of-range were revised based on best engineering judgment. The results of the above calculations were provided to S/L/T for review and approval (see Appendix H). We formatted the emission factors into the ERTAC Control File format (see Appendix I).

### 3.3. PROJECTING EMISSIONS FROM OTHER POINT SOURCES

Emissions projections require accounting for both emissions changes resulting from change to sector activity and reductions resulting from the application of control programs.

#### 3.3.1. Sector Activity Change

S/L/T agencies use a variety of indicators as surrogates for future sector activity including projections for energy consumption, vehicle miles traveled, population and employment. While recognizing that these surrogates may not track exactly with emissions, states consider these surrogates to be the “best available” data for projecting emissions for non-EGU point sources.

In developing factors from these indicators, we followed, to the extent possible, EPA guidance (EPA2007) on developing emission projections for use with modeling attainment demonstrations for ozone, fine particles, and regional haze. Growth indicators were mapped to specific source classification codes as described later in this document. The following sections describe each growth indicator used to project sources.

##### 3.3.1.1. Energy Consumption Projections

Energy consumption projections from the U.S. Energy Information Administration (EIA) 2015 Annual Energy Outlook (AEO) (EIA2015) is the growth indicator used for most fuel burning sources. AEO 2015 presents long-term projections of energy consumption supply, demand, and prices through 2040, based on results from EIA’s National Energy Modeling System (NEMS). NEMS projects production, import, conversion, consumption, and price of energy, subject to assumptions on macroeconomic and financial factors, world energy markets, resource availability and costs, behavioral and technological choice criteria, energy technology cost and performance characteristics, and demographics.



AEO2015 provides regional fuel-use forecasts for various fuel types (e.g., coal, residual oil, distillate oil, natural gas, renewables) by end use sector (e.g., residential, commercial, industrial, transportation, and electric power). In addition, they provide a national projection of annual vehicle miles (VMT). AEO also accounts for most current laws and regulations, including those associated with air pollution control. Refer to the AEO web site for a complete description of the methodologies, data sources, and assumptions made by EIA in developing the energy projections.

AEO2015 projects energy use at census division level which groups states as follows:

- New England region includes CT, MA, ME, NH, RI and VT
- Mid-Atlantic region includes NJ, NY, and PA
- South Atlantic region includes DC, DE, MD, NC, VA and WV (as well as a few other states not in the MARAMA study area)

AEO2015 reference case projections were used for all sectors except ERTAC EGU where the High Oil and Gas Resource projection was used. The reference case is a business-as-usual trend estimates, given known technology and technological and demographic trends. Appendices J, K and L contain tables of AEO2015 reference case data for the three regions.

AEO2015 provides projection estimates for each year from 2012 to 2040. To develop complete growth tables from 2007 to 2011, actual data tabulated by EIA AEO were used to obtain energy consumption data as follows:

- AEO2014 for 2011 energy consumption data
- AEO2013 for 2010 energy consumption data
- AEO2012 for 2009 energy consumption data
- AEO2011 for 2008 energy consumption data
- AEO2010 for 2007 energy consumption data

While there are slight differences in the methods used to produce the earlier versions of AEO, the combined data set provides a cohesive data set covering all years from 2007 to 2040.

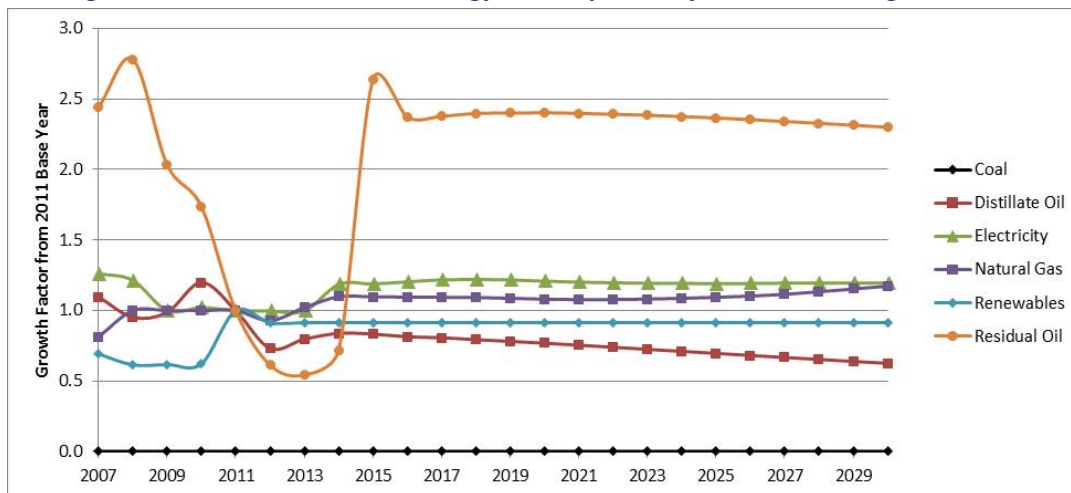
Figure 8 to Figure 11 show the AEO2015 projections for **commercial energy consumption** in the three regions. AEO projects increases in residual oil consumption in all three regions, which is unexpected and may require further investigation in states where residual oil is widely used in commercial facilities. Because of the uncertainty of the residual oil projection, states decided to use a “no growth” projection factor for commercial residual oil sources in all three AEO regions. AEO also projects declines in distillate oil consumption in all three regions compared to 2011 consumption. Coal consumption by commercial sources decreased from 2007 to 2011, but AEO projects coal consumption to remain relatively constant after 2011. AEO projects positive growth in natural gas consumption.

Figure 12 to Figure 14 show the AEO projections for **industrial energy consumption** in the three regions. In all three regions, AEO projects an upward trend in renewable energy and natural gas consumption, and relatively small changes in distillate. Residual oil consumption is projected to decrease in all three AEO regions between 2011 and 2020. In the Mid-Atlantic region, AEO projects small increases in coal consumption from 2012 through 2021 and a downward trend after 2021. AEO is projecting upward trend in industrial coal combustion in the South Atlantic region after 2011.

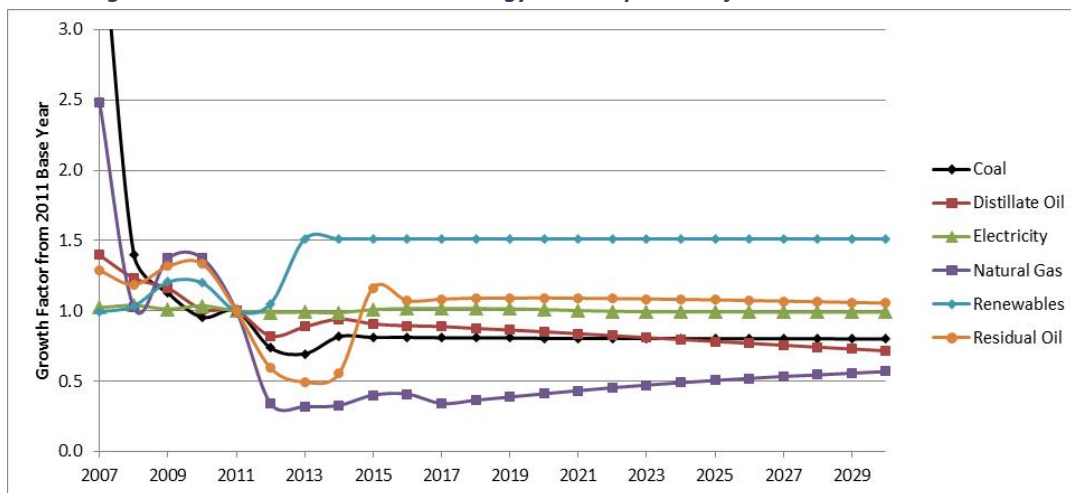


Figure 15 to Figure 17 show the AEO projections for **electric power energy consumption** in the three regions. We used these projections for EGUs that are not included in the ERTAC EGU forecasting tool. In New England, AEO projects increases in renewable fuel sources, dramatic decreases in distillate and residual oil consumption, and very little change in other fuel sources. In the Mid-Atlantic region, AEO projects dramatic decreases in residual oil consumption, virtually eliminating its use by 2019. Other fuels are projected to have modest changes compared to 2011. In the South Atlantic region, AEO projects large decreases in residual oil consumption and significant increases in renewable energy sources.

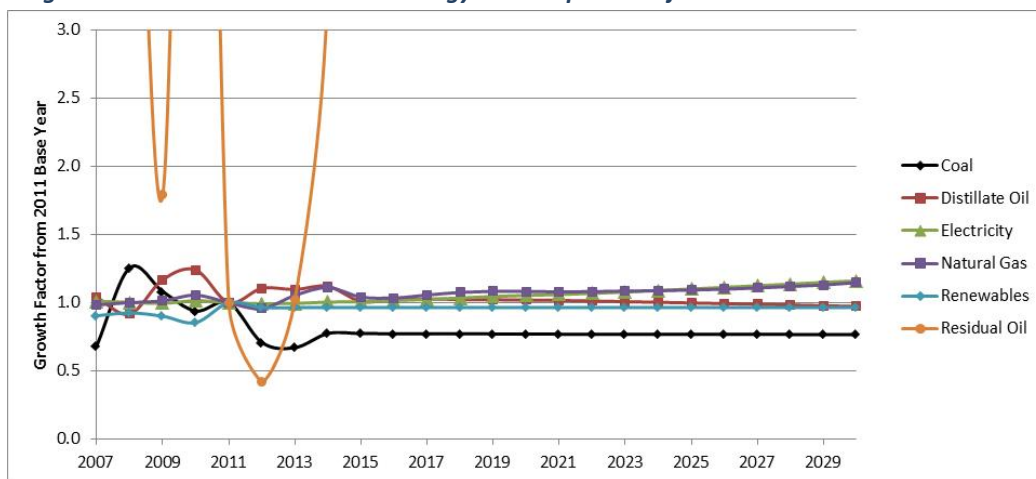
**Figure 9: AEO 2015 Commercial Energy Consumption Projections – New England States**



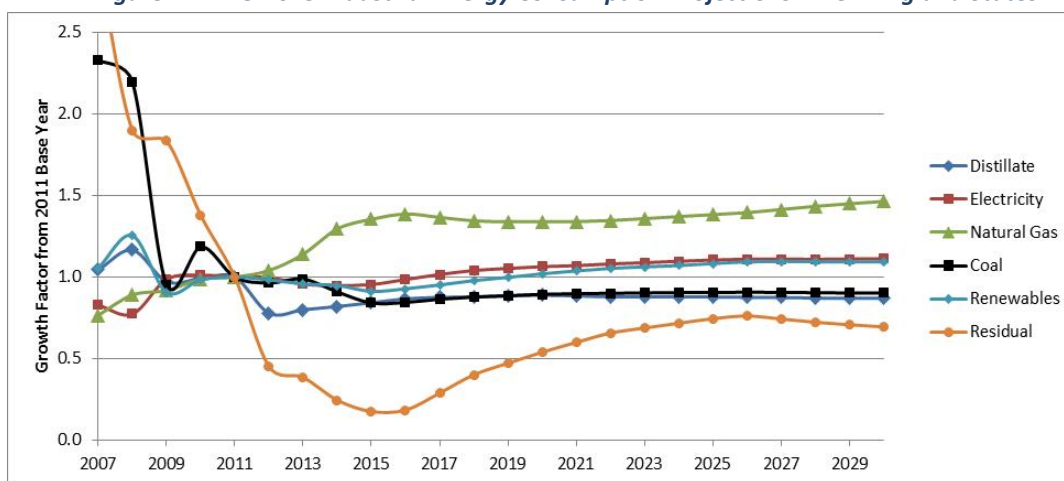
**Figure 10: AEO 2015 Commercial Energy Consumption Projections – Mid-Atlantic States**



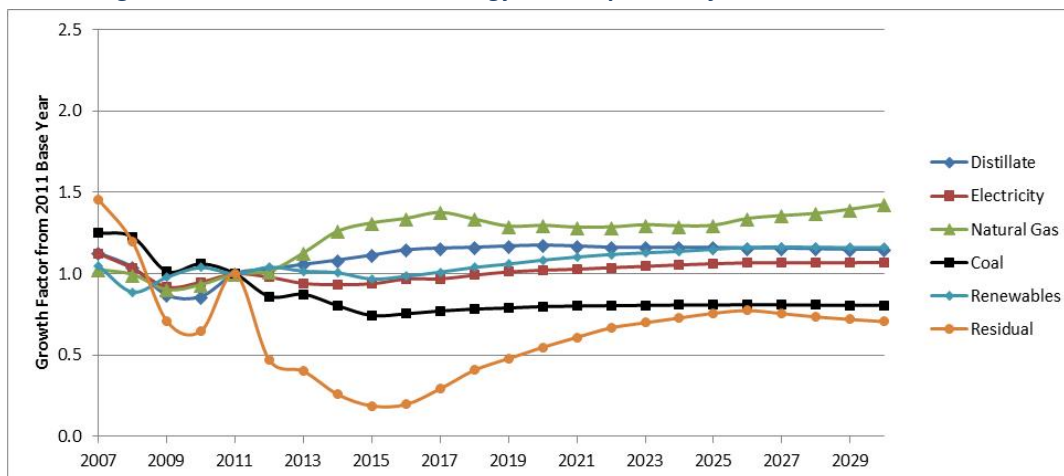
**Figure 11: AEO 2015 Commercial Energy Consumption Projections – South-Atlantic Jurisdictions**



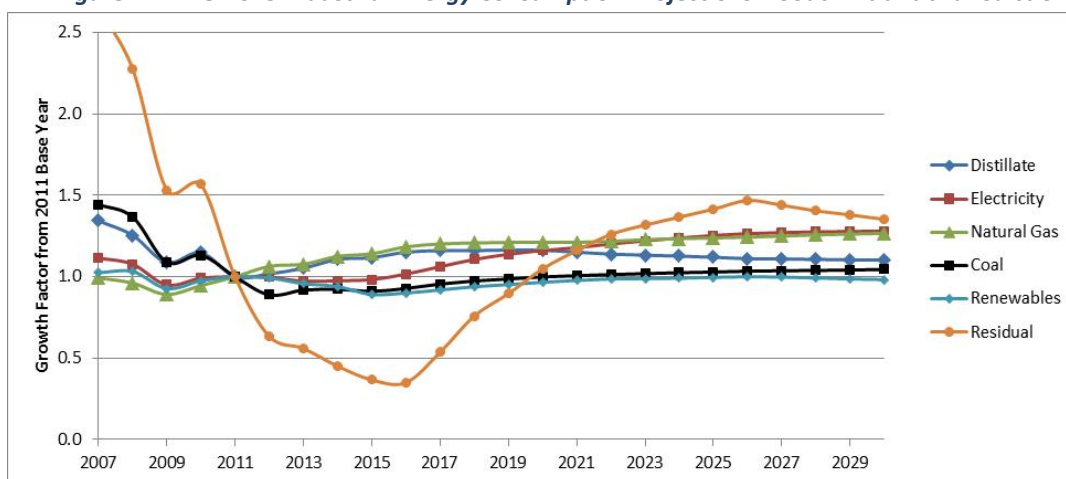
**Figure 12: AEO 2015 Industrial Energy Consumption Projections – New England States**



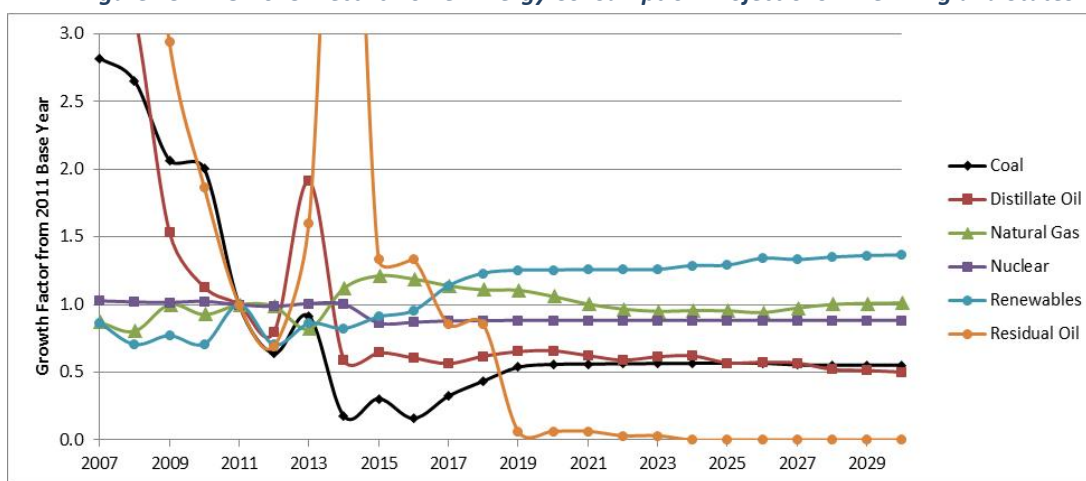
**Figure 13: AEO 2015 Industrial Energy Consumption Projections – Mid-Atlantic States**



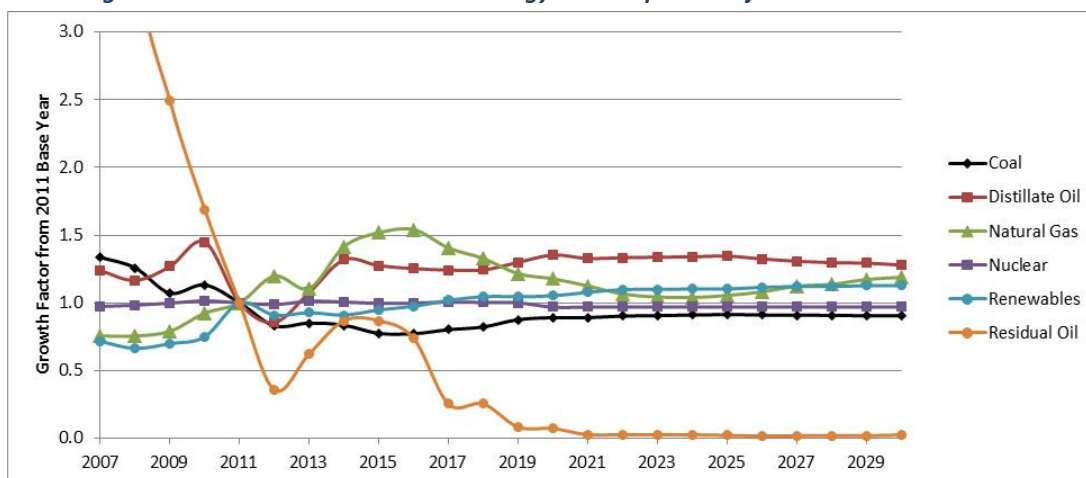
**Figure 14: AEO 2015 Industrial Energy Consumption Projections – South-Atlantic Jurisdictions**



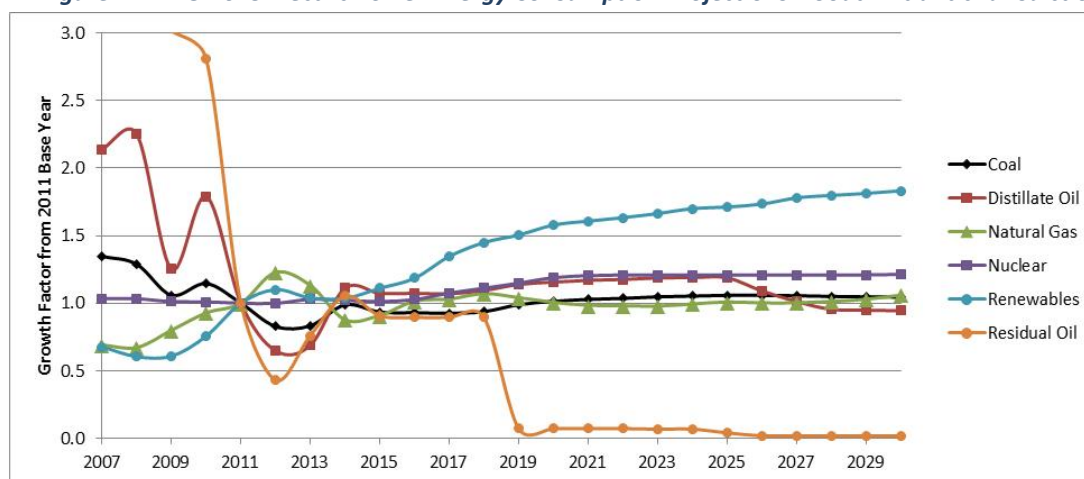
**Figure 15: AEO 2015 Electric Power Energy Consumption Projections – New England States**



**Figure 16: AEO 2015 Electric Power Energy Consumption Projections – Mid-Atlantic States**



**Figure 17: AEO 2015 Electric Power Energy Consumption Projections – South-Atlantic Jurisdictions**



### 3.3.1.2. Employment Projections

We obtained employment projections by 3- or 4-digit NAICS code from each state using the references shown in Figure 18 (also included as Appendix M). Every two years, each individual state department of labor produces long-term industry employment forecasts for 10 years into the future. The employment projections are available by state and Workforce Investment Areas (individual counties or groups of counties). For most states, the most recent data are for two years - 2010 and 2020. Massachusetts provided employment data for 2012 and 2022. Massachusetts provided employment data for 2012 and 2022.

**Figure 18: Employment Data Sources**

State	Reference
CT	2010 and 2020 statewide data from Department of Labor Office of Research's <i>State of Connecticut Occupational Projections: 2010-2020</i> ; retrieved 10/3/13 from: <a href="http://www1.ctdol.state.ct.us/lmi/projections.asp">http://www1.ctdol.state.ct.us/lmi/projections.asp</a>
DC	2010 and 2020 statewide data from Department of Employment Services' <i>DC Industry and Occupational Projections 2010-2020</i> ; retrieved 10/3/13 from: <a href="http://does.dc.gov/publication/dc-industry-and-occupational-projections-2010-2020">http://does.dc.gov/publication/dc-industry-and-occupational-projections-2010-2020</a>
DE	2010 and 2020 statewide data from Department of Labor, Office of Labor Market Information's <i>Delaware Occupation and Industry Projections</i> ; retrieved on 10/3/13 from: <a href="http://www.delawareworks.com/oolmi/Information/LMIData/Projections.aspx">http://www.delawareworks.com/oolmi/Information/LMIData/Projections.aspx</a>
MA	2012 and 2022 statewide data from Labor and Workforce Development's <i>Long-Term Industry Projections</i> ; retrieved 10/3/13 from: <a href="http://lmi2.detma.org/lmi/projections.asp">http://lmi2.detma.org/lmi/projections.asp</a>
MD	2010 and 2020 statewide data from Department of Labor, Licensing, and Regulation's <i>Maryland Industry Projections</i> ; retrieved 10/3/13 from: <a href="http://www.dlir.state.md.us/lmi/iandoproj/">http://www.dlir.state.md.us/lmi/iandoproj/</a>
ME	2010 and 2020 statewide data from Center for Workforce Research and Information's <i>Job Outlook to 2020</i> ; retrieved 10/3/13 from: <a href="http://www.maine.gov/labor/cwri/outlook.html">http://www.maine.gov/labor/cwri/outlook.html</a>
NC	2010 and 2020 statewide data from Department of Commerce's <i>NC Statewide Industry Projections</i> ; retrieved 10/3/13 from: <a href="http://www.nccommerce.com/lead/data-tools/industry/projections">http://www.nccommerce.com/lead/data-tools/industry/projections</a> and used for nonpoint source projections; Also provided AEO projections of industrial output by NAICS code for use in projection nonEGU point source emissions.
NH	2010 and 2020 statewide data from New Hampshire Employment Security's <i>Employment Projections by Industry and Occupation, 2010-2020</i> ; retrieved on 10/3/13 from: <a href="http://www.nhes.nh.gov/elmi/products/proj.htm">http://www.nhes.nh.gov/elmi/products/proj.htm</a>
NJ	2010 and 2020 statewide data from New Jersey Department of Labor and Workforce Development's <i>Industry and Occupational Employment Projections</i> ; retrieved 10/3/13 from: <a href="http://lwd.dol.state.nj.us/labor/lpa/employ/indoccpj/st_index.html">http://lwd.dol.state.nj.us/labor/lpa/employ/indoccpj/st_index.html</a>

State	Reference
NY	2010 and 2020 statewide data from Department of Labor's <i>Long-Term Industry Employment Projections</i> ; retrieved 10/3/13 from: <a href="http://www.labor.ny.gov/stats/lspoj.shtm">http://www.labor.ny.gov/stats/lspoj.shtm</a>
PA	2010 and 2020 statewide data from Department of Labor and Industry's <i>Long Term Industry Employment Projections</i> ; retrieved 10/3/13 from: <a href="http://www.portal.state.pa.us/portal/server.pt?open=514&amp;objID=809913&amp;mode=2">http://www.portal.state.pa.us/portal/server.pt?open=514&amp;objID=809913&amp;mode=2</a>
RI	2010 and 2020 statewide data from Department of Labor and Training's <i>Employment Projections 3-Digit Industry NAICS</i> ; retrieved 10/4/13 from: <a href="http://www.dlt.ri.gov/lmi/proj.htm">http://www.dlt.ri.gov/lmi/proj.htm</a>
VA	2010 and 2020 statewide data from Virginia Workforce Connection's <i>Industry Employment and Projections (Long Term)</i> ; retrieved 10/4/13 from: <a href="https://www.vawc.virginia.gov/analyzer/session/session.asp?CAT=HST_EMP_WAGE_IND">https://www.vawc.virginia.gov/analyzer/session/session.asp?CAT=HST_EMP_WAGE_IND</a>
VT	2010 and 2020 statewide data from Vermont Department of Labor's <i>Vermont Industry Projections 2010-2020</i> ; retrieved 10/4/13 from: <a href="http://www.vtmi.info/industry.cfm">http://www.vtmi.info/industry.cfm</a>
WV	2010 and 2020 statewide data from Work Force West Virginia's <i>Industry Employment Projections 2010-2020</i> ; retrieved 10/3/13 from: <a href="http://www.workforcewv.org/lmi/IndProj/longterm/WV.html">http://www.workforcewv.org/lmi/IndProj/longterm/WV.html</a>

To estimate employment in years between 2010 and 2020, we performed a linear interpolation of the available data. For years 2007 to 2009, we used a trend function as is available in the EXCEL software package to estimate employment. This procedure may not accurately estimate employment for 2007 to 2009 since it does not account for short-term recession job losses in those years. For years after 2020, we assumed no additional growth due to the lack of forecast data in those years and the uncertainty in continuing a linear trend beyond 2020.

Figure 19 shows the employment data for agricultural crop production (NAICS=111). This sector encompasses activities associated with crop production, such as soil preparation, soil fertilization, planting, harvesting, and management. Two states (NC and WV) are projecting a large decrease in the number of employees in this sector, while two states (CT and MD) are projecting a large increase. The remaining states show smaller employment losses or gains.

Figure 20 shows the employment data for oil and gas extraction (NAICS=211). This sector includes establishments engaged in (1) the exploration, development and/or the production of petroleum or natural gas from wells, (2) the production of crude petroleum from surface shale and (3) the recovery of liquid hydrocarbons from oil and gas field gases. Only five states (ME, NY, PA, VA, WV) report employment data for the oil and gas extraction industry. New York and Pennsylvania project large increases in employment in this sector, while the three other states report more modest employment gains.

Figure 21 shows the employment data for a group of manufacturing industries (NAICS=31x) that primarily produce finished consumer goods. The sector includes plants, factories, or mills that produce finished products such as food, beverages, textiles, and apparel. Most states report a decline in employment in this sector, with New York and Maine showing the largest declines. Two states (DE, VT) show modest employment gains for this sector.

Figure 22 shows the employment data for a group of manufacturing industries (NAICS=32x) that primarily transform raw materials into semi-finished products that are inputs for an establishment engaged in further manufacturing. The sector includes refineries, chemical plants, factories, or mills that produce semi-finished goods such as wood products, paper, petroleum products, chemicals, plastics and nonmetallic mineral products. Four states (ME, NJ, NY, WV) report large employment declines for this sector.

Figure 23 shows the employment data for a group of manufacturing industries (NAICS=33x) that primarily produce both semi-finished products that are an input for an establishment engaged in further manufacturing as well as finished products ready for utilization or consumption. The sector includes plants, factories, or mills that produce semi-finished goods such as metal products and finished goods such as machinery, transportation equipment, appliances, and furniture. There is no clear trend in this sector. Delaware projects an employment gain of 12 percent from 2010 to 2020, while West Virginia projects an employment loss of 11 percent. Half of the remaining states project employment gains and half project employment losses.

Figure 24 shows the employment data for repair and maintenance (NAICS=811), which includes automotive body, paint, and interior repair and maintenance. All jurisdictions except the District of Columbia project employment increases for this sector.



**Figure 19: Employment Projections for Crop Production (NAICS=111)**

State	2010 Estimated Employment	2020 Estimated Employment	Net Change 2010-2020	Annualized Growth Rate (% per year)	Total Percentage Change (%)
CT	3,469	3,958	489	1.3	14.1
DC	0	0	0	0.0	0.0
DE	2,460	2,400	-60	-0.2	-2.4
MA	n/a	n/a	n/a	n/a	n/a
MD	2,525	3,005	480	1.8	19.0
ME	5,858	6,196	338	0.6	5.8
NC	8,300	6,760	-1,540	-2.0	-18.6
NH	2,994	3,159	165	0.5	5.5
NJ	n/a	n/a	n/a	n/a	n/a
NY	16,660	15,530	-1,130	-0.7	-6.8
PA	40,770	41,300	530	0.1	1.3
RI	519	520	1	0.0	0.2
VA	54,211	50,044	-4,167	-0.8	-7.7
VT	541	575	34	0.6	6.3
WV	551	416	-135	-2.8	-24.5

**Figure 20: Employment Projections for Oil & Gas Extraction (NAICS=211)**

State	2010 Estimated Employment	2020 Estimated Employment	Net Change 2010-20	Annualized Growth Rate (% per year)	Total Percentage Change (%)
CT	0	0	0	0.0	0.0
DC	0	0	0	0.0	0.0
DE	0	0	0	0.0	0.0
MA	0	0	0	0.0	0.0
MD	0	0	0	0.0	0.0
ME	179	202	23	1.2	12.8
NC	0	0	0	0.0	0.0
NH	0	0	0	0.0	0.0
NJ	0	0	0	0.0	0.0
NY	450	1,180	730	10.1	162.2
PA	3,810	7,030	3,220	6.3	84.5
RI	0	0	0	0.0	0.0
VA	446	512	66	1.4	14.8
VT	0	0	0	0.0	0.0
WV	2,260	2,482	222	0.9	9.8



**Figure 21: Employment Projections for Manufacturing (NAICS=31x)  
 Food, Beverage, Textiles, Apparel**

State	2010 Estimated Employment	2020 Estimated Employment	Net Change 2010-2020	Annualized Growth Rate (% per year)	Total Percentage Change (%)
CT	9,894	9,604	-290	-0.3	-2.9
DC	n/a	n/a	n/a	n/a	n/a
DE	9,911	10,081	170	0.2	1.7
MA	36,616	36,048	-568	-0.2	-1.6
MD	21,651	20,271	-1,380	-0.7	-6.4
ME	10,290	8,997	-1,293	-1.3	-12.6
NC	111,010	104,730	-6,280	-0.6	-5.7
NH	5,123	4,822	-301	-0.6	-5.9
NJ	44,100	41,700	-2,400	-0.6	-5.4
NY	85,240	71,590	-13,650	-1.7	-16.0
PA	88,530	80,930	-7,600	-0.9	-8.6
RI	6,180	5,850	-330	-0.5	-5.3
VA	45,676	42,998	-2,678	-0.6	-5.9
VT	4,976	5,193	217	0.4	4.4
WV	4,061	3,755	-306	-0.8	-7.5

**Figure 22: Employment Projections for Manufacturing (NAICS=32x)  
 Wood, Paper, Petroleum, Chemicals, Plastics**

State	2010 Estimated Employment	2020 Estimated Employment	Net Change 2010-20	Annualized Growth Rate (% per year)	Total Percentage Change (%)
CT	31,188	31,474	286	0.1	0.9
DC	n/a	n/a	n/a	n/a	n/a
DE	7,120	7,040	-80	-0.1	-1.1
MA	56,924	55,872	-1,052	-0.2	-1.8
MD	37,180	35,500	-1,680	-0.5	-4.5
ME	18,710	14,973	-3,737	-2.2	-20.0
NC	127,640	131,380	3,740	0.3	2.9
NH	13,938	14,382	444	0.3	3.2
NJ	131,100	116,700	-14,400	-1.2	-11.0
NY	125,630	105,720	-19,910	-1.7	-15.8
PA	178,320	173,970	-4,350	-0.2	-2.4
RI	9,213	9,930	717	0.8	7.8
VA	72,442	76,490	4,048	0.5	5.6
VT	7,272	7,610	338	0.5	4.6
WV	22,953	20,136	-2,817	-1.3	-12.3

**Figure 23: Employment Projections for Manufacturing (NAICS=33x)  
 Metals, Machinery, Electronics, Transportation Equipment, Furniture**

State	2010 Estimated Employment	2020 Estimated Employment	Net Change 2010-2020	Annualized Growth Rate (% per year)	Total Percentage Change (%)
CT	124,083	120,173	-3,910	-0.3	-3.2
DC	n/a	n/a	n/a	n/a	n/a
DE	8,800	9,910	1,110	1.2	12.6
MA	157,685	136,287	-21,398	-1.4	-13.6
MD	52,026	48,456	-3,570	-0.7	-6.9
ME	21,658	20,017	-1,641	-0.8	-7.6
NC	192,740	197,640	4,900	0.3	2.5
NH	46,707	46,793	86	0.0	0.2
NJ	82,000	79,100	-2,900	-0.4	-3.5
NY	246,240	235,770	-10,470	-0.4	-4.3
PA	293,590	302,860	9,270	0.3	3.2
RI	24,454	24,870	416	0.2	1.7
VA	110,697	114,979	4,282	0.4	3.9
VT	18,124	17,829	-295	-0.2	-1.6
WV	21,399	19,078	-2,321	-1.1	-10.8

**Figure 24: Employment Projections for Repair and Maintenance (NAICS=811)  
 including Automobile Repair and Maintenance**

State	2010 Estimated Employment	2020 Estimated Employment	Net Change 2010-20	Annualized Growth Rate (% per year)	Total Percentage Change (%)
CT	13,342	14,508	1,166	0.8	8.7
DC	596	538	-58	-1.0	-9.7
DE	3,320	3,650	330	1.0	9.9
MA	24,462	24,826	364	0.1	1.5
MD	22,840	24,215	1,375	0.6	6.0
ME	4,779	4,918	139	0.3	2.9
NC	31,470	32,580	1,110	0.3	3.5
NH	6,225	6,680	455	0.7	7.3
NJ	32,100	35,500	3,400	1.0	10.6
NY	55,800	63,240	7,440	1.3	13.3
PA	48,470	54,090	5,620	1.1	11.6
RI	3,936	4,300	364	0.9	9.2
VA	32,064	41,212	9,148	2.5	28.5
VT	2,442	2,759	317	1.2	13.0
WV	7,149	7,442	293	0.4	4.1

### 3.3.1.3. State Preferences

S/L/T agencies were provided the choice of using (1) the AEO energy projections for fuel burning sources and employment projections for process sources, (2) only employment projections for all nonERTAC point sources, or (3) using a no growth projection.

Some of the growth factors used to project emissions for non-EGU sources show declining trends. For example, AEO projects negative growth for many fuel consumption sectors. Similarly, the employment projections show declines in the predicted number of employees for many sectors of the economy. This is particularly true for the manufacturing sector, which is of interest because this sector is often associated with higher emissions than those for other sectors. By contrast, the employment projections show increasing trends in retail and service-related sectors. However, these sectors are not typically associated with significant emissions.

Predicted declines in fuel use and employment resulted in growth factors less than unity (i.e., represent negative growth) for many non-EGU point source categories. Consequently, for some categories, emissions will be projected to be lower in future years compared to the base year, even before the application of emission control programs. The MARAMA emissions inventory workgroup was polled as to whether or not they felt that the negative growth factors were realistic for their state. Some state representatives mentioned that they have observed historic state-specific data that supports the negative trends. Other representatives mentioned that they feel comfortable with the negative growth factors and do not have a technical basis to change them or suggest others. Still other states recommended a conservative approach for addressing negative growth by setting a minimum growth rate of 1 (no growth). This also addresses states that have an emission offset program and therefore any emission decreases in the point source inventory have the potential to be sold. As a result of these discussions, each state provided guidance on how to handle projections when negative growth is indicated.

Some of the growth factors used to project emissions for non-EGU sources showed very large increasing trends. S/L/T agencies were polled to determine whether factors with large positive growth should be capped so that unrealistically high growth would not occur. Initially, we established a cumulative growth cap of +25% over the 2011 to 2017 period. S/L/T agencies reviewed the growth factors that exceeded the +25% cap and provided their recommendations for adjusting the cap. In nearly all cases, the S/L/T agencies agreed that the +25% growth factor cap was appropriate.

Figure 25 summarizes the state recommendations for the growth factors to use for the nonERTAC point source sector. Appendix N contains further details on each state's recommendation.

**Figure 25: State Preferences for nonERTAC Point Source Growth Factors**

State	AEO 2015 Energy Projections	Employment Projections
CT	Do not use AEO energy projections, use employment for all processes	Use employment projections for all SCCs for positive growth; use no growth when employment growth is negative
CT	Flat line growth for MWC and landfill sources with NAICS codes of 562 and 924.	
DC	Use AEO projections for Fuel Burning SCCs; use no growth when AEO growth is negative	Use employment projections for Process SCCs; use no growth when employment growth is negative
DE	Use AEO projections for Fuel Burning SCCs; use no growth when AEO growth is negative	Use employment projections for Process SCCs; use no growth when employment growth is negative

State	AEO 2015 Energy Projections	Employment Projections
MA	Use AEO projections for Fuel Burning SCCs; use no growth when AEO growth is negative	Use employment projections for Process SCCs; use no growth when employment growth is negative
MD	Do not use AEO energy projections, use employment for all processes	Use employment projections for all SCCs for positive growth; use no growth when employment growth is negative
ME	Use AEO projections for Fuel Burning SCCs; use no growth when AEO growth is negative	Use employment projections for Process SCCs; use no growth when employment growth is negative
NC	Do not use AEO energy projections, use employment for all processes	Use employment projections for all SCCs for positive growth; use no growth when employment growth is negative; use no-growth for small sources included in NEI2011v2 that were not in NEI2011v1
NH	Use AEO projections for Fuel Burning SCCs; use no growth when AEO growth is negative	Use employment projections for Process SCCs; use no growth when employment growth is negative
NJ	Do not use AEO energy projections, use employment for all processes	Use employment projections for all SCCs for positive growth; use no growth when employment growth is negative
NY	Use AEO projections for Fuel Burning SCCs; use no growth when AEO growth is negative	Use employment projections for Process SCCs; use no growth when employment growth is negative
PA	Use AEO projections for Fuel Burning SCCs; use no growth when AEO growth is negative	Use employment projections for Process SCCs; use no growth when employment growth is negative
RI	Use AEO projections for Fuel Burning SCCs; use no growth when AEO growth is negative	Use employment projections for Process SCCs; use no growth when employment growth is negative
VA	Use AEO projections for Fuel Burning SCCs; use no growth when AEO growth is negative	Use employment projections for Process SCCs; use no growth when employment growth is negative
VT	Use AEO projections for Fuel Burning SCCs; use no growth when AEO growth is negative	Use employment projections for Process SCCs; use no growth when employment growth is negative
WV	Use no growth for all nonERTAC point sources	Use no growth for all nonERTAC point sources

### 3.3.1.4. Growth Factor Spreadsheets and EMF Packets

To facilitate state review of the growth factors, user-friendly spreadsheets were developed that provide the surrogate growth parameters, match the growth parameters to inventory records, and configure the growth factors into the required EMF format. The spreadsheets allow the user to create a projection packet for any combination of base year and future year for the 2007 to 2040 period.

For nonERTAC point sources, four projection spreadsheets were developed:

- **Point source oil & gas sources:** this file contains specific sources in the point source oil and gas sector that extracted from the overall point sources based on specific NAICS codes representing the oil & gas extraction, transportation and distribution industries.
- **Aircraft engines, APU and GSE:** this file contains airport specific projection factors for aircraft engines, APU, and GSE; the FAA projection factors contained in this file are discussed later in this document.
- **“Small EGUs”:** this file contains a number of small sources, many of which generate a small amount of power for the grid that were included in EPA’s IPM modeling but are not found in either ERTAC EGU or non-EGU point files. Examples of sources included landfill gas fired engines and Cogen facilities located at industrial plants.

- **NonERTAC point sources:** this file contains all other point sources not included in the ERTAC EGU file, the point oil & gas file, the aircraft and support equipment file, and the “small EGU” file.

Each spreadsheet contains four tabs as described in Section 3.1. The spreadsheets are available on the MARAMA ShareFile site. Instructions for using the spreadsheet are contained in the “Methodology” tab. The “Growth Raw Data” tab contains the AEO and employment data described in the previous section. The “NEI to Growth Factor XWALK” tab is a list of list of facilities or emission processes that we initially obtained from the NEI2011v2.6. For states that chose to project all emission processes at a given facility using the same growth code (NAICS employment), there is only one record per facility. Other states chose to project emissions by individual emission process and there is one record for each emission process in the NEI.

### 3.3.2. Facility and Unit Closures and Emission Offsets

We obtained EPA’s NEI2011v2.6 modeling platform closure records and provided these to S/L/T agencies for review and approval. The MARAMA ShareFile site contains the final facility and unit closures file in EMF format. In most States emissions from these post-2011 closed facilities and units were zeroed out in the future year. Additional information on pre-2011 closures/emission offset banks was obtained from Connecticut, the District of Columbia, New Jersey, Connecticut, New York, Massachusetts, North Carolina and West Virginia and incorporated into the 2017 BETA2 inventory. The states elected to include emissions from pre-2011 closures in the 2017 BETA2 inventory to account for the potential sale of emission offsets.

The approach to representing these pre-2011 emissions in the inventory varied by state. In some cases, states elected to represent the offset emissions as a point located at the centroid of the county containing the closure, in other cases the state elected to represent the emissions as a nonpoint source distributed throughout the county. Figure 26 shows how each state elected to represent offset emissions. All offset emissions were assigned to SCC = 2399000000.

**Figure 26: State Totals of Emissions Offsets**

State	Emissions offsets	Pollutant	Total State Offset (TPY)
CT	Point sources at centroids of FIPS 09001, 09003, 09009, 09011, 09013	NOx	1,063
DE	Point sources at centroids of FIPS 10001, 10003	NOx	428
		VOC	333
DC	Nonpoint source	NOx	204
		SO2	723
MD	Point sources at centroids of FIPS 24005, 24043, 24510	NOx	3,210
		VOC	158
NJ	Nonpoint sources in each county	NOx	2,000
		VOC	1,500
VA	Point sources at centroid of FIPS 51510	NOx	558
		VOC	4.5

### **3.3.3. NonERTAC Point Source Control Factors**

This section describes how we compiled emission control information for nonERTAC point sources. We developed emission control factors relative to a 2011 base year emissions inventory. We initially obtained data from EPA's EPA 2011 v6.2 modeling platform (EPA, 2015b) which includes a set of EMF/CoST model control and closure records specific to stationary nonEGU point sources.

S/L/T agencies reviewed the EPA control packets and provided guidance on adjustments needed to the EPA factors and state rules not included in the EPA control packets. We augmented the EPA control factors with additional factors for state-specific measures not included in the EPA control packets and modified some of the EPA control factors in response to state requests. We organized the following sub-sections to address the specific types of controls used to calculate future year emission reductions from nonERTAC point sources. The EMF control packets are available on the MARAMA SharePoint site.

Control Measures included in the 2017 BETA2 projection inventory include:

- Federal Boiler MACT
- Federal RICE MACT
- Federal RICE NESHAP
- Federal Process Heater NSPS
- Federal Oil and Gas NSPS
- Federal Natural Gas Turbines NSPS
- Federal Residential Wood NSPS
- State specific low sulfur fuel rules
- State specific OTC model rules: Consumer Products, Autobody refinishing, Architectural coatings
- Other state specific rules

#### **3.3.3.1. Adjustment of USEPA NSPS Control Measures**

##### **3.3.3.1.1. Reductions due to NSPS Adjusted to Reflect AEO2015 Growth**

NSPS controls are only required for new sources. To represent the effect of NSPS controls on new sources in future-year for oil and gas, RICE, Natural Gas Turbines, and Process Heaters, EPA developed an equation that excludes existing sources and applies NSPS controls only to the difference between the new and existing source emission rates. This approach is described in Section 4.2.4 of the 2011 Modeling Platform Version 6.2 TSD (EPA, 2015b). The USEPA inventory was predicated on AEO2014 growth factors. As the MARAMA BETA2 inventory incorporated the more current AEO2015 growth factors we updated EPA's NEI2011v2.6 control efficiency estimates to reflect AEO2015 growth. We developed NSPS control factors that varied by pollutant and SCC using the same general methodology is described in section 4.2.4 of the EPA 2011 Modeling Platform Version 6.2 TSD (EPA, 2015b). The NSPS control spreadsheets are available on the MARAMA ShareFile site.

### 3.3.3.1.2. Boiler Maximum Achievable Control Technology (MACT) Rules

The Industrial/Commercial/Institutional Boilers and Process Heaters MACT Rule promulgates national emission standards for the control of hazardous air pollutants (HAP) for new and existing industrial, commercial, and institutional (ICI) boilers and process heaters at major HAPs sources. The final rule was published in the Federal Register in January 2013 and requires existing major sources to comply with the standards by January 2016. In addition, there is an area source Boiler MACT rule that requires tune ups for smaller boilers. It is expected that many boilers that burn coal or oil will be replaced by new natural gas boilers as a result of the rule. The expected co-benefit for CAPs at these facilities is significant.

MARAMA coordinated a state review of EPA's NEI2011v2.6 estimation of the effect of Boiler MACT as described in EPA's NEI2011v2.6. EPA developed control factors based on a study prepared by the OTC which relied on CIBO data that varied by pollutant, SCC, and facility for both point and area sources. The CIBO work found that many facilities will comply with the standard by replaced coal or oil fired boilers with new Natural Gas fired boilers to rather than install controls. EPA applied reductions to applicable point sources identified as subject to HAP regulations in the 2011 NEIv2.

MARAMA separately analyzed the NEI to confirm that EPA had identified all boilers subject to HAP regulations. Facility HAP emissions were summed and screened for the thresholds of 10 TPY of any one HAP or 25 TPY of total HAP. Additional boilers were identified in West Virginia and added to the list.

States developed an alternate set of reduction factors based on both EPA's NEI2011v2.6 and additional data collected by New Jersey and North Carolina as described in more detail in Appendix DD. For area sources, states uniformly applied reductions that were estimated to represent improved energy efficiency resulting from a boiler tune up. For NJ and NY, the same reductions were applied, but assigned to state specific rules that were in place and requiring boiler tune-ups prior to the Boiler MACT. These reductions are shown in Figure 27. They were derived from the North Carolina study. These reductions were applied to the following SCCs:

2102001000, 2102002000, 2102004000, 2102004001, 2102005000, 2102006000, 2102007000, 2102008000, 2102011000, 2103001000, 2103002000, 2103004000, 2103004001, 2103005000, 2103006000, 2103007000, 2103008000, 2103011000

Some area source SCCs represent a combination of boiler and engine emissions. For these SCCs, for all states except New Jersey, the reductions were cut in half to represent that only one half of the emissions come from boilers. This ratio was selected as it is the default assumption for these SCCs that was made for the engine:boiler ratio in NEI2011v2. (confirmed by email with Alison Eyth). New Jersey's inventory for this SCC code only includes boiler emissions, therefore the full reduction was applied to these SCCs in New Jersey.

For point sources, North Carolina, West Virginia and Connecticut preferred to apply reductions similar to area sources, which reflected boiler tune ups (Figure 27). All other states preferred application of the reductions shown in Figure 28. Reductions for Anthracite, Bituminous Coal, Distillate and residual oil were based on EPA's NEI2011v2.6. Reductions to natural gas and wood burning sources were based on the North Carolina study. The Boiler MACT EMF control packet is available on the MARAMA ShareFile site.



**Figure 27: Boiler MACT Tune-up Reductions**

Effect of Boiler MACT on Affected Area Source SCCs – Based on Impact of Tune Up Requirement						
	Anthracite Coal	Bituminous Coal	Distillate	Residual	Natural Gas	Wood
NOx	4	4	4	4	NA	4
CO	34	34	6	6	NA	29
PM10	4	4	4	4	NA	4
PM2.5	4	4	4	4	NA	4
SO2	4	4	4	4	NA	4
VOC	34	34	6	6	NA	29

**Figure 28: Boiler MACT Conversion Reductions**

Effect of Boiler MACT on Affected Point Source SCCs – Based on widespread conversion of coal and oil burning sources to Natural Gas						
	Anthracite Coal	Bituminous Coal	Distillate	Residual	Natural Gas	Wood
NOx	60.6	70.7	38.8	57.1	4	4
CO	98.9	98.9	99.9	99.9	4	29
PM10	72.2	95.99	68.4	92.4	4	4
PM2.5	72.2	95.99	68.4	92.4	4	4
SO2	73	97.4	99.9	97	4	4
VOC	98.9	98.9	99.9	99.9	4	29

### 3.3.3.1.3. RICE MACT Standards

EPA developed control factors for three 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, NOX, VOC, PM, and SO2. In 2014 and beyond, compliance dates have passed for all three rules; thus all three rules are included in the emissions projection. These RICE reductions also reflect the recent (proposed January, 2012) Reconsideration Amendments, which results in significantly less stringent NOX controls (fewer reductions) than the 2010 final rules.

We relied upon EPA's NEI2011v2.6 estimates of the expected emission reductions from the RICE standards. EPA developed control factors that varied by pollutant and SCC. See section 4.2.4.2 of the 2011 Modeling Platform Version 6.2 TSD (EPA, 2015b) for additional information. The RICE NESHAP EMF control packet is available on the MARAMA ShareFile site.

### 3.3.3.2. Consent Decrees

EPA developed control factors that contain information about the expected emission reductions that have been agreed to between EPA (and the Department of Justice) and the affected companies. The following consent decrees affected sources in the project study area:

- EPA estimated reductions needed to achieve post year-2008 emissions values from the Cross State Air Pollution Rule (CSAPR) response to comments. These reductions reflect fuel switching, cleaner fuels, and permit targets via specific information on control equipment in the following states: New York (LaFarge Albany County), and Virginia (Virginia Tech, GP Big Island).
- EPA estimated the emission reductions from enforcement settlements with Lafarge Company and St. Gobain Containers, Inc. These settlements are the first system-wide settlements for these sectors under the Clean Air Act and require pollution control upgrades, acceptance of enforceable emission limits, and payment of civil penalties. The settlements require various NO<sub>x</sub> controls. Affected facilities are located in Massachusetts, North Carolina, and Pennsylvania.

EPA estimated the NO<sub>x</sub> and SO<sub>2</sub> emission reductions from an enforcement settlement with the Holcim (US), Inc. cement plant in Maryland. The settlement specifies a NO<sub>x</sub> reduction of 92 tons per year and an SO<sub>2</sub> reduction of 230 tons per year. The Consent Decree EMF control packet is available on the MARAMA ShareFile site.

#### **3.3.3.3. Regional Haze Plan Controls**

EPA estimated the expected NO<sub>x</sub> and SO<sub>2</sub> emission reductions associated with controls (Best Available Retrofit Technology) in regional haze plans. These controls affect expected emission reductions and future year caps for individual facilities in various industries (cement, taconite, steel, pulp and paper, and mining). EPA included two facilities in the project study area: Lehigh Northeast Cement in New York and Meadwestvaco Packaging in Covington, Virginia. EPA provided the estimated compliance dates and control efficiencies by pollutant, SCC, and facility.

#### **3.3.4. Stand Alone Inventories**

Stand-alone future year inventories contain units that are new to the future year because they did not exist in 2011 but that EPA projected to be necessary to cover increased future year production. These inventories include, biodiesel plants, cellulosic plants and new cement plants. See section 4.2.5 of the 2011 Modeling Platform Version 6.2 TSD (EPA, 2015b).

For 2017 BETA2, the EPA files were also included without change for states outside the 15 states covered by this inventory. The EPA stand-alone point source biodiesel file included sources in the following states covered by this inventory: Connecticut, Massachusetts, New Jersey, New York, North Carolina, Pennsylvania, Rhode Island and Virginia. These sources were included without change from the EPA file; emissions from these sources are minor. Pennsylvania and North Carolina were the only states to have sources in EPA's other stand-alone inventories. After reviewing the EPA files, both states instructed us to exclude all of these sources.

#### **3.3.5. OTC and MANE-VU Control Measures**

For the past 20 years, the Ozone Transport Commission (OTC) has identified strategies to achieve cost-effective reductions of ozone-forming pollutants. Similarly, the Mid-Atlantic/Northeast Visibility Union (MANE-VU) coordinated the development of emission management strategies to assure reasonable progress toward remedying any existing impairment of visibility and preventing future impairment. Each S/L/T agency can pursue rulemakings or other implementation methods to establish the OTC/MANE-VU recommended emission reductions, emission rates or emission control technologies as appropriate and necessary.

Individual states are in various stages of adopting the OTC/MANE-VU recommendations into the rules and SIPs. We reviewed the OTC's status reports to identify each state's adoption status (see Appendices O, P, and Q). To obtain further clarification about each state's status with respect to the OTC/MANE-VU measures, we polled the states to determine whether they have adopted a rule that would achieve reductions equivalent to the OTC/MANE-VU recommendation. We obtained information on the effective date of the rule, whether credit for each rule was reflected in the 2011 inventory and what additional post-2011 reductions are expected. Appendix R contains each state's recommendations for accounting for each OTC control measure recommendation. The following subsections discuss the control measures with post-2011 effective dates.

#### **3.3.5.1. State NO<sub>x</sub> Rules and Control Requirements**

The OTC developed NO<sub>x</sub> control measures for industrial, commercial, and institutional (ICI) boilers and distributed generation units in 2001. We reviewed the OTC's status reports and state feedback to identify states status in adopting this recommendation. Most states have rules in place with compliance dates in 2007 or earlier. As a result, we concluded that the emission reductions are already reflected in the 2011 inventory and no post- 2011 reductions were applied.

In 2006, the OTC introduced new or more stringent requirements for several NO<sub>x</sub> source categories (asphalt production plants, cement kilns, glass/fiberglass furnaces, and ICI boilers). The OTC recommendations during 2009 to 2014 did not include any measures affecting NO<sub>x</sub> emissions from nonEGU point sources. Several states have adopted rules reflecting the recommendations of the OTC with compliance dates after 2011. We developed control factors for the following state rules affecting point sources with post-2011 compliance dates:

- Delaware identified that the Delaware City refinery is subject to an enforceable emission cap for NO<sub>x</sub>. Delaware estimated that a 23% reduction in NO<sub>x</sub> emissions beginning in 2016.
- Maine provided comments to EPA that identified facility-wide NO<sub>x</sub> reductions at three facilities: McCain Foods Easton, FLP Energy Wyman LLC, and Bath Iron Works Bath Facility.
- New Jersey adopted a rule limiting the NO<sub>x</sub> emissions from glass furnaces. New Jersey identified the affected units and estimated a 45% reduction in NO<sub>x</sub> emissions effective in 2012.
- New Jersey's boiler rule with post 2011 effective dates was incorporated into the inventory as described in Appendix R.
- Virginia provided comments to EPA that identified facility-wide NO<sub>x</sub> reductions at three facilities: GP Big Island, Honeywell Hopewell, and Invista Waynesboro.

The percent reductions shown above were either provided directly by the individual state agency or obtained from the OTC Control Measures TSD (OTC, 2007).

#### **3.3.5.2. State VOC Rules and Control Requirements**

The OTC developed VOC control measures for two point source categories. The OTC established VOC content limits and other restrictions on adhesives used in industrial and commercial settings. The OTC also established control requirements for high vapor pressure VOCs, such as gasoline and crude oil, stored in large aboveground stationary storage tanks,

which are typically located at refineries, terminals and pipeline breakout stations. The following states have adopted rules reflecting the recommendations of the OTC with compliance dates after 2011.

- Massachusetts adopted a rule limiting the VOC content of adhesives and sealants. The rule has a compliance date of May 1, 2016 and is expected to result in a 64% reduction.
- New Jersey adopted a rule requiring additional controls on petroleum storage tanks. New Jersey identified the affected SCCs and estimated the VOC percent reduction for individual years between 2012 and 2020.
- Pennsylvania adopted a rule limiting the VOC content of adhesives and sealants. The rule has a compliance date of January 1, 2012 and is expected to result in a 64% reduction.
- Virginia revised its rule limiting the VOC content of adhesives and sealants to include the Richmond VOC Control Area. The rule had a compliance date of March 1, 2014 and is expected to result in a 64% reduction in VOC emissions.

The percent reductions shown above were either provided directly by the individual state agency or obtained from the OTC Control Measures TSD (OTC, 2007).

### 3.3.5.3. State Fuel Oil Sulfur Rules

MANE-VU developed a low sulfur fuel oil strategy to help states achieve goals to reduce Regional Haze. Lower sulfur fuel affects not only SO<sub>2</sub> emissions, but also has co-benefits for other pollutants including NO<sub>x</sub>. In past inventories, only the effect on SO<sub>2</sub> was included. The base and final sulfur in fuel oil varies by state, type of fuel oil, and year of implementation.

For this BETA2 inventory state specific SO<sub>2</sub> control factors were developed for distillate, residual, and #4 fuel oil and kerosene and NO<sub>x</sub> control factors for distillate oil and kerosene., and for Delaware reductions were also taken for PM<sub>2.5</sub> and PM<sub>10</sub>. Sulfur reductions were based on a mass ratio of fuel sulfur comparing each state's base and controlled sulfur content in the state's rule. In many cases, sulfur reduction rules are implemented in two phases. In general, the baseline sulfur content was 3000 ppm 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. We used state- or county-specific baseline residual oil sulfur contents to calculate a state- or county-specific control factors for residual oil. See Appendix S for the specific reductions by state/county and fuel type.

NO<sub>x</sub> reduction estimates are based on studies of NO<sub>x</sub> emissions performed burning fuels with different sulfur contents in both boilers and engines. Reductions range from 22% when burning Ultra Low Sulfur fuel (ULSF) (15 ppm) in boilers to 1% when burning ULSF in engines. Development of the NO<sub>x</sub> reduction factors are described in detail in a technical memorandum provided by New York DEC. (NY2016).

We polled states regarding the status of state rules implementing the low sulfur fuel oil strategy and reviewed state rules to determine enforceable sulfur limits and compliance dates. Figure 29 shows the status for each jurisdiction's rule development.

**Figure 29: Status of State Fuel Oil Sulfur Rules (as of February 2015)**

State	Reference
CT	Section 22a-174-19a. Control of sulfur dioxide emissions from power plants and other large stationary sources of

State	Reference
	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, 2017 Residual: 1.0% effective July 1, 2014; 0.3% effective July 1, 2017 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, 2017
DC	No rule in place
DE	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
MA	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, 2017 Residual: 1.0% effective July 1, 2014; 0.5% effective July 1, 2018
MD	No rule in place
ME	Chapter 106: Low Sulfur Fuel Distillate: 500 ppm effective July 1, 2014; 15 ppm effective July 1, 2018 Residual: 0.5% effective July 1, 2018
NC	No rule in place
NH	No rule in place
NJ	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
NY	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
PA	§ 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
RI	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
VA	No rule in place
VT	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
WV	No rule in place

### 3.4. NONPOINT SOURCES

S/L/T agencies have traditionally used energy consumption, employment and demographic parameters as surrogates for projecting future emissions. While recognizing that these surrogates may not track exactly with emissions, states consider these surrogates to be the “best available” data for projecting emissions for nonpoint sources. S/L/T agencies also account for the effect of

emission control programs in reducing future year emissions. CSRA assisted states in developing growth and control factors for use within the EMF tool.

#### 3.4.1. Growth Factors

We relied on EPA guidance, an EPA-developed crosswalk, and state recommendations to match the surrogate growth parameters to the nonpoint sources in the NEI2011v2. We selected surrogate growth data for each emission source after considering several criteria:

- Is the surrogate parameter readily available in a publicly available, non-proprietary data source?
- How well is methodology and data used to develop the surrogate parameter documented?
- How closely does the surrogate parameter relate to the activity indicator used to develop the base year emission?
- How closely does the surrogate data approximate changes in the emission generating activity?
- How well does it characterize the activity in a given geographic area and during the time frame of interest?

The specific surrogate growth parameters used for the nonpoint sector are described in the following subsections.

##### 3.4.1.1. Energy Consumption Projections

We used the AEO2015 projections for commercial and industrial fuel consumption as previously described in Section 3.3.1.1. In addition, we used AEO2015 projections for residential and transportation fuel consumption. See Appendices J, K and L for the AEO data by region, year and fuel type.

**Residential energy consumption** - Figure 30 to Figure 32 show the AEO projections for residential energy consumption in the three regions. AEO projects a 20 to 25 percent reduction in heating oil consumption by 2025 in all three regions. In New England, AEO projects all other residential energy sources to have only a small change in consumption. In the Mid-Atlantic region, AEO projects a downward trend in natural gas consumption and an upward trend in renewable energy sources. In the South Atlantic region, AEO is projecting upward trends in electricity, renewable, and natural gas. These upward trends are presumably due in part to the growing populations in this region. There are big swings in residential coal consumption in the years 2007 to 2011. However, the total amount of residential energy derived from coal is very small compared to other energy sources, and this volatility should have very little if any impact on future year emission totals.

**Transportation energy consumption** - Figure 33 to Figure 35 show the AEO projections for transportation energy consumption in the three regions. AEO projects increases in alternative fuel vehicle (electricity, CNG/LPG) in all three regions. AEO also projects the gasoline consumption will decrease after 2011 in all three regions. These AEO projections are used for certain types of sources such as the marketing and distribution of petroleum products.

##### 3.4.1.1. Population

We obtained historical population counts by county for the years 2000 to 2010 from the U.S. Census Bureau. We obtained population projections by county for available future years from each state's population data center. See Figure 36 for references and Appendix T for the actual data. For years where published values were not available, we estimated the population by



interpolating between years with published values. For any projection year beyond the last year of each state's population growth data sets, we assumed no additional growth after the last year of published data.

Figure 37 shows the population growth factors for the six states in New England AEO region. Population in the New England region is projected to grow from 14.5 million in 2011 to 14.8 million in 2017 and 15.2 million in 2025. Population growth is relatively modest (2 – 3 percent over the six-year period from 2011 to 2017) in Connecticut, Massachusetts, New Hampshire and Vermont. Essentially no growth in population is projected for Maine from 2011 to 2017. Rhode Island is projected to have a small decrease in population.

Figure 38 shows the population growth factors for the three states in Mid-Atlantic AEO region. Population in these three states is projected to grow from 40.0 million in 2011 to 41.5 million in 2017 and 42.3 million in 2025. Population in New Jersey is projected to grow by about 3 percent from 2011 to 2017. Population in New York and Pennsylvania is project to grow by about 1 percent from 2011 to 2017.

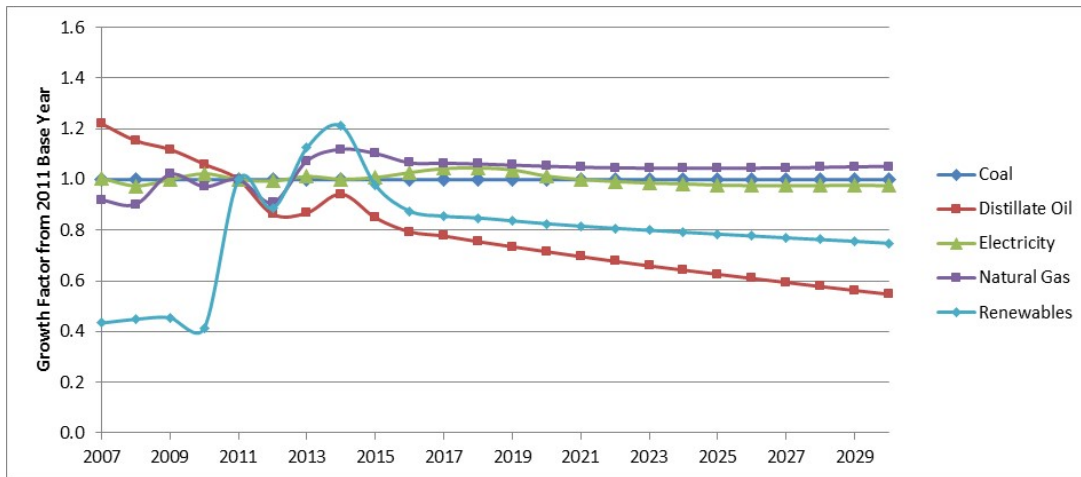
Figure 39 shows that population in the southern part of the study area is projected to grow much faster than the middle/northern part of the region. Population in these jurisdictions is projected to grow from 27.0 million in 2011 to 28.4 million in 2017 and 30.4 million in 2025. These jurisdictions (except West Virginia) have population growth rates that range from 4 to 7½ percent from 2011 to 2017.

#### **3.4.1.1. Employment Projections**

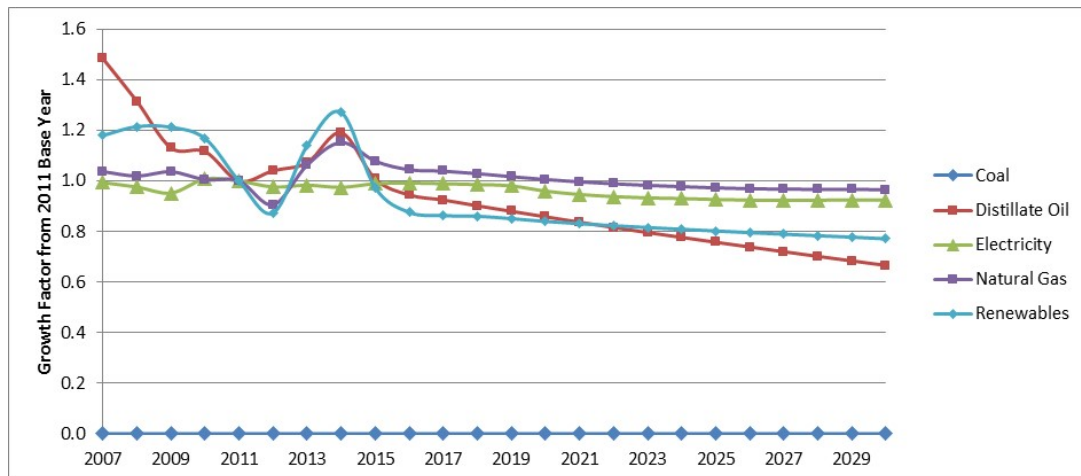
We used the same state employment projections by 3-digit NAICS code for nonpoint industrial process as previously described in Section 3.3.1.2.



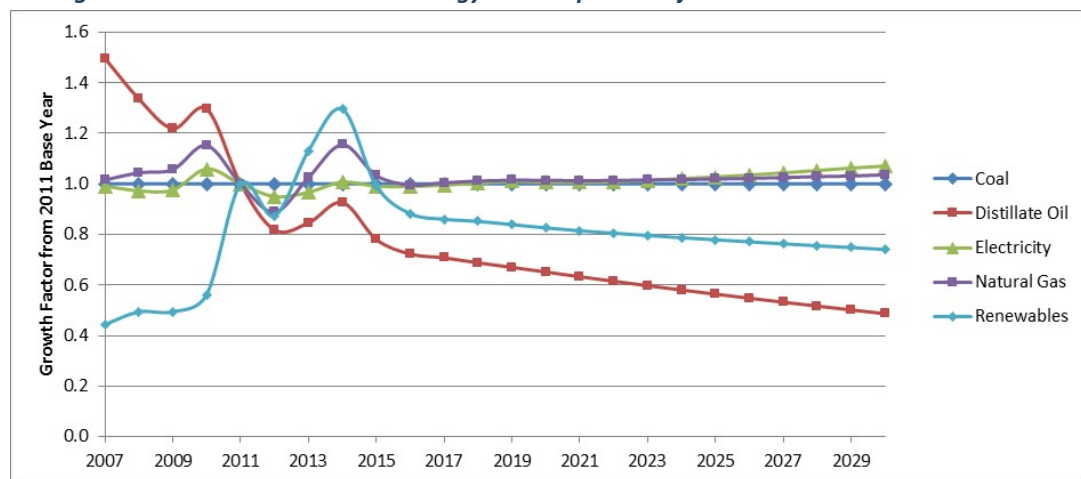
**Figure 30: AEO 2015 Residential Energy Consumption Projections – New England States**



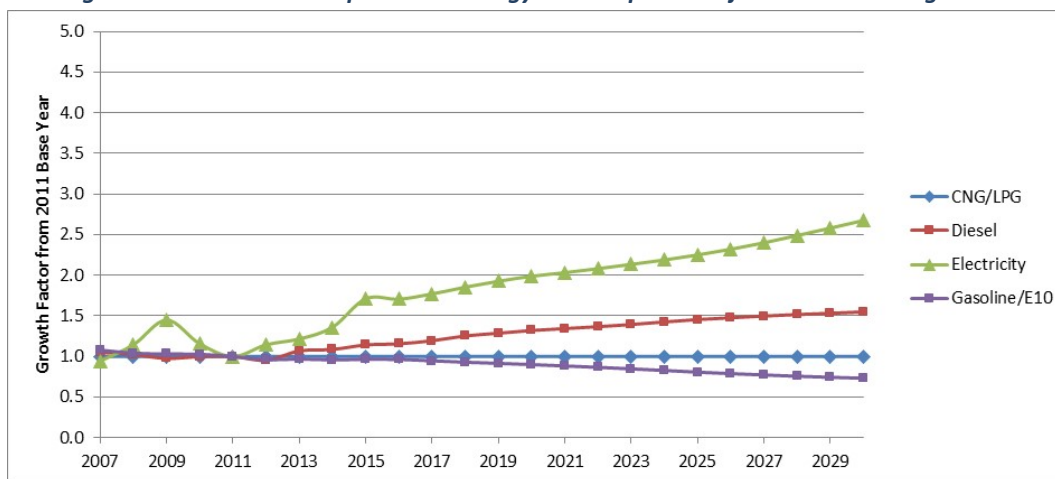
**Figure 31: AEO2015 Residential Energy Consumption Projections – Mid-Atlantic States**



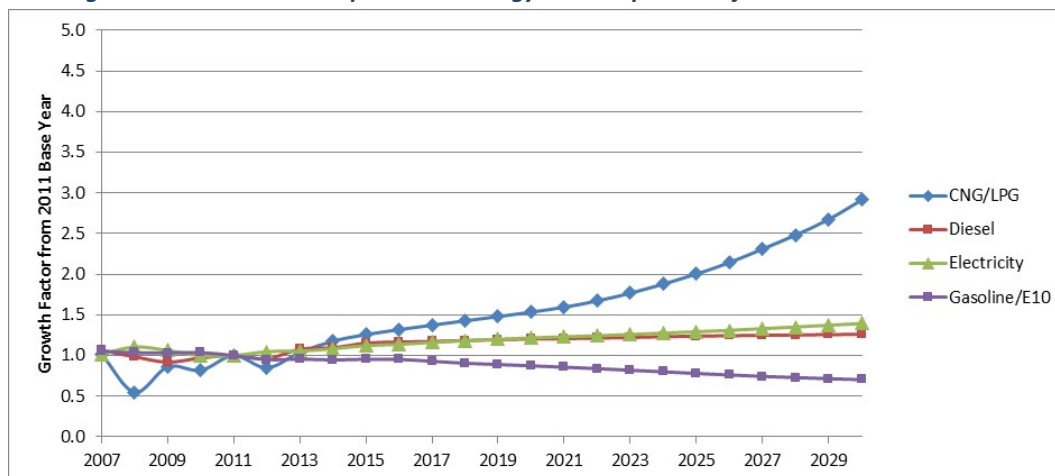
**Figure 32: AEO2015 Residential Energy Consumption Projections – South-Atlantic Jurisdictions**



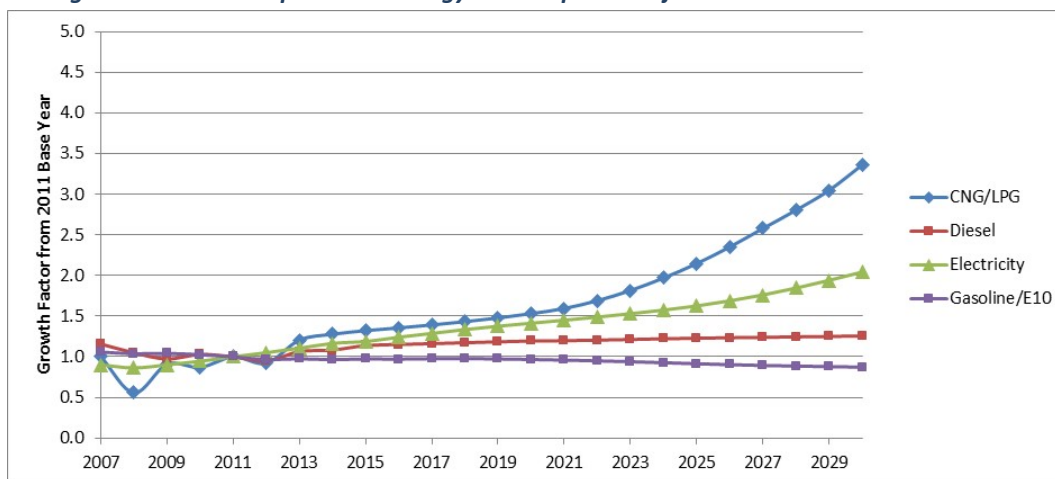
**Figure 33: AEO2015 Transportation Energy Consumption Projections – New England States**



**Figure 34: AEO2015 Transportation Energy Consumption Projections – Mid-Atlantic States**



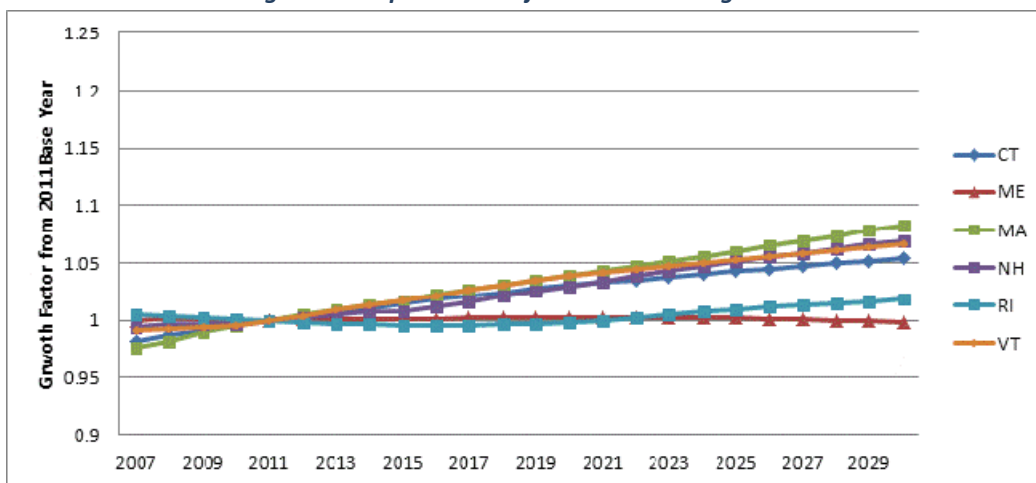
**Figure 35: AEO Transportation Energy Consumption Projections – South-Atlantic Jurisdictions**



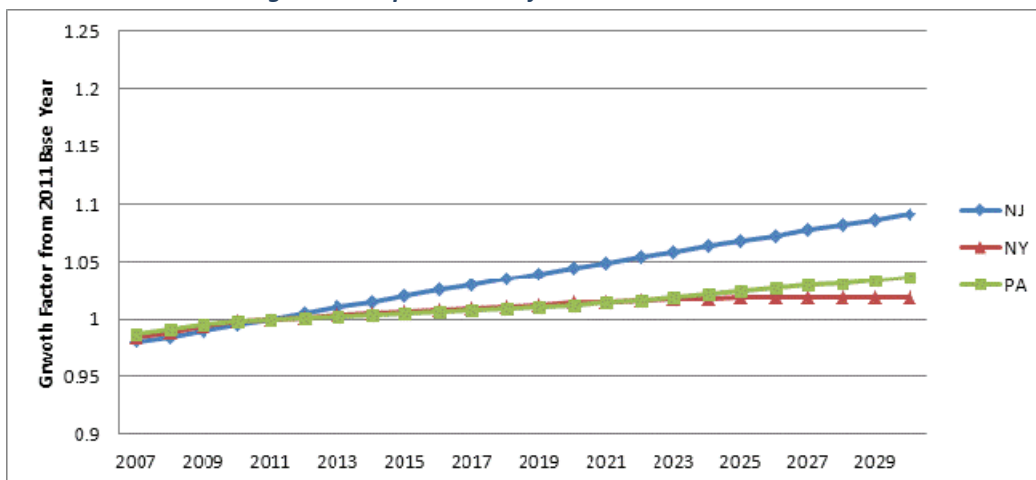
**Figure 36: Population Data Sources**

State	Reference
All	Historical data for 2000 to 2010 obtained from U.S. Census Bureau. <i>Intercensal Estimates of the Resident Population by County: July 1, 2001 to July 1, 2010</i> . Accessed on November 21, 2013. <a href="http://www.census.gov/popest/data/intercensal/county/CO-EST00INT-01.html">http://www.census.gov/popest/data/intercensal/county/CO-EST00INT-01.html</a>
CT	Connecticut State Data Center at the University of Connecticut Libraries Map and Geographic Information Center - MAGIC. <i>2015-2025 Population Projections for Connecticut at State, County, Regional Planning Organization, and Town levels - November 1, 2012 edition</i> . retrieved on 10/2/13 from: <a href="http://ctsdc.uconn.edu/2015_2025_projections/">http://ctsdc.uconn.edu/2015_2025_projections/</a>
DC	DC Office of Planning, <i>Metropolitan Washington Council of Governments Population Forecast Round 8.0</i> ; retrieved 10/3/13 from: <a href="http://planning.dc.gov/DC/Planning/DC+Data+and+Maps/DC+Data">http://planning.dc.gov/DC/Planning/DC+Data+and+Maps/DC+Data</a>
DE	Delaware Census State Data Center, <i>The Delaware Population Consortium Annual Projections, October 25, 2012, Version 2012.0</i> ; retrieved on 10/2/13 from: <a href="http://stateplanning.delaware.gov/information/dpc_projections.shtml">http://stateplanning.delaware.gov/information/dpc_projections.shtml</a>
MA	Massachusetts Department of Transportation, <i>Massachusetts Population Projections from MassDOT Planning</i> ; retrieved on 10/2/13 from: <a href="http://www.massdot.state.ma.us/Portals/17/docs/Demographics/MunicipalDemographics-Population.csv">www.massdot.state.ma.us/Portals/17/docs/Demographics/MunicipalDemographics-Population.csv</a>
MD	Department of Planning, <i>Historical and Projected Total Population for Maryland's Jurisdictions</i> ; retrieved 10/3/2012 from: <a href="http://www.mdp.state.md.us/msdc/s3_projection.shtml">http://www.mdp.state.md.us/msdc/s3_projection.shtml</a>
ME	Office of Policy and Management, <i>Maine state and county population outlook to 2030</i> ; retrieved on 10/3/13 from: <a href="http://www.maine.gov/economist/econdemo/article.shtml?id=501734">http://www.maine.gov/economist/econdemo/article.shtml?id=501734</a>
NC	Office and State Budget and Management, <i>County/State Population Projections</i> ; retrieved on 10/3/13 from: <a href="http://www.osbm.state.nc.us/ncosbm/facts_and_figures/socioeconomic_data/population_estimates/county_projections.shtml">http://www.osbm.state.nc.us/ncosbm/facts_and_figures/socioeconomic_data/population_estimates/county_projections.shtml</a>
NH	Office of Energy and Planning, <i>Population projections for New Hampshire counties, cities and towns</i> ; retrieved on 11/21/13 from: <a href="http://www.nh.gov/oep/data-center/population-projections.htm">http://www.nh.gov/oep/data-center/population-projections.htm</a>
NJ	Department of Labor and Workforce Development, <i>Projections of Total Population by County: New Jersey, 2010 to 2030</i> ; retrieved 10/3/13 from <a href="http://lwd.dol.state.nj.us/labor/lpa/dmograph/lfpjproj/lfpjproj_index.html">http://lwd.dol.state.nj.us/labor/lpa/dmograph/lfpjproj/lfpjproj_index.html</a>
NY	Department of Labor, <i>New York State and County Population Projections by Age and Sex</i> ; retrieved on 10/3/13 from: <a href="http://www.labor.ny.gov/stats/nys/statewide-population-data.shtml">http://www.labor.ny.gov/stats/nys/statewide-population-data.shtml</a>
PA	Pennsylvania State Data Center, <i>Total population projections for Pennsylvania Counties, 2000-2030</i> ; retrieved 10/3/13 from: <a href="http://pasdc.hbg.psu.edu/Data/Projections/tabid/1013/Default.aspx">http://pasdc.hbg.psu.edu/Data/Projections/tabid/1013/Default.aspx</a>
RI	Division of Planning, <i>City and Town Population Projections</i> ; retrieved on 10/3/13 from: <a href="http://www.planning.ri.gov/geodeminfo/data/popprojections.php">http://www.planning.ri.gov/geodeminfo/data/popprojections.php</a>
VA	Virginia Employment Commission, <i>Total Population Projections for Virginia and its Localities, 2020-2040</i> ; retrieved 10/3/13 from: <a href="http://www.coopercenter.org/demographics/virginia-population-projections">http://www.coopercenter.org/demographics/virginia-population-projections</a>
VT	Vermont Agency of Commerce and Community Development's <i>Vermont Population Projections – 2010 - 2030</i> ; retrieved 10/3/13 from: <a href="http://accd.vermont.gov/business/strategic_planning">http://accd.vermont.gov/business/strategic_planning</a>
WV	Bureau for Business and Economic Research's <i>Population Projection for West Virginia Counties</i> ; retrieved 10/3/13 from: <a href="http://www.be.wvu.edu/demographics/populationprojection.htm">http://www.be.wvu.edu/demographics/populationprojection.htm</a>

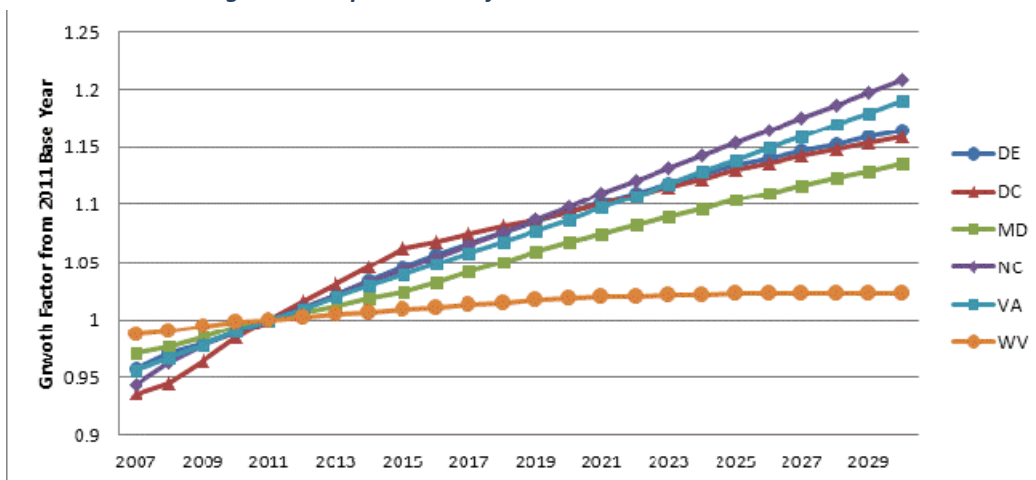
**Figure 37: Population Projections – New England States**



**Figure 38: Population Projections – Mid-Atlantic States**



**Figure 39: Population Projections – South Atlantic Jurisdictions**



### 3.4.1.2. Reentrained Road Dust

Vehicle miles traveled (VMT) projection data are used as the growth factor for projecting emissions from re-entrained road dust from travel on paved roads (SCC 22-94-000-000). A few states (CT, DC, MA, NH, NJ, VT, VA) were able to provide VMT projections by county. For states that were unable to provide state-specific VMT, we used national VMT projections from AEO2015.

### 3.4.1.3. Agricultural Fertilizer and Livestock Waste

We used EPA 2011 v6.2 approach to develop projection factors for agricultural activities including fertilizer and pesticide application, agricultural tilling/harvesting, and livestock waste processing. Since EPA developed projection factors only for 2017, we developed projection factors for all remaining years via interpolation or extrapolation. See Section 4.2.3 of the EPA 2011 v6.2 TSD (EPA, 2015b) for additional information.

### 3.4.1.4. Residential Wood Combustion

CSRA used EPA 2011 v6.2 approach to develop projection factors for residential wood combustion (RWC) activities. See Section 4.2.3 the EPA 2011 v6.2 TSD (EPA, 2015b) for details of the methodology. EPA included reductions to account for the recently promulgated national New Source Performance Standards (NSPS) for wood stoves. This is a change from the earlier EPA 2011 v6.0 platform, as the NSPS was finalized since completion of that inventory. EPA projected emissions to the year 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. More details on the EPA approach can be found in the EPA 2011 v6.2 TSD (EPA2015b). The EPA platform provides a combined emissions projection factor that accounts for both activity change as well as emission reductions due to the NSPS. Since EPA developed projection factors only for 2017 and 2025, we developed projection factors for all remaining years via interpolation or extrapolation.

### 3.4.1.5. Oil and Gas Production

Area source oil and gas production projection factors were developed based on AEO2015 Northeast regional oil, gas and coalbed methane growth projections. (see Appendices T and U) These factors were applied to base year emissions for most states with a few exceptions, as follows. New York has a moratorium on hydraulically fractured well development, therefore emissions were held stagnant into the future. In addition, Pennsylvania applied no growth to SCCs related to Oil and Gas well development including the following SCCs:

2310000220	Oil & Gas Expl & Prod /All Processes /Drill Rigs
2310000230	Oil & Gas Expl & Prod /All Processes /Workover Rigs
2310000330	Oil & Gas Expl & Prod /All Processes /Artificial Lift
2310000550	Oil & Gas Expl & Prod /All Processes /Produced Water
2310000660	Oil and Gas Exploration and Production; All Processes; Hydraulic

We used the EPA 2011 v6.2 approach to develop control factors for the NSPS that apply to nonpoint source oil and gas emissions. Because NSPS only applies to new sources, the controls only applied to emissions beyond the base year county total. See Section 4.2.4 the EPA 2011

v6.2 TSD (EPA, 2015b) for additional details on the methodology. The two NSPS that apply to Oil and gas are: 1) Oil and Gas, which affects VOC emissions from evaporative sources and 2) RICE, which affects NOX, CO and VOC emissions from engines.

#### **3.4.1.6. State Preferences**

As discussed in Section 3.2.1.3 of this TSD, some growth factors used to project emissions for nonpoint sources show declining trends. For example, AEO projects negative growth for many fuel consumption sectors. Similarly, the employment projections show declines in the predicted number of employees for many sectors of the economy. Each state provided guidance on how to handle projections when negative growth is indicated. Delaware and Maryland chose to set a minimum growth rate of 1 (no growth) for nonpoint sources when the chosen growth indicator was estimating negative growth. New Jersey provided specific growth factor guidance for each category based on state specific data, caps or no growth on negative growth, and no growth on certain employment categories where the employment activity was not a specific indicator of the actual emissions. New Jersey also specified no growth in employment categories after 2020. All other states accepted the estimated projection data as is and made no adjustments for negative growth.

#### **3.4.1.7. Growth Factor Spreadsheets and EMF Packets**

To facilitate state review of the growth factors, user-friendly spreadsheets were developed that provide the surrogate growth parameters, match the growth parameters to inventory records, and configure the growth factors into the required EMF format. The spreadsheets allow the user to create a projection packet for any combination of base year and future year for the 2007 to 2040 period. See Section 3.1 of this TSD for a description of the spreadsheet format.

For nonpoint sources, the following projection spreadsheets were developed:

- Agriculture – contains projection factors for ammonia emissions from livestock and fertilizer application
- Fugitive dust – contains projection factors for paved and unpaved roads, mining and quarrying operations, agricultural tilling, and construction activities
- Nonpoint refueling – contains projection factors for nonpoint Stage I fuel unloading
- Nonpoint oil and gas processes – contains projection factors for nonpoint oil and gas exploration and production activities
- Portable fuel containers – contains projection factors for residential and commercial portable fuel containers
- Residential wood combustion – contains projection factors for wood stoves, pellet stoves, fireplaces, and outdoor wood boilers
- Other nonpoint sources – contains projection factors for all other nonpoint categories not mentioned above

These projection spreadsheets are available on the MARAMA ShareFile site.

#### **3.4.2. NonPoint Control Factors**

Emission control factors for nonpoint sources were developed relative to a 2011 base year emissions inventory. We obtained EPA's NEI2011v2.6 modeling platform EMF/CoST model control records specific to stationary nonpoint sources.



S/L/T agencies reviewed the EPA control packets and provided guidance on adjustments needed and state rules not included in the packets. The EPA packets were augmented with additional factors for the missing state-specific measures. In addition, some EPA control factors were modified in response to state requests. The EMF control packets are available on the MARAMA ShareFile site. The following sub-sections describe how controls were represented to reduce future emissions from nonpoint sources.

#### **3.4.2.1. OTC and MANE-VU Control Measures**

For the past 20 years, the OTC has identified strategies to achieve cost-effective reductions of ozone-forming pollutants. Similarly, MANE-VU coordinated the development of emission management strategies to assure reasonable progress toward remedying any existing impairment of visibility and preventing future impairment. Each S/L/T agency can pursue rulemakings or other implementation methods to establish the OTC/MANE-VU recommended emission reductions, emission rates, or emission control technologies as appropriate and necessary.

Individual states are in various stages of adopting the OTC/MANE-VU recommendations into the rules and SIPs. We reviewed the OTC's status reports to identify each state's adoption status (see Appendices O, P and Q). States were polled to confirm and obtain further clarification about state rules including effective dates, expected post-2011 emission reductions by pollutant and whether credit was already reflected in the 2011 inventory. Appendix R contains each state's recommendations for accounting for each OTC control measure recommendation. The following subsections discuss the control measures with post-2011 effective dates.

#### **3.4.2.2. State Specific VOC Rules**

Several states have adopted rules reflecting the recommendations of the OTC with compliance dates after 2011. CSRA developed control factors for the following state rules with post-2011 compliance dates:

- Delaware's auto refinishing rule is expected to result in a 90% reduction in VOCs from the nonpoint auto refinishing sector beginning in 2012.
- Maryland adopted rules in 2016 restricting emissions from architectural and industrial maintenance coatings, vehicle refinishing, and metal parts coating.
- Massachusetts adopted a rule limiting the VOC content of adhesives and sealants. The rule has a compliance date of May 1, 2016 and is expected to result in a 64% reduction in VOC emissions.
- New Hampshire adopted a rule with enhanced limitations on the VOC content of consumer products.
- Pennsylvania adopted a rule limiting the VOC content of adhesives and sealants. The rule has a compliance date of January 1, 2012 and is expected to result in a 64% reduction in VOC emissions.
- Virginia revised five rules to expand coverage to the Richmond VOC Control Area with an effective date of March 1, 2014. Previously these rules only applied to the northern Virginia counties that are part of the Ozone Transport Region. These rules included architectural and industrial maintenance coatings, portable fuel containers, consumer products, motor vehicle and mobile equipment coatings/solvents, and adhesives/sealants.



The percent reductions shown above were either provided directly by the individual state agency or obtained from the OTC Control Measures TSD (OTC, 2007).

#### **3.4.2.3. State Fuel Oil Sulfur Rules**

The MANE-VU low sulfur fuel oil strategy described in Section 3.3.5.3 of the TSD also applies to certain nonpoint source categories. Please refer to Section 3.3.5.3 for further information.

The rule applies to the following SCC codes:

- 21-02-004-000 – Industrial/Distillate Oil/Total: Boilers and Engines
- 21-02-004-001 – Industrial/Distillate Oil/Boilers
- 21-02-004-002 – Industrial/Distillate Oil/Engines
- 21-02-005-000 – Industrial/Residual Oil/Total: All Boiler Types
- 21-02-011-000 – Industrial/Kerosene/Total: All Boiler Types
- 21-03-004-000 – Commercial & Institutional/Distillate Oil/Total: Boilers and Engines
- 21-03-004-001 – Commercial & Institutional/Distillate Oil/Boilers
- 21-03-004-002 – Commercial & Institutional/Distillate Oil/Engines
- 21-03-005-000 – Commercial & Institutional/Residual Oil/Total: All Boiler Types
- 21-03-011-000 – Commercial & Institutional/Kerosene/Total: All Combustor Types
- 21-04-004-000 – Residential/Distillate Oil/Total: All Combustor Types
- 21-04-011-000 – Residential/Kerosene/Total: All Heater Types

Since the NO<sub>x</sub> reductions associated with ultra-low sulfur fuel oil are different for boilers and engines (see Section 3.3.5.3), it was necessary to determine the split of emissions in the combined boiler/engine categories in order to properly account for the anticipated emission reductions. Based on how the NEI2011 was developed, it was determined that the emissions for the combined SCCs were evenly split between boilers and engines. Thus, those states reporting using the combined boiler/engine SCCs were assigned only one-half of the NO<sub>x</sub> reductions described in Section 3.3.5.3. With two exceptions: NJ and NY both specified that the emissions for the combined boiler/engine SCCs in their states were entirely attributable to boilers, and thus those states were assigned the full NO<sub>x</sub> reductions specified in Section 3.3.5.3.

#### **3.4.2.4. Portable Fuel Container Rules**

Many states have adopted the OTC model rule limiting VOC emissions from portable fuel containers. These state-specific rules have different compliance dates depending on when the state completed its rulemaking. The remaining states are relying on federal requirements that became effective on January 1, 2009. Both the state and federal rules apply to new containers, and thus the anticipated reductions depend on the turnover of older non-compliant containers to new, lower-emitting containers. The emission reduction calculations assume a 10-year turnover period. Emission reduction percentage were calculated for each state and year, depending on the individual state's compliance date or the compliance date for the federal rule.

For example, states relying on the federal rule anticipate that hydrocarbon emissions from uncontrolled fuel containers will be reduced by approximately 75 percent at full implementation. Assuming a 10-year turnover to compliant containers beginning in 2009, only 10 percent of the existing inventory of PFCs will comply with the new requirements in 2010. Therefore, only 10 percent of the full emission benefit estimated by USEPA will occur by 2010 – the incremental reduction will be about 7.5 percent in 2010. In 2013, there will be a 40 percent turnover to

compliant cans, resulting in an incremental reduction of about 30 percent. By 2017, there will be 80 percent penetration to compliant PFCs, resulting in an incremental reduction of 60 percent in 2017. By 2020, there will be 100 percent penetration to compliant PFCs, resulting in an incremental reduction of 75 percent in 2020. Appendix W documents the percent reduction calculations for each by year.

#### **3.4.2.5. Boiler MACT Rules**

The Boiler MACT rules described in Section 3.3.2.2 of this TSD also apply to certain nonpoint source categories. See section 3.33.22 of this TSD for a description of how this rule was applied to nonpoint sources.

#### **3.4.2.6. RICE MACT Rules**

The RICE MACT rules described in Section 3.3.2.4 of this TSD also apply to certain nonpoint source categories. See section 4.2.5 of the EPA 2011 v6.2 TSD (EPA, 2015b) for additional information.

### **3.5. AIRCRAFT, LOCOMOTIVES, AND COMMERCIAL MARINE VESSELS**

#### **3.5.1. Locomotives and Commercial Marine Vessels**

The NEI2011v1 EMP methodology was used to develop projection factors for locomotive and Category 1 and Category 2 marine diesel engines. EPA classifies locomotive engines into five types: Line Haul Class I operations, Line Haul Class II/III operations, passenger trains (AMTRAK), commuter trains, and yard locomotives. C1/C2 marine vessel engines typically range in size from about 500 to 8,000 kW (700 to 11,000 hp). These engines provide propulsion power on many kinds of vessels including tugboats, pushboats, supply vessels, fishing vessels, and other commercial vessels in and around ports. They are also used as stand-alone generators for auxiliary electrical power on vessels.

EPA developed national emission inventories for locomotives and C1/C2 vessels for calendar years 2002 through 2040 as part of its effort to develop emission standards for these vessels. EPA documented the methodologies used to develop the emission projections (for both a baseline and controlled scenario) in a regulatory impact assessment (EPA, 2008). CSRA used the EPA data and methodologies to develop a projection factor (combined growth and control factor) for locomotives and C1/C2 vessels. See Appendix X the data and calculations.

EPA estimated future-year emissions to account for increased fuel consumption based on Energy Information Administration (EIA) fuel consumption projections, and emissions reductions resulting from emissions standards promulgated in 2009. These standards lowered diesel sulfur content and tightened emission standards for existing and new locomotive/vessel emissions to lower future-year PM, SO<sub>2</sub>, and NO<sub>x</sub>. Using the EPA data, CSRA computed projection (combined growth and control) factors for all years from 2007 to 2040 for each year for each type of engine and each pollutant.

Note that the EPA approach is based on the growth predictions of AEO2006 together with the phase-in of cleaner diesel engines. A few states commented that using AEO2006 overpredicts emissions compared to AEO2014 for future years. This over prediction of growth applies to Class I, II, and III railroads and rail yards as well as C1/C2 commercial marine vessels. States have requested that EPA adjust their projections to use AEO2014 in the NEI2011v2.

### **3.5.2. Aircraft Engines, GSE, and APUs**

CSRA followed EPA's approach to develop aircraft growth factors using the Federal Aviation Administration's (FAA's) Terminal Area Forecast (TAF) system (FAA, 2014). The TAF is the official forecast of aviation activity at FAA facilities. The TAF includes forecasts for 452 airports in the MARAMA study area, including historical data (1990–2012) and forecasts (2013–2040) for the following activities:

- Air carrier operations representing landings and take-offs (LTOs) of commercial aircraft with seating capacity of more than 60 seats.
- Commuter/air taxi operations is a single category. Commuter operations include LTOs by aircraft with 60 or fewer seats that transport regional passengers on scheduled commercial flights. Air taxi operations include LTO by aircraft with 60 or fewer seats conducted on non-scheduled or for-hire flights.
- General aviation itinerant operations represent all civil aviation aircraft LTOs not classified as commercial.
- General aviation local operations represent all civil aviation aircraft practice LTOs and low approaches.
- Military itinerant operations represent LTOs by military aircraft.
- Military local operations represent military aircraft practice LTOs and low approaches.

Both the FAA TAF data and the 2011 NEI point source emission inventory are by airport. However, the 2011 NEI nonpoint source inventory contains emission estimates for aviation gasoline refueling operation on a county basis.

To facilitate state review of the growth factors, user-friendly spreadsheets were developed that provide the surrogate growth parameters, match the growth parameters to inventory records, and configure the growth factors into the required EMF format. The spreadsheets allow the user to create a projection packet for any combination of base year and future year for the 2007 to 2040 period. See Section 3.1 of this TSD for a description of the spreadsheet format.

## **3.6. NONROAD EQUIPMENT**

For the BETA2 inventory, MARAMA used the EPA 2011 v6.2 inventory files for both 2011 and 2017.

## **3.7. ONROAD EQUIPMENT**

For the BETA2 inventory, MARAMA used the EPA NEI2017v2 for 2017.

## **3.8. FIRES**

MARAMA used the EPA 2011 v6.2 inventory files for both 2011 and 2017.

## **3.9. BIOGENIC SOURCES**

MARAMA used an updated version of the Biogenic Emission Inventory System (BEIS) to estimate biogenic sources for both 2011 and 2017. This version termed BEIS 3.6.1 includes updated input vegetation data and canopy model formulation for estimating leaf temperature and vegetation data on estimated BVOC. The Biogenic Emission Land Use Database (BELD) was revised to incorporate land use data from the Moderate Resolution Imaging Spectroradiometer (MODIS) land product and 2006 National Land Cover Database (NLCD) land coverage.

Vegetation species data is based on the US Forest Service (USFS) Forest Inventory and Analysis (FIA) version 5.1 for years from 2002 to 2013 and US Department of Agriculture (USDA) 2007 census of agriculture data. This update results in generally higher BVOC emissions compared with the previous version of BEIS.

## 4. QUALITY ASSURANCE PROCEDURES

Quality assurance (QA) and quality control (QC) procedures were part of the entire inventory development process and were performed by S/L/T agencies, EPA, CSRA, and MARAMA. The following sections summarize the QA/QC activities carried out in developing the 2011 and future year inventories.

### 4.1. QA OF 2011 INVENTORY

S/L/T agencies are responsible for the collection, processing, analysis, and quality assurance of annual emission inventories. S/L/T agencies perform the initial QA/QC activities using their QA/QC plan that defines systematic procedures that:

- ensure the inventory is complete
- ensure the emission inventory is accurate and of the highest quality possible
- secure the reasonableness of the emissions inventory
- confirm the emissions inventory is in compliance with EPA reporting requirements

Each S/L/T agency carries out systematic procedures that incorporate four basic elements: task planning, data collection and analysis, data handling, and data reporting. Refer to each agencies' emission inventory web site for the specifics of their annual inventory QA/QC activities.

S/L/T agencies perform a second set of QA/QC activities as part of the process of submitting their annual inventory to EPA's EIS. The EIS contains hundreds of automated QA/QC checks of the data provided by the S/L/T agencies (see Appendix Y). S/L/T agencies must resolve any QA/QC issue before the data is accepted by EIS.

EPA performs a number of QA/QC activities in developing the NEI (see Appendix Y). See also Section 7 of the 2011 NEI Version 2 documentation (EPA, 2015a).

Once EPA compiled a draft of the 2011 inventory, they issued a Federal Register notice stating that the inventory and supporting data were available for public review and comment. EPA received 47 comments from S/L/T agencies, stakeholders and other interested parties. EPA considered these comments in developing the NEI2011v2.

MARAMA conducted additional QA/QC activities when it loaded the 2011 NEI inventory files into the EMF system. The EMF provides integrated quality control processes to foster high quality data handling, organization, and summarization.

### 4.2. QA OF 2017 INVENTORIES

The following activities were completed in assuring the quality of the 2017 inventories:

- EPA performed a number of QA/QC activities in developing the projection and control factors used in developing EPA 2011 v6.2.
- EPA compiled a draft of the 2017 inventory and issued a Federal Register notice stating that the inventory and supporting data were available for public review and comment.
- S/L/T agencies reviewed EPA's draft 2017 inventory and provided MARAMA with guidance on how to adjust EPA's projections to incorporate state specific data. The state guidance was used to replace EPA's projections with state-specific data where available.

- S/L/T agencies conducted QA/QC of the data used by the ERTAC EGU Projection Tool, including activities to ensure that all sources were accounted for and no sources were double-counted. S/L/T agencies reviewed annual and peak growth rates for reasonableness. S/L/T agencies also reviewed ERTAC data files with information on future year shutdowns, fuel-switches, and new/improved control equipment.
- S/L/T agencies reviewed all projection factor spreadsheets for reasonableness.
- MARAMA used the CoST model to perform numerous automated quality assurance routines.
- MARAMA prepared emission summary reports by state, sector, pollutant and year. These summaries were reviewed for reasonableness, completeness, and accuracy.
- S/L/T emission modelers used the QA/QC routines built into the SMOKE emission modeling system to assess reasonableness, completeness, and accuracy.
- CSRA performed a variety of QA spot-checks to verify that the emission projections calculated by EMF were reasonable and explainable. These checks included verifying the 2011 emissions for a randomly chosen set of sources, verifying that the correct projection and control factors were used, independently calculating the 2017 emissions using the projection and control factors, and comparing the independently calculated 2017 emissions with the EMF 2017 calculations. Spot-checks were also performed to compare the 2017 BETA2 emissions to the EPA NEI2017 and MARAMA 2017 ALPHA2 emissions. Any differences between these three data sets were reviewed and were easily explained as a result of changes in projection factors (using AEO2015 instead of AEO2014) or control factors (new RWC NSPS, revised NSPS factors for RICE, etc.).

## 5. DATA FILES

MARAMA and S/L/T agencies use a variety of databases and tools to prepare the data files needed to run the Sparse Matrix Operator Kernel Emissions (SMOKE) modeling system to prepare emissions input data for air quality modeling. These databases and tools include:

- The Emissions Modeling Framework (EMF) software system to manage and assure the quality of emissions inventories and emissions modeling-related data. One of the modules within the EMF system is the Control Strategy Tool (CoST) module.
- NEI2011v2 annual emission inventory files. EPA provides these files in the Flat File 2010, also known as the FF10 format, for various subsectors in order to facilitate processing by SMOKE.
- The ERTAC Forecast Tool with associated input databases to project emissions from EGUs.
- Various EMF projection, closure and control packets to project emissions from nonERTAC point sources, nonpoint sources, and aircraft engines/GSE/APUs.
- Other models (NMIM/NONROAD, MOVES, SMARTFIRE, BEIS) with associated input databases to project emissions from nonroad equipment, onroad vehicles, fires and biogenic sources. For this inventory, S/L/T agencies are collaborating with EPA in developing the model input files and reviewing the modeling results. See EPA documentation for the input files used by these models for 2011 and 2017.

Figure 40 and Figure 41 list the annual emission inventory EMF datasets for 2011 and 2017 respectively. Other auxiliary files needed to run the SMOKE emission modeling system are documented elsewhere.



**Figure 40: Annual Emission Inventory Files for 2011**

MARAMA Sector	2011 Inventory File	Notes
Point – ERTAC EGUs	CENSARA_2011_ERTACEGUv25_20160603_TXOKNEKSIAARLAMO LADCO_2011_ERTACEGUv25_20160603_MIOHINILWIMN OTC_2011_ERTACEGUv25_20160603_MENHVTMARICTNYNJDEPAMDDCVA SESARM_2011_ERTACEGUv25_20160603_WVNCSCGAKYTNALMS	NEI2011v2 point sources included in the ERTAC EGU projection tool; hourly NOX and SO2 CEMS data replaces annual NOX and SO2 NEI data in the air quality model inputs. ERTAC v2.5 files were post-processed to include all criteria pollutants.
Point – NonEGUs	ptnonERTAC_ipm_2011NEIv2_20160512.csv	NEI2011v2 point sources included in the ERTAC UAF but not included in the ERTAC EGU projection tool; and any IPM units not included in the ERTAC forecasting tool.
	ptnonipm_2011NEIv2_POINT_20140913_revised_20150115_09feb2015_v2_MARAMA	NEI2011v2 non EGU point sources
	ethanol_plants_2011NEIv2_POINT_20141123_03feb2015_v1	2011 ethanol plant facilities from EPA's Office of Transportation and Air Quality (OTAQ) that were not identified in the NEI2011v1.
	othpt_offshore_oil_2011NEIv2_POINT_20140913_16sep2014_v0.csv	EPA augmentation to include U.S. offshore oil production platforms outside the typical 3-10 nautical mile boundary defining state waters
	pt_oilgas_2011NEIv2_POINT_20140913_03feb2015_v4	Onshore oil & gas production point sources
	refueling_2011NEIv2_POINT_20140913_04dec2014_v2	Gasoline refueling processes at point source facilities
NonPoint	nonpt_2011NEIv2_NONPOINT_20141108_21jan2015_v5_MARAMA	NEI2011v2 for all nonpoint source SCCs not included in the individual tables below.
	afdust_2011NEIv2_NONPOINT_20141108_11nov2014_v1.csv EPA_2011_afdust_no_precipadj_paved_unpaved_noNEIv2RPOstates_23sep2014_v0.csv	NEI2011v2 PM emissions for paved roads, unpaved roads and airstrips, construction (residential, industrial, road and total), agriculture production, and mining and quarrying
	ag_2011NEIv2_NONPOINT_20141108_04feb2015_v3	NEI2011v2 NH3 emissions from EPA 'eh' platform nonpoint livestock and fertilizer application, county and annual resolution
	np_oilgas_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv	NEI2011v2 nonpoint sources from oil and gas-related processes
	pfc_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv	NEI2011v2 portable fuel container nonpoint sources

MARAMA Sector	2011 Inventory File	Notes
	refueling_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv	NEI2011v2 Stage I gasoline refueling nonpoint sources. (State II emissions were moved to onroad in the BETA2 inventory)
	rwc_2011NEIv2_NONPOINT_20141108_24nov2014_v3	NEI2011v2 residential wood combustion nonpoint sources
Nonroad – CMV, Aircraft, Locomotives	c1c2_offshore_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv	C1/C2 commercial marine vessel (CMV) emissions sources from the 2011NEIv6.2 nonpoint inventory located outside of state territorial waters
	c1c2rail_2011NEIv2_NONPOINT_20141108_11nov2014_v1.csv	Locomotives (except those at rail yards) and C1/C2 CMV emissions sources from the 2011NEIv6.2 nonpoint inventory located within state territorial waters
	eca_imo_nonUS_nonCANADA_caps_vochaps_2011_16jun2015_v1_orl_MARAMA.txt	C3 CMV emissions sources projected from the 2002 ECA-IMO point inventory located outside of state territorial waters
	c3marine_2011NEIv2_NONPOINT_20141108_14nov2014_v1.csv	C3 CMV emissions sources from the NEI2011v2 nonpoint inventory located within state territorial waters
	ptnonipm_2011NEIv2_POINT_20140913_revised_20150115_09feb2015_v2_MARAMA	Aircraft, GSE and APU sources are included in the NEI2011v2 point source inventory
Nonroad – NONROAD Model Sources	2011NEIv1_nonroad_20130621_17oct2014_v6_MARAMA	2011NEIv1 nonroad equipment emissions developed using the NMIM/NONROAD model
Onroad – MOVES Model Sources	MOVES2014a_ONROAD_EPA2011ek_FF10	2011 NEIv2 onroad equipment emissions developed using the MOVES2014 model
Fires	agburn_monthly_2011NEIv2_NONPOINT_20141108_11nov2014_v0.csv	NEI2011v2 annual and monthly emissions for agricultural burning activities
	ptfire_*_2011v2_prescribed_16jan2015_v0 (* = January – December) ptfire_*_2011v2_wild_16jan2015_v0 (* = January – April; July – December) ptfire_*_2011v2_wild_16jan2015_v0_MARAMA.txt (* = May, June only)	NEI2011v2 prescribed and wild fire events: May and June wild fires were updated to remove exceptional wild fires in NC from each month.
Biogenics	biogenic_2011ek_BEIS3_61_BELD4_1_08spe2016.csv	County-level biogenic emissions from 2011 v6.3 Modeling Platform

**Figure 41: Annual Emission Inventory Files for 2017**

MARAMA Sector	2017 Inventory File	Notes
Point – ERTAC EGUs	CENSARA_2017_ERTACEGUv25L_20160919_TXOKNEKSIAARLAMO LADCO_2017_ERTACEGUv25L_20160919_MIOHINILWIMN OTC_2017_ERTACEGUv25L_20160919_MENHVTMARICTNYNJDEPAMDDCVA SESARM_2017_ERTACEGUv25L_20160919_WVNCSCGAKYTNALMS	NEI2011v2 point sources included in the ERTAC EGU projection tool; ERTAC EGU v2.5L runs were used. Details of which are summarized in TTTT of this document.
Point – NonEGUs	2017_POINT_PTNONERTAC_IPM_20jun2016	NEI2011v2 point sources included in the ERTAC UAF but not included in the ERTAC EGU projection tool; and any IPM units not included in the ERTAC forecasting tool. Projected using MARAMA V2 growth factors.
	2017_POINT_ptnonipm_25jul2016	NEI2011v2 non EGU point sources. Projected using MARAMA V2 growth factors.
	2017eh_from_ethanol_plants_2011NEIv2_POINT_20141123_10mar2015_v0_MARAMA	2011 ethanol plant facilities from EPA's Office of Transportation and Air Quality (OTAQ) that were not identified in the NEI2011v1.
	othpt_offshore_oil_2011NEIv2_POINT_20140913_16sep2014_v0.csv	EPA augmentation to include U.S. offshore oil production platforms outside the typical 3-10 nautical mile boundary defining state waters. Used 2011 for 2017 (consistent with EPA)
	2017_POINT_oilgas_23jul2016	Onshore oil & gas production point sources with SCCs 31000101 through 31000506, 31088801 through 31088811, and 31700101. Projected using MARAMA V2 growth factors.
	2017_POINT_refueling_15jul2016	Gasoline refueling processes at point source facilities. Projected using MARAMA V2 growth factors.
	Biodiesel_Plants_2018_ff10_11apr2013_v0.csv	Planned sources that did not exist in the NEI2011v2. Year 2018 new biodiesel plants based on planned sited plants production volumes provided by OTAQ. Consistent with EPA, used 2018 for 2017.
	MARAMA_Beta_2017_cement_newkilns_year_2018_from_ISIS2013_NEI2011v1_17mar2015_v2	Permitted sources that did not exist in the NEI2011v2. Year 2017 new cement kilns based on ISIS policy case-derived permitted kilns. <b>Note: None of the 15 Northeastern states has new cement kilns projected for 2017.</b>

MARAMA Sector	2017 Inventory File	Notes
NonPoint	2017_NONPOINT_nonpt_29jun2016	NEI2011v2 for all nonpoint source SCCs not included in the individual tables below. Projected using MARAMA V2 growth factors.
	2017_NONPOINT_afdust_unadj_NEI_28jun2016 2017_NONPOINT_afdust_unadj_RPOstates_paved_unpaved_28jun2016	NEI2011v2 PM emissions for paved roads, unpaved roads and airstrips, construction (residential, industrial, road and total), agriculture production, and mining and quarrying. Projected using MARAMA V2 growth factors.
	2017_NONPOINT_ag_28jun2016	NEI2011v2 NH3 emissions from 2011NEIv1 nonpoint livestock and fertilizer application, county and annual resolution. Projected using MARAMA V2 growth factors.
	2017_NONPOINT_oilgas_15jul2016	NEI2011v2 nonpoint sources from oil and gas-related processes. Projected using MARAMA V2 growth factors.
	2017_NONPOINT_pfc_29jun2016	NEI2011v2 portable fuel container nonpoint sources. Projected using MARAMA V2 growth factors.
	2017_NONPOINT_refueling_20jun2016	NEI2011v2 Stage I and Stage II gasoline refueling nonpoint sources. Projected using MARAMA V2 growth factors.
	2017_NONPOINT_RWC_20jun2016	NEI2011v2 residential wood combustion nonpoint sources. Projected using MARAMA V2 growth factors.
	2017_cellulosic_inventory_06jan2014_v1_MARAMA 2017_cellulosic_new_iowa_plants_from2018docket_2011v6_2_ff10_28jan2015_v0 cement_newkilns_year_2018_from_ISIS2013_NEI2011v1_NONPOINT_12feb2015_v1_MARAMA	Sources that did not exist in the NEI2011v2, but are projected to be needed in 2017. New cellulosic plants based on cellulosic biofuel refinery siting provided by OTAQ and 2018 NODA; year 2018 new cement kilns based on shifted capacity from some closed units to open units. Consistent with EPA, used 2018 for 2017. <b>Note: None of the 15 Northeastern states has new cellulosic sources or cement kilns projected for 2017.</b>
Nonroad – CMV, Aircraft, Locomotives	2017_NONPOINT_c1c2offshore_06may2016.csv	C1/C2 commercial marine vessel (CMV) emissions sources from the 2011NEIv6.2 nonpoint inventory located outside of state territorial waters. Projected using MARAMA V2 growth factors.

MARAMA Sector	2017 Inventory File	Notes
	2017_NONPOINT_c1c2rail_27jun2016	Locomotives (except those at rail yards) and C1/C2 CMV emissions sources from the 2011NElv6.2 nonpoint inventory located within state territorial waters. Projected using MARAMA V2 growth factors.
	ptinv_2017eh_from_eca_imo_nonUS_nonCANADA_caps_vochaps_2011_25feb2015_v0_orl_MARAMA .txt	C3 CMV emissions sources projected from the 2002 ECA-IMO point inventory located outside of state territorial waters
	2017_NONPOINT_c3marine_28jun2016	C3 CMV emissions sources from the NEI2011v2 nonpoint inventory located within state territorial waters
	2017_POINT_ptnonipm_25jul2016	Aircraft, GSE and APU sources are included in the NEI2011v2 point source inventory with the following SCCs: 285000201, 2265xxxxxx, 2267xxxxxx, 2268xxxxxx, 2270xxxxxx, and 2275xxxxxx
Nonroad – NONROAD Model Sources	2017_nonroad_ff10_adjusted_from_2018_noCalif_23mar2015_v0_MARAMA	2017NElv1 nonroad equipment emissions developed using the NMIM/NONROAD model
Onroad – MOVES Model Sources	MOVES2014a_ONROAD_EPA2017ek_FF10	2017 NElv2 onroad equipment emissions developed using the MOVES2014 model
Fires	agburn_monthly_2011NElv2_NONPOINT_20141108_11nov2014_v0.csv	NEI2011v2 annual and monthly emissions for agricultural burning activities
	ptfire_*_2011v2_prescribed_16jan2015_v0 (* = January – December) ptfire_*_2011v2_wild_16jan2015_v0 (* = January – April; July – December) ptfire_*_2011v2_wild_16jan2015_v0_MARAMA.txt (* = May, June only)	NEI2011v2 prescribed and wild fire events: May and June wild fires were updated to remove exceptional wild fires in NC from each month.
Biogenics	biogenic_2011ek_BEIS3_61_BELD4_1_08spe2016.csv	County-level biogenic emissions from 2011 v6.3 Modeling Platform. Consistent with EPA, used 2011 for 2017.
Emissions Offsets from closed plants/units	2017_MARAMA_NONPT_offsets_DCNJ.csv 2017_MARAMA_PT_offsets_CTDEMDVA.csv	County-level emissions from plants/units that were closed after 2011. Emissions provided by states.

## 6. DATA SUMMARIES

This section provides emission summary graphs for each pollutant by state, year and sector. Additional numerical summaries in tabular format are provided in Appendix AA. The sectors shown in the following figures are defined below. Appendix BB lists how SCCs were assigned to sectors.

- **ERTAC EGU Point Sources.** This sector includes emission units located primarily at electric power plants that are included in the ERTAC EGU forecasting tool. These sources are required to report continuous emission monitoring data to EPA's Clean Air Market Division (CAMD). Air quality modeling uses the hourly emissions data for these units to accurately reflect the temporal variation in emissions
- **Small EGU (NonERTAC IPM) Point Sources.** This sector includes emission units that are NOT included in the ERTAC EGU Projection Tool but are included in EPA's IPM scenarios. This is the same as the "Point non-ERTAC EGU" source group.
- **NonEGU Point Sources.** This sector includes facilities and sources located at a fixed, stationary location such as larger industrial, commercial and institutional facilities.
- **Aircraft/GSE/APU Point Sources.** This sector includes emissions from aircraft engines, ground support equipment and auxiliary power units that are identified as point sources (e.g., emissions are located at specific airport locations).
- **Nonpoint Sources.** This sector includes sources which individually are too small in magnitude or too numerous to inventory as individual point sources. Nonpoint sources include consumer products, paints, residential, commercial and industrial fuel combustion not in the point source inventory, smaller industrial, commercial and institutional facilities, Stage I unloading emissions from the filling of underground storage tanks. Stage II refueling emissions are included in onroad sector. This sector does not include locomotive emissions outside of the rail yards and commercial marine vessel emissions, which are included in the other nonroad sector described below. S/L/T agencies and EPA estimate nonpoint emissions at the county level.
- **Rail/CMV Nonroad Sources.** This category includes internal combustion engines used to propel marine vessels and locomotives.
- **Nonroad Sources in the NONROAD Model.** This category contains mobile sources included in NONROAD model within the National Mobile Inventory Model (NMIM). Nonroad emissions result from the use of fuel in a diverse collection of vehicles and equipment such as construction equipment, recreational vehicles, and landscaping equipment.
- **Onroad Sources.** This category contains mobile sources included in the MOVES model. Onroad emissions result from the combustion and evaporation of fuel used by motorized vehicles, including vehicle refueling (Stage 2) emissions that are normally operated on public roadways. This includes passenger cars, motorcycles, minivans, sport-utility vehicles, light-duty trucks, heavy-duty trucks, and buses.
- **Fire Sources.** This source category includes wildfires and prescribed burning sources of pollution caused by the inadvertent or intentional burning of biomass including forest,

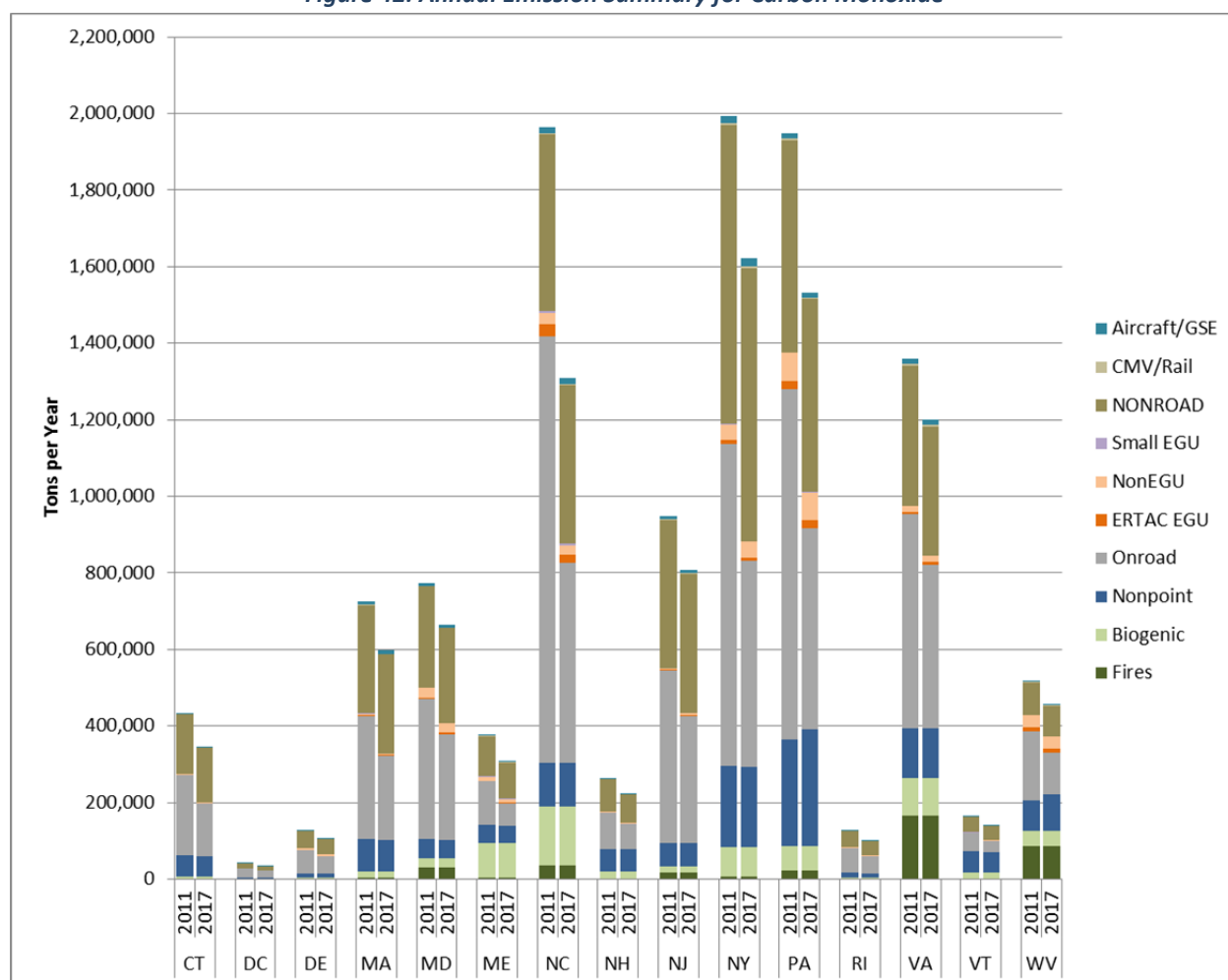
rangeland (e.g., grasses and shrubs), and agricultural vegetative residue. Other burning sources such as permitted agricultural burning are included in the nonpoint inventory.

- **Biogenic Sources.** This category includes emissions from vegetation and soils that are computed via a model that utilizes spatial information on vegetation and land use, and environmental conditions of temperature and solar radiation.

## 6.1. CARBON MONOXIDE

Figure 42 summarizes CO emissions by state, year and sector. For the 15-state region, CO emissions are projected to decrease by 20 percent from 11.8 to 9.4 million tons between 2011 and 2017. The reduction is associated with the significant reductions in emissions from the onroad and nonroad sectors resulting from national emissions standards for highway vehicle and nonroad engines.

Figure 42: Annual Emission Summary for Carbon Monoxide

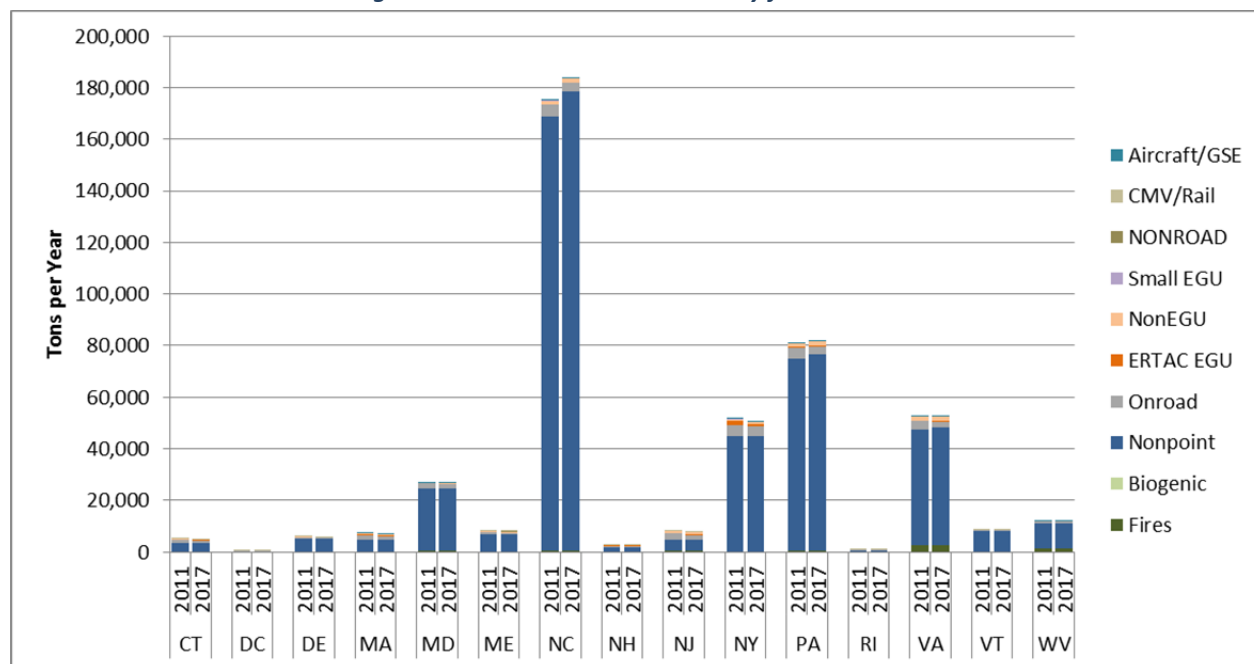




## 6.2. AMMONIA

Figure 43 summarizes NH<sub>3</sub> emissions by state, year and sector. For the 15-state region, NH<sub>3</sub> emissions are projected to increase by 1.3% percent from 446,000 to for 452,000 tons between 2011 and 2017. Nearly all of the NH<sub>3</sub> emissions are from the nonpoint sector, primarily agricultural fertilizer application and livestock waste operations.

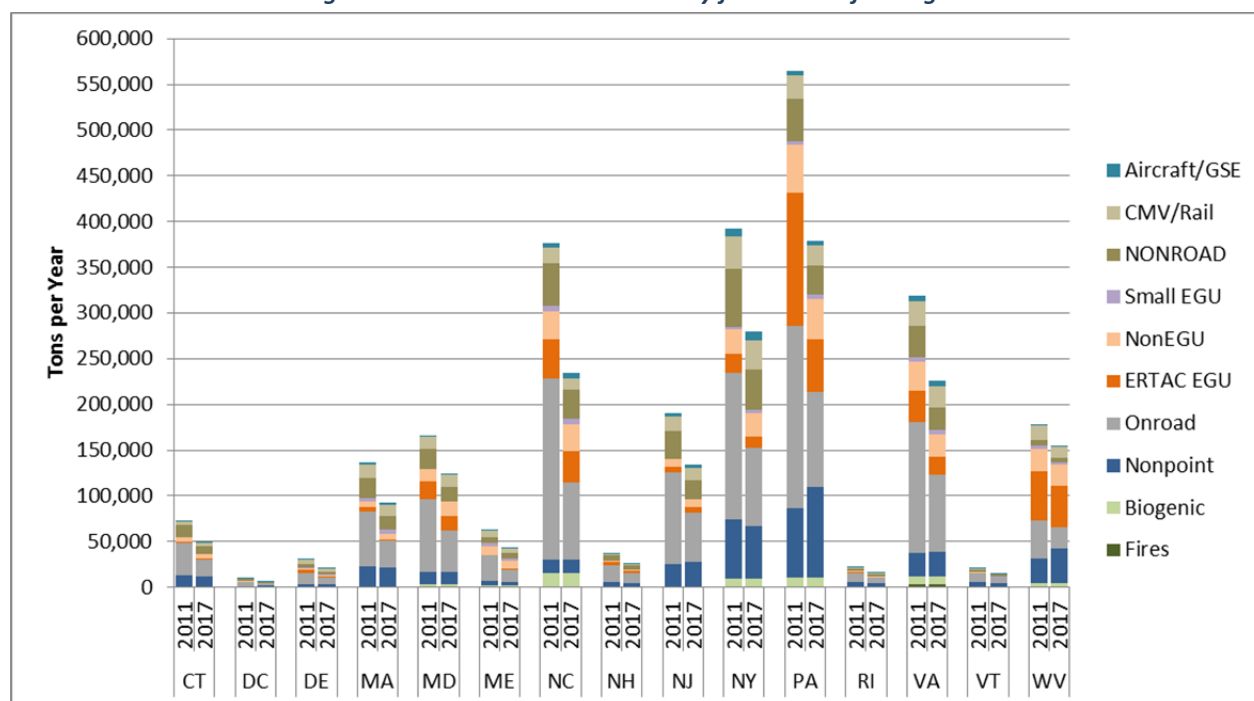
**Figure 43: Annual Emission Summary for Ammonia**



### 6.3. OXIDES OF NITROGEN

Figure 44 summarizes NO<sub>x</sub> emissions by state, year and sector. For the 15-state region, NO<sub>x</sub> emissions are projected to decrease by 30 percent from 2.6 to 1.8 million tons between 2011 and 2017. Three sectors show significant reductions in emissions between 2011 and 2017 – onroad emissions decrease by 48 percent, nonroad emissions decrease by 31 percent, and ERTAC EGU emissions decrease by 41 percent. Two sectors show significant increases – nonpoint emissions (in particular, emissions from oil & gas exploration) are projected to increase by 8 percent and aircraft emission increase by 11 percent between 2011. NO<sub>x</sub> emissions from nonEGUs are projected to decrease by 6 percent between 2011 and 2017.

Figure 44: Annual Emission Summary for Oxides of Nitrogen

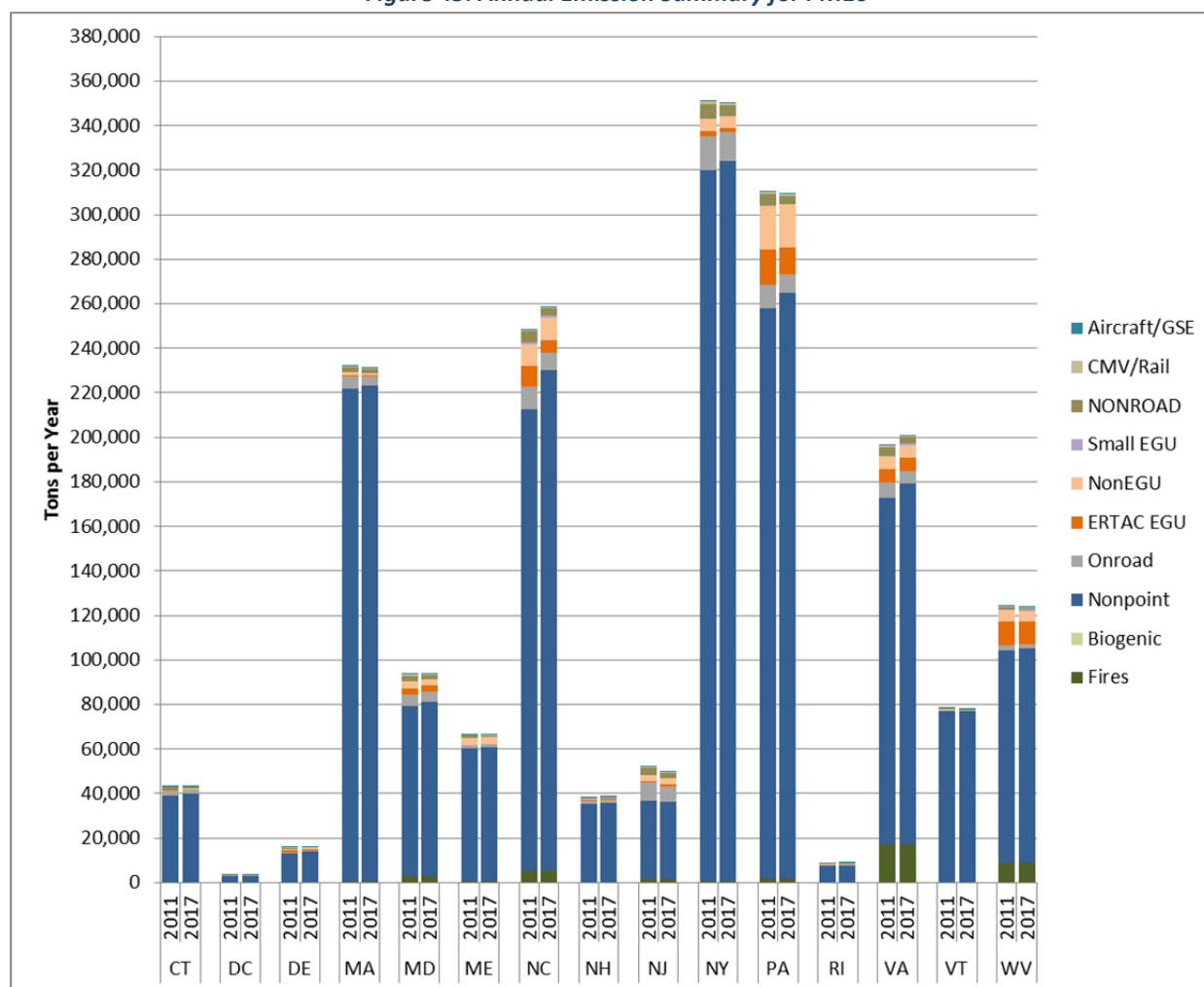


## 6.4. PM10

Figure 45 summarizes unadjusted PM10 emissions by state, year and sector. For the 15-state region, PM10 emissions are projected to remain relatively unchanged at 1.9 million tons in both 2011 and 2017. Most of the PM10 emissions resulted from dust that is re-entrained by vehicles traveling on paved roads.

Footnote the PM graphs as including unadjusted fugitive dust or adjusted fugitive dust, I think you are showing unadjusted

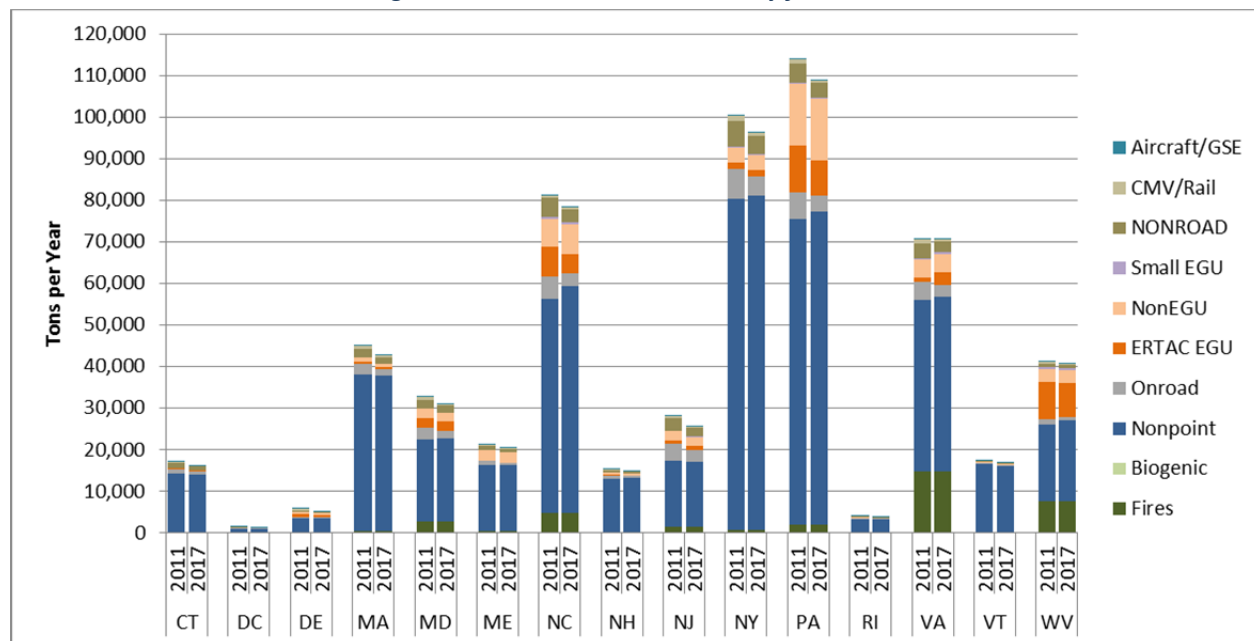
**Figure 45: Annual Emission Summary for PM10**



## 6.5. PM2.5

Figure 46 summarizes unadjusted PM2.5 emissions by state, year and sector. For the 15-state region, PM2.5 emissions are projected to decrease slightly from 0.6 million tons in 2011 to 0.57 million tons in 2017. Most of the PM2.5 emissions resulted from dust that is re-entrained by vehicles traveling on paved roads and from residential/commercial/industrial fuel combustion. Residential wood combustion is also a significant source of PM2.5 in the region.

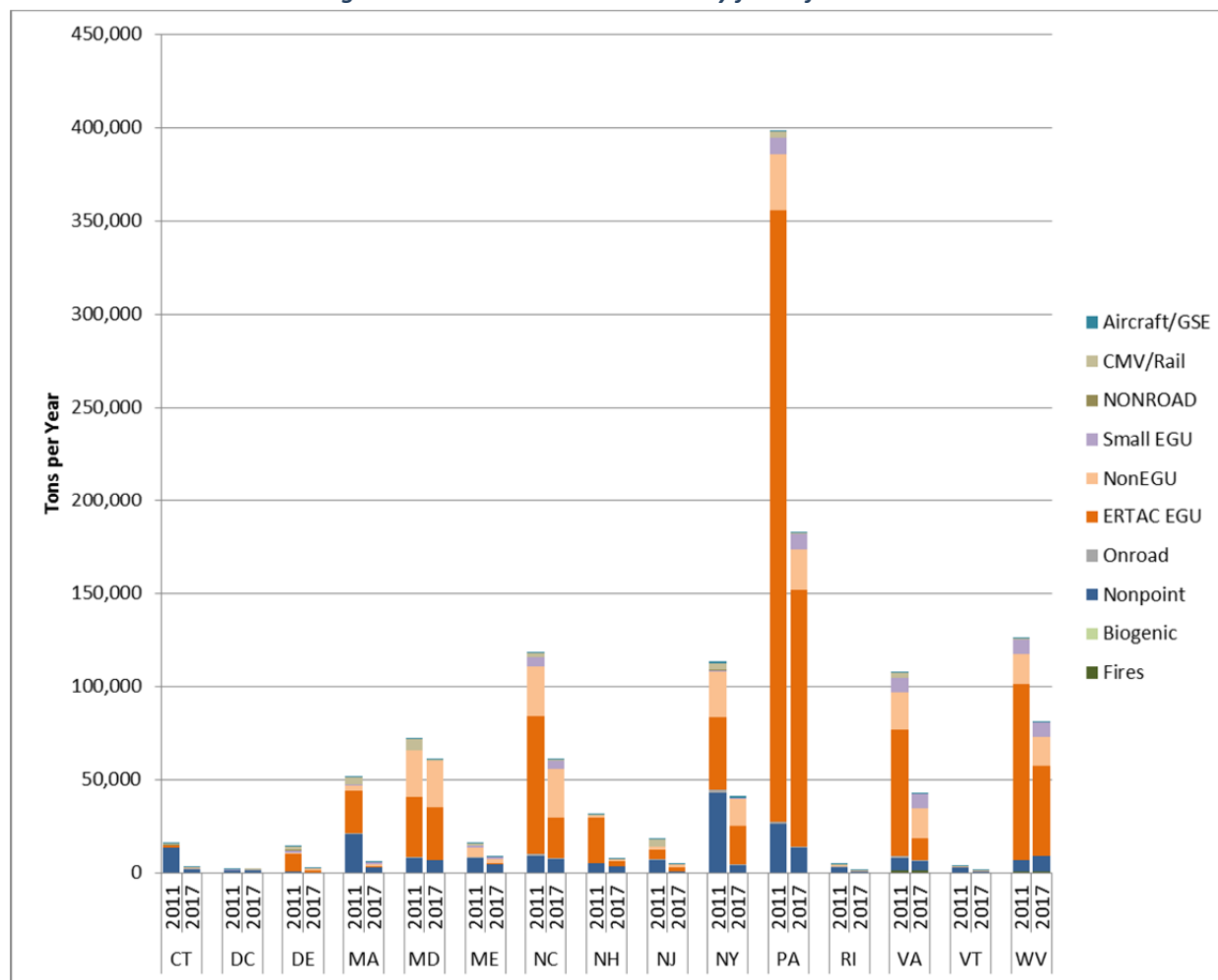
Figure 46: Annual Emission Summary for PM2.5



## 6.6. SULFUR DIOXIDE

Figure 47 summarizes SO<sub>2</sub> emissions by state, year and sector. For the 15-state region, SO<sub>2</sub> emissions are projected to decrease by 54 percent from 1.1 to 0.5 million tons between 2011 and 2017. The emissions from ERTAC EGUs are projected to decrease by 61 percent. Significant SO<sub>2</sub> reductions are projected for the onroad and nonroad sectors due to lower sulfur content limits for gasoline and diesel fuels. Additional SO<sub>2</sub> reductions are projected from the nonpoint sector due to more stringent sulfur content limits for home heating oil and other distillate/residual fuel oils.

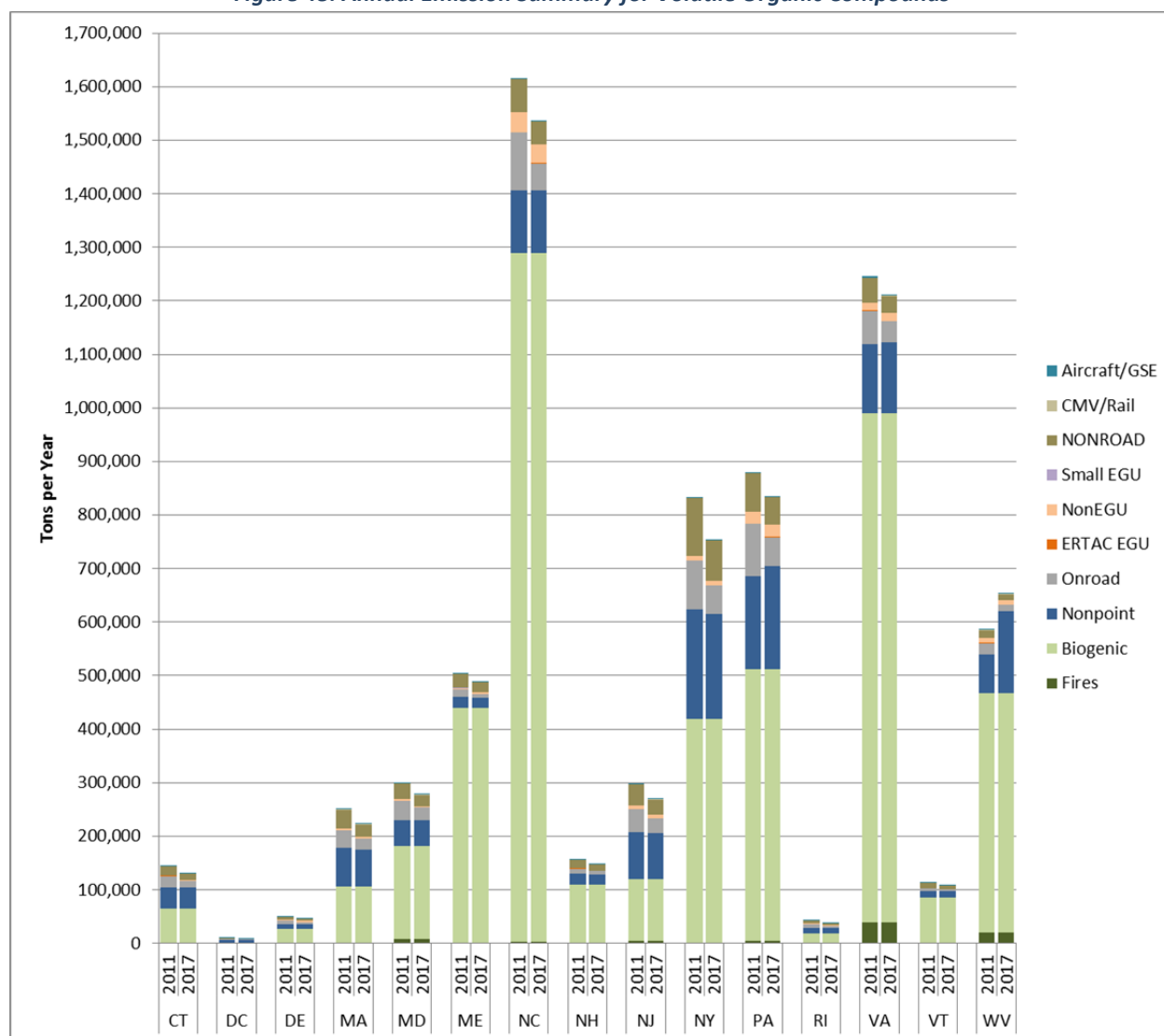
Figure 47: Annual Emission Summary for Sulfur Dioxide



## 6.7. VOLATILE ORGANIC COMPOUNDS

Figure 48 summarizes VOC emissions by state, year and sector. For the 15-state region, VOC emissions are projected to decrease by 4 percent from 7 to 6.7 million tons from 2011 and 2017. Biogenic emissions represent about 68 percent of the total VOC emissions in 2011 and are projected to remain unchanged between 2011 and 2017. Man-made VOC emissions are projected to decrease by 14 percent, due primarily to reductions in the onroad and nonroad sectors.

**Figure 48: Annual Emission Summary for Volatile Organic Compounds**



## 6.8. PROJECTION OF EMISSIONS FROM OUTSIDE NORTHEASTERN STATES INCLUDING CANADIAN EMISSIONS

As noted in Section 1, this detailed documentation is only for the 15 states in the Northeastern US. Since the modeling domain includes 20 other states, off-shore sources and Canadian provinces, we needed to estimate these emissions to have a complete modeling inventory.

EPA provided national 2017 emission inventories and EMF Closure, Control and Projection packets. MARAMA used these resources for its 2017 emission projections for the other 20 states and off-shore sources as follows:

- Fire (agricultural, prescribed, wild), Biogenic, and Offshore Oil inventories: used EPA 2011 inventories directly. Consistent with EPA, 2017 = 2011
- Offshore C3 marine inventory: used EPA 2017 inventory directly
- Remaining nonpoint and point sectors: projected 2011 MARAMA BETA2 inventories to 2017 using EPA Closure, Control and Projection packets.

The Canadian government provided USEPA with a 2010 emissions inventory. This is the most current inventory available for that country. No projections to future years were provided by Canadian officials. This inventory was shared with the NE regional modeling group.

These 2010 Canadian emissions are used to represent their 2011 emissions in both USEPA and NE regional modeling. To estimate Canadian emissions in 2017, the OTC modeling committee decided to apply the average change in emissions between base year 2011 and 2017 expected to occur in our own modeling domain, by pollutant sector. Figure 49 shows the adjustments and resulting multiplicative factors for 2018 applied to the Canadian 2010 inventory.

The Canadian inventory groups all point sources together, rather than splitting out EGU emissions, as is done in this inventory. Total point source reductions were estimated by proportionately weighing regional EGU and non-EGU point emissions to calculate a combined reduction. This reduction was then applied to all Canadian emissions.

**Figure 49: Adjustments to Project Canadian 2010 Inventory to 2018**

Sector	CO	NH3	NOx	PM2.5	SO2	VOC
Percent Change 2010 to 2018						
Onroad	-43	-29	-51	-42	-58	-50
Nonroad	-7	17	-30	-31	-52	-31
Point	-2	1	-13	-3	-45	2
Area	0	0	0	0	-31	-6



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