OTC Stationary and Area Source Committee, ICI Boiler Workgroup

An Analysis of Emissions from Industrial and Commercial/Institutional Boilers Using the Emissions Modeling Framework – VERSION 2

PRELIMINARY DRAFT 6/16/15 – DO NOTE CITE OR QUOTE

Executive Summary

The Industrial/Commercial/Institutional (ICI) Boiler Workgroup of the Ozone Transport Commission (OTC) Stationary and Area Source (SAS) Committee performed an analysis of annual ICI boiler nitrogen oxides (NOx) and annual sulfur dioxide (SO_2) emissions using the Mid-Atlantic Regional Air Management Association's (MARAMA) installation of EPA's Emissions Modeling Framework (EMF). The Workgroup's analysis included the years 2007, 2011, and 2018 and the geographic regions included the Northeast states, the Midwest states, the Southeast states, and the remainder of the CONUS states. Analyses were performed for ICI boiler emissions by fuel type as well as ICI boiler emissions compared to total emissions from other inventory sectors. The Workgroup also used EPA's Emissions Inventory System (EIS) Gateway to quality-assure the results obtained with EMF. In brief, the Workgroup was trying to answer the following questions:

- How did ICI boiler emissions change between 2007 and 2011?
- What is the expected change in ICI boiler emissions between 2011 and 2018?
- What is the fuel type breakdown for ICI boiler emissions?
- Are emissions from ICI boilers substantial enough to warrant further analysis of their impact on ozone and regional haze?

The Workgroup's analysis shows that between 2007 and 2011, total annual ICI boiler NOx and SO_2 emissions for the Northeast states plus Virginia region decreased by 29% and 57% respectively. Modest decreases in ICI boiler NOx emissions are expected between 2011 and 2018 (between 7 and 12%). More substantial decreases in ICI boiler SO_2 are expected between 2011 and 2018, ranging from 51 to 56%.

The Workgroup also performed an analysis of ICI boiler emissions by fuel type. In 2011, the Northeast region displayed a fairly heterogeneous pattern amongst states; that is, each individual state in the Northeast had a unique fuel use makeup. Natural gas, oil, and coal were all important contributors to ICI boiler emissions in the Northeast states, with coal being prominent in MD, NY, PA, and VA. Residual oil was also prominent for NY. The rural states of ME and VT were dominated by wood and oil. The Midwest states display a much more homogeneous pattern in fuel use, with coal and natural gas being the most important contributors. The Southeast states also displayed a fairly homogeneous pattern of fuel use. Coal, natural gas, and wood were the most important contributors to ICI boiler emissions in the Southeast, with wood being more prominent in this region than the Northeast or the Midwest.

The Workgroup's analysis also included a comparison of ICI boiler emissions to emissions from other sectors. According to these comparisons, 2011 ICI boiler NOx emissions ranged from 6% to 7% of total emissions from all sectors for the three geographic regions. 2011 ICI boiler SO_2 emissions ranged from

10% to 16% of total emissions from all sectors for the three geographic regions. For the continental U.S. as a whole, 2011 ICI boiler NOx emissions were 5% of total emissions for all sectors, and ICI boiler SO_2 emissions were 11% of the total. These figures compare well with the findings of an ICI boiler Workgroup formed in 2006 by the OTC and the Lake Michigan Air Directors Consortium (LADCO). The results of the OTC/LADCO study found that, according to EPA's 2002 National Emissions Inventory, ICI boilers emitted 6% of total NOx emissions and 13% of total SO_2 emissions. For 2018, as controls on other sectors (e.g. mobile sources) tighten, ICI boiler emissions become a somewhat higher percentage of the total. 2018 ICI boiler NOx emissions range from 8 to 9% of total emissions for the three regions (as compared with 6% to 7% for 2011), and 2018 ICI boiler SO_2 emissions range from 12% to 22% of total emissions (as compared with 10% to 16% for 2011). For the continental U.S., 2018 ICI boiler NOx emissions are 7% of total emissions and 2018 ICI boiler SO_2 emissions are 13% of total emissions.

According to this analysis, emissions from ICI boilers are substantial enough to warrant a further analysis of their impact on ozone and regional haze (and other pollutants such as NO_2, particulate matter and SO_2). Although ICI boiler NOx emissions are only a modest portion of total NOx emissions (5% of the total for 2011 and 7% of the total for 2018 in the continental U.S.), the national ambient air quality standard (NAAQS) for ozone continues to be lowered. The final 8-hr NAAQS for ozone will likely be in the range of 60 to 70 parts per billion (ppb). As a result, changes of as little as 1 ppb in ambient air ozone design values might mean the difference between attainment and non-attainment of the standard, and therefore even small changes in NOx emissions will have an effect on whether or not the standard can be met. Similarly, states and other agencies are currently implementing their State Implementation Plans (SIPs) for meeting regional haze goals, and even modest changes in emissions may help or hurt in meeting those goals. The data from this analysis shows that ICI boiler SO_2 emissions are an even bigger portion of the total (11% of the total for 2011 and 13% of the total for 2018 for the continental U.S.; 16% of the total for 2011 and 22% of the total for 2018 for the Northeast).

Although there is still work to be done, substantial benefits to air quality have been achieved by improving controls and reducing emissions for inventory sectors such as electric generating units (EGUs) and mobile sources. But as mentioned above, further controls and emissions reductions are needed to meet the soon-to-be-revised 8-hr ozone NAAQS, the Regional Haze Rule requirements, the NAAQS for particulate matter less than 2.5 microns ($PM_{2.5}$), and the more stringent 2010 1-hr NO_2 and SO_2 NAAQS. As sectors such as EGUs and mobile sources continue to be controlled, it is likely that these needed emissions reductions will have to come from other sectors. Therefore, the ICI Boiler Workgroup recommends a further analysis of the impact of ICI boiler emissions on ozone, regional haze, and other pollutants using screening-level air quality modeling or other means. This analysis shows that ICI boiler emissions are expected to continue decreasing between 2011 and 2018; however, the ICI Boiler Workgroup feels that opportunities exist for further reductions in ICI boiler emissions, particularly in the coal and oil fuel use categories.

1. Introduction

In 2006, a workgroup was formed by the OTC and LADCO to evaluate control options for ICI boilers. The workgroup findings were documented in a 2010 report titled "Evaluation of Control Options for Industrial, Commercial and Institutional (ICI) Boilers, Technical Support Document (TSD), FINAL, 05/14/10". The OTC/LADCO Workgroup found that, according to EPA's 2002 National Emissions Inventory, ICI boilers emitted 6% of total NOx emissions and 13% of total SO_2 emissions. Based on these findings, and after an extensive review of technological options and costs, the OTC/LADCO Workgroup developed a 3-part control program for ICI boilers: (1) performance based NOx and SO_2 emissions limits, (2) annual boiler tune ups, and (3) annual emissions reporting. The OTC/LADCO Workgroup's ICI boiler control program is discussed in more detail in Appendix A.

To further the work already done by the OTC/LADCO Workgroup, a workgroup of the OTC SAS Committee was formed in 2014 to perform an analysis of ICI boiler emissions using MARAMA's installation of the EMF. The EMF is a software system used by the EPA to manage emissions inventory files and ancillary data for use in the complex process of emissions modeling. MARAMA has established its own EMF server to assist its member agencies with maintaining, quality assuring, and projecting emissions inventories for use in SIP planning, regional photochemical modeling, and other air quality management efforts. The goals of the 2014 OTC ICI Boiler Workgroup's efforts were as follows:

- Identify the changes in ICI boiler NOx and SO_2 emissions inventories that occurred between 2007 and 2011.
- Identify the amount of projected ICI boiler emissions that could occur in 2018.
- Determine whether the amount of NOx and SO_2 emissions from the ICI boiler sector are large enough to warrant further analysis of potential adverse ozone and regional haze impacts caused by NOx and SO_2 emissions from this sector.
- Identify potential NOx and SO_2 emission control strategies for the ICI boiler sector if the amount of NOx and SO_2 emissions from the ICI boiler sector is large enough to warrant further analysis of potential adverse ozone and regional haze impacts.

The scope of this inventory analysis was as follows:

- **Years:** The years 2007, 2011, and 2018 were selected as the years of interest. The year 2007 was selected because the 2007 modeling platform was previously developed and used by the OTC states for air quality modeling. The year 2011 was selected because a new modeling platform is being developed by the OTC states and EPA for use in transport analyses and because 2011 was a full National Emissions Inventory (NEI) submittal year. The year 2018 was selected as a future year because EPA and the OTC states have developed 2018 emissions projections which will be used for multiple air quality analyses.

- **Geographic Area:** This analysis was completed for three distinct geographic regions: the Northeast states (Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont); the Midwest states (Illinois, Indiana, Michigan, Minnesota, Ohio and Wisconsin); and the Southeast states

(Alabama, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia). Additional analysis for 2011 and 2018 was performed for the remaining states in the continental U.S. (CONUS).

- **Inventory Sector:** This analysis was completed for all ICI boilers included in the point source inventory and the area source, or nonpoint, inventory. The ICI boiler source classification code (SCC) inventory is divided into 3 sections: point source ICI boilers, area source industrial boilers and area source commercial boilers.

- **Pollutants considered:** The pollutants considered were NOx and SO_2.

Technical Approach

- Data from the MARAMA 2007 emissions inventory (Final 2007 Version 3.3, "2007 v3 EI") were loaded onto the EMF server.
- 2011 Version 2 base year emissions inventory data from EPA's 2011 emissions modeling platform (ftp://ftp.epa.gov/EmisInventory/2011v6/v2platform/2011emissions/) and MARAMA's 2018 Alpha inventory were loaded onto the EMF server.
- The ICI Boiler Workgroup determined a list of appropriate SCCs to be analyzed for: point source ICI boilers, area source industrial boilers, and area source commercial/institutional boilers. Using this list, the Workgroup then developed a set of SQL queries to extract the applicable NOx and SO_2 emissions by state from the EMF server. A list of the SCCs used in this analysis is shown in Appendix B. Examples of the SQL queries that were used to extract the ICI boiler emissions are shown in Appendix C.
- The extracted data from the MARAMA 2007 Inventory, the EPA v2 2011 inventory, and the MARAMA 2018 Alpha inventory were sorted by SCC and state so that emissions summaries could be produced by fuel type for the geographic regions of interest.

Section 2 of this white paper presents the 2007 ICI boiler emissions and the changes that occurred in this sector in 2011. Section 3 discusses the projected 2018 ICI boiler emissions and compares them with base year 2011 ICI boiler emissions. In addition to the project goals described above, an analysis was made of ICI boiler emissions by fuel type. This is discussed in Section 4. In order to determine whether the amount of NOx and SO_2 emissions from the ICI boiler sector are large enough to warrant further analyses of potential adverse ozone and regional haze impacts, total ICI boiler emissions were compared with total emissions for all other sectors (e.g. point, area, non-road, and on-road). These comparisons were made for 2011 and 2018 for the Northeast states, Midwest states, and Southeast states and are presented in Section 5. Section 6 is a discussion of the data anomalies, limitations, and caveats that were encountered during the course of this project. Finally, conclusions are drawn in Section 7.

2. 2007 ICI Boiler Emissions and Changes that Occurred Between 2007 and 2011

As described above, data from the 2007 MARAMA Version 3.3 modeling emissions inventory were loaded onto the EMF server and ICI boiler emissions were queried and extracted by state using the list of

SCCs developed by the Workgroup. Because the MARAMA 2007 modeling inventory covered only the states in the OTR domain, 2007 emissions were limited to the Northeast states plus Virginia for this analysis. 2007 ICI boiler NOx emissions for this region are shown below in Table 2-1, and 2007 ICI boiler SO_2 emissions are shown in Table 2-2. Tables 2-1 and 2-2 also show the corresponding 2011 ICI boiler emissions. As described earlier, 2011 data were loaded onto the EMF server from EPA's emissions modeling platform FTP site and queried by state and SCC in a similar manner as the 2007 emissions (note: as a quality assurance measure, 2011 emissions were also queried from EPA's EIS Gateway and results compared well with those queried from the EMF; the results of these comparisons are shown in Appendix D). 2007 and 2011 total ICI boiler NOx and SO_2 emissions for the Northeast states plus Virginia are shown graphically in Figures 2-1 and 2-2.

Table 2-1: 2007 and 2011 ICI Boiler NOx Emissions for the Northeast States plus VA (Tons per Year)

	Point		Nonpoint		Total	
State	**2007**	**2011**	**2007**	**2011**	**2007**	**2011**
CT	1,365	586	4,190	3,538	5,554	4,124
DE	5,714	1,588	1,104	1,168	6,818	2,755
DC	660	426	770	622	1,430	1,047
ME	8,839	5,971	2,316	1,144	11,155	7,116
MD	8,882	4,652	3,141	5,639	12,022	10,292
MA	4,994	2,607	6,788	7,808	11,782	10,415
NH	901	499	1,399	1,622	2,301	2,121
NJ	3,624	1,606	10,350	9,922	13,974	11,529
NY	14,451	8,639	19,509	23,915	33,960	32,554
PA	22,034	12,681	23,817	13,431	45,851	26,111
RI	468	411	1,241	155	1,709	566
VT	223	267	1,654	1,080	1,877	1,347
VA	28,564	15,141	8,520	7,099	37,084	22,240
Total	**100,719**	**55,074**	**84,799**	**77,142**	**185,517**	**132,216**

Table 2-2: 2007 and 2011 ICI Boiler SO_2 Emissions for the Northeast States plus VA (Tons per Year)

	Point		Nonpoint		Total	
State	**2007**	**2011**	**2007**	**2011**	**2007**	**2011**
CT	861	34	4,069	1,136	4,931	1,170
DE	8,074	1,868	502	28	8,576	1,896
DC	349	57	628	374	977	431
ME	13,606	4,513	2,303	2,559	15,909	7,072
MD	43,638	22,961	2,356	4,268	45,993	27,229
MA	7,738	2,029	5,109	7,055	12,847	9,084
NH	2,415	1,038	1,291	1,698	3,707	2,736
NJ	827	279	3,620	2,458	4,447	2,737
NY	40,462	10,780	35,148	24,569	75,610	35,349
PA	44,581	21,254	49,876	10,163	94,457	31,417
RI	867	343	1,254	235	2,121	578
VT	311	415	2,049	1,598	2,360	2,014
VA	35,145	13,222	11,196	2,741	46,340	15,963
Total	**198,874**	**78,793**	**119,401**	**58,881**	**318,275**	**137,674**

Figure 2-1: 2007 and 2011 Total ICI Boiler NOx Emissions for the Northeast States plus VA

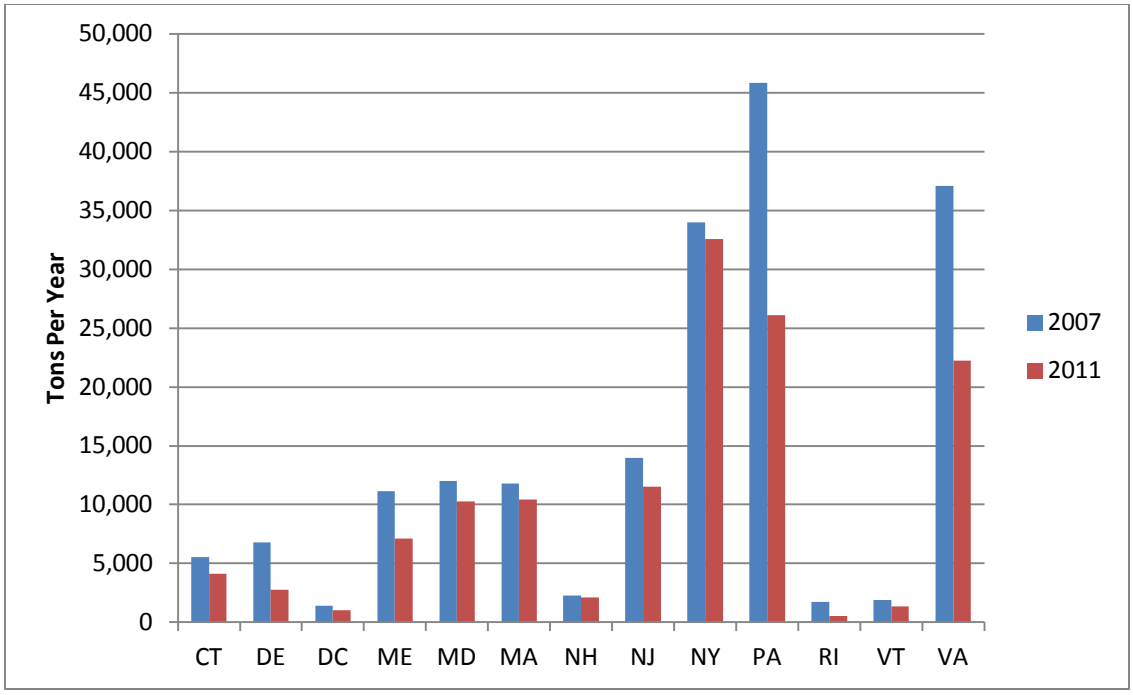
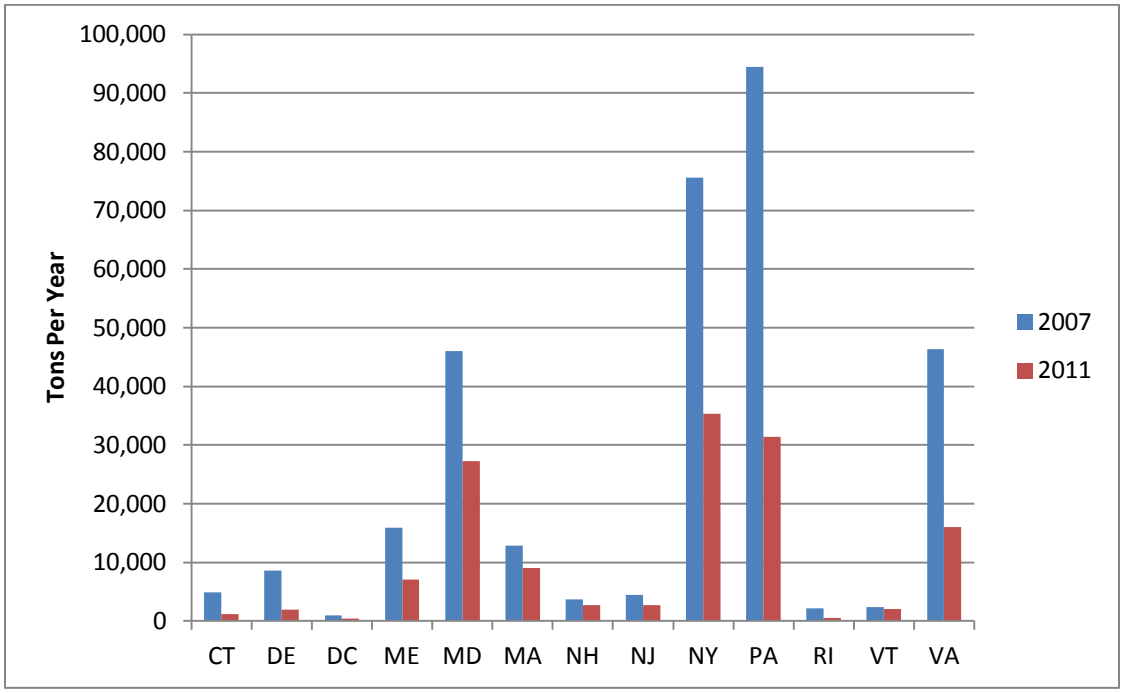


Figure 2-2: 2007 and 2011 ICI Boiler Total SO_2 Emissions for the Northeast States plus VA



It can be seen in Table 2-1 that total ICI boiler NOx emissions for the Northeast states plus Virginia region decreased by 29% from 185,517 tons per year in 2007 to 132,216 tons per year in 2011. Similarly, total ICI boiler SO_2 emissions for this region decreased by 57% from 318,275 tons per year in 2007 to 137,674 tons per year in 2011. For both NOx and SO_2, the largest overall decreases came from the point source sector. It can be seen in Figures 2-1 and 2-2 that some states had substantial reductions in ICI boiler NOx and SO_2 (PA and VA, for example). As discussed above, there was an overall decrease in ICI boiler NOx and SO_2 emissions in the Northeast states plus Virginia region. This is an expected trend and is likely the result of low sulfur fuel standards that began to be phased in between 2007 and 2011 as well as the economic shift to cleaner burning fuels such as natural gas.

3. Projected 2018 ICI Boiler Emissions

As discussed earlier, emissions from MARAMA's 2018 Alpha inventory were queried by SCC using the query statements developed by the Workgroup. Comparisons were made of 2011 and 2018 ICI boiler NOx and SO_2 emissions for the Northeast states, the Midwest states, the Southeast states, and the remainder of the CONUS states. These comparisons are described in the following subsections.

Northeast States

2011 and 2018 ICI boiler NOx and SO_2 emissions for the Northeast states are shown in Tables 3-1 and 3-2 and graphically in Figures 3-1 and 3-2.

Table 3-1: 2011 and 2018 ICI Boiler NOx Emissions for the Northeast States (Tons per Year)

	Point		Nonpoint		Total	
State	**2011**	**2018**	**2011**	**2018**	**2011**	**2018**
CT	586	581	3,538	3,815	4,124	4,396
DE	1,588	1,166	1,168	1,262	2,755	2,428
DC	426	458	622	633	1,047	1,091
ME	5,971	5,229	1,144	1,136	7,116	6,364
MD	4,652	4,653	5,639	5,801	10,292	10,455
MA	2,607	2,646	7,808	8,316	10,415	10,962
NH	499	481	1,622	1,694	2,121	2,175
NJ	1,606	1,634	9,922	10,420	11,529	12,054
NY	8,639	3,839	23,915	22,097	32,554	25,936
PA	12,681	10,144	13,431	14,481	26,111	24,625
RI	411	446	155	152	566	598
VT	267	283	1,080	1,157	1,347	1,441
Total	**39,932**	**31,561**	**70,043**	**70,964**	**109,976**	**102,524**

Table 3-2: 2011 and 2018 ICI Boiler SO_2 Emissions for the Northeast States (Tons per Year)

	Point		Nonpoint		Total	
State	**2011**	**2018**	**2011**	**2018**	**2011**	**2018**
CT	34	17	1,136	198	1,170	214
DE	1,868	385	28	9	1,896	394
DC	57	15	374	334	431	349
ME	4,513	1,025	2,559	726	7,072	1,751
MD	22,961	22,970	4,268	3,961	27,229	26,932
MA	2,029	1,273	7,055	2,171	9,084	3,445
NH	1,038	890	1,698	1,574	2,736	2,464
NJ	279	210	2,458	272	2,737	483
NY	10,780	646	24,569	7,147	35,349	7,792
PA	21,254	900	10,163	6,608	31,417	7,507
RI	343	218	235	233	578	451
VT	415	414	1,598	1,601	2,014	2,015
Total	**65,571**	**28,964**	**56,140**	**24,833**	**121,711**	**53,797**

Figure 3-1: 2011 and 2018 ICI Boiler Total NOx Emissions for the Northeast States

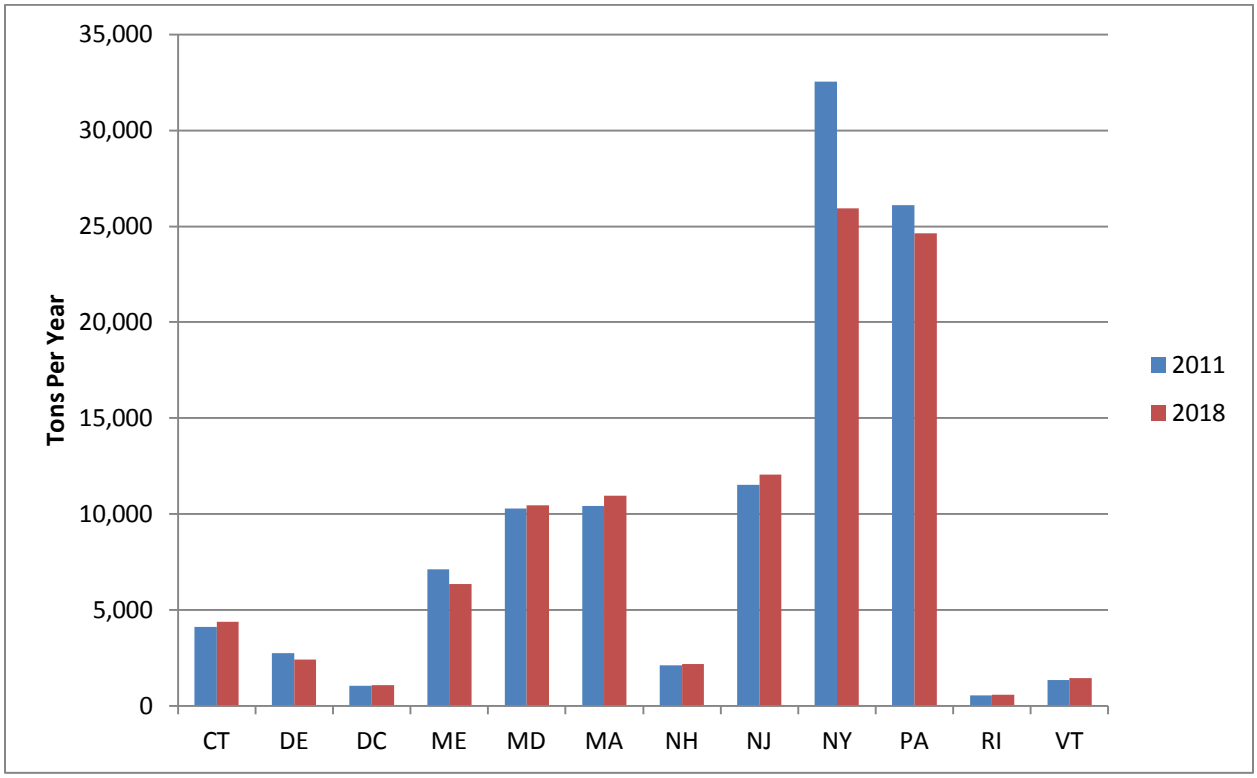
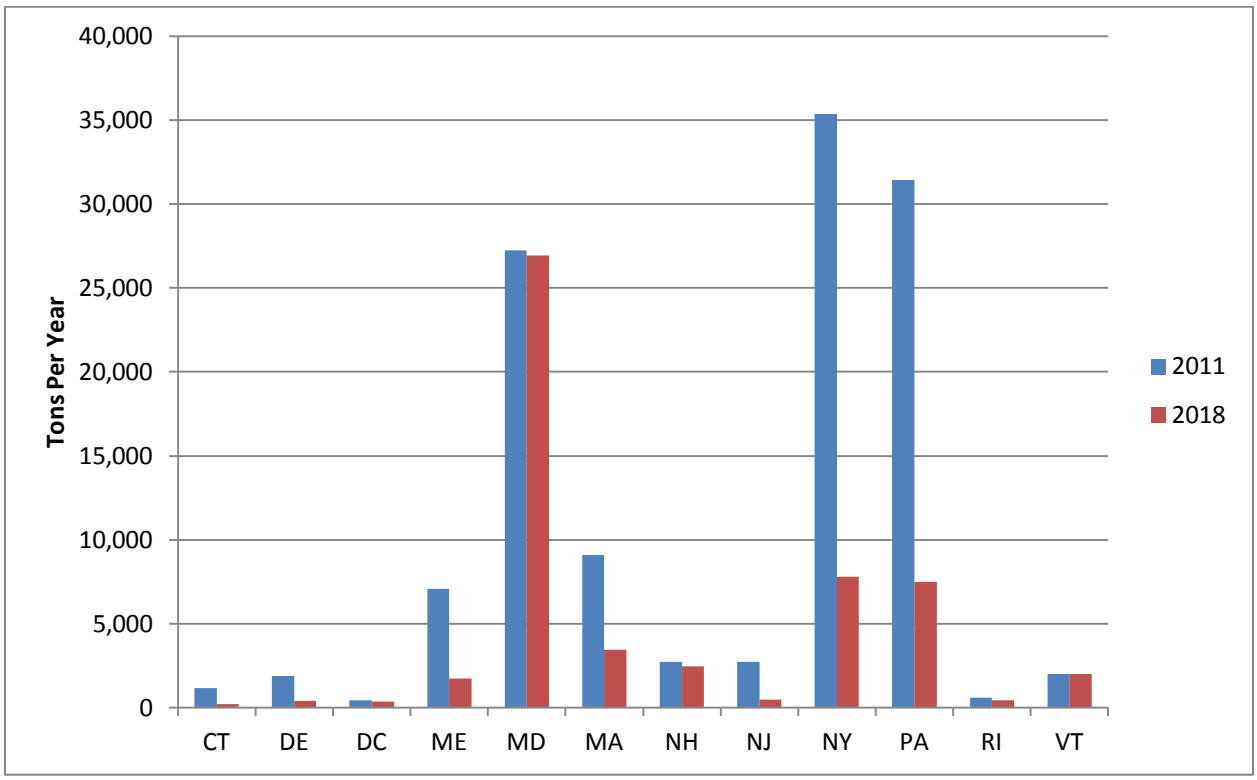


Figure 3-2: 2011 and 2018 ICI Boiler Total SO_2 Emissions for the Northeast States



It can be seen in Tables 3-1 and 3-2 that ICI boiler total NOx emissions decrease by 7% from 109,976 tons per year in 2011 to 102,524 tons per year in 2018 in the Northeast states region and ICI boiler total SO_2 emissions decrease 56% from 121,711 tons in 2011 to 53,797 tons per year in 2018. Figure 3-1 shows that ICI boiler NOx emissions are fairly similar in the Northeast states region between 2011 and 2018. Figure 3-2 shows that many of the Northeast states, including CT, DE, ME, MA, NJ, NY and PA, are expecting substantial reductions in ICI boiler SO_2 emissions between 2011 and 2018. For the other states, 2018 emissions are similar to – and slightly lower than – the corresponding 2011 emissions.

Midwest States

2011 and 2018 ICI boiler NOx and SO_2 emissions for the Midwest states are shown in Tables 3-3 and 3-4 and graphically in Figures 3-3 and 3-4.

Table 3-3: 2011 and 2018 ICI Boiler NOx Emissions for the Midwest States (Tons per Year)

	Point		Nonpoint		Total	
State	**2011**	**2018**	**2011**	**2018**	**2011**	**2018**
IL	12,913	9,683	17,986	17,816	30,899	27,499
IN	15,542	14,429	5,791	5,737	21,333	20,166
MI	9,986	8,526	10,810	10,714	20,796	19,241
MN	9,254	8,401	11,200	11,143	20,454	19,544
OH	15,807	15,422	16,326	16,183	32,133	31,605
WI	20,087	17,381	5,810	5,760	25,897	23,141
Total	**83,589**	**73,843**	**67,922**	**67,354**	**151,511**	**141,196**

Table 3-4: 2011 and 2018 ICI Boiler SO_2 Emissions for the Midwest States (Tons per Year)

	Point		Nonpoint		Total	
State	**2011**	**2018**	**2011**	**2018**	**2011**	**2018**
IL	33,516	3,818	1,892	1,726	35,408	5,544
IN	35,227	31,104	112	112	35,339	31,216
MI	12,335	6,993	1,835	1,820	14,170	8,813
MN	5,254	691	3,805	3,805	9,059	4,496
OH	52,534	13,102	784	784	53,318	13,886
WI	45,365	30,062	576	576	45,941	30,638
Total	**184,231**	**85,770**	**9,005**	**8,823**	**193,236**	**94,593**

Figure 3-3: 2011 and 2018 ICI Boiler Total NOx Emissions for the Midwest States

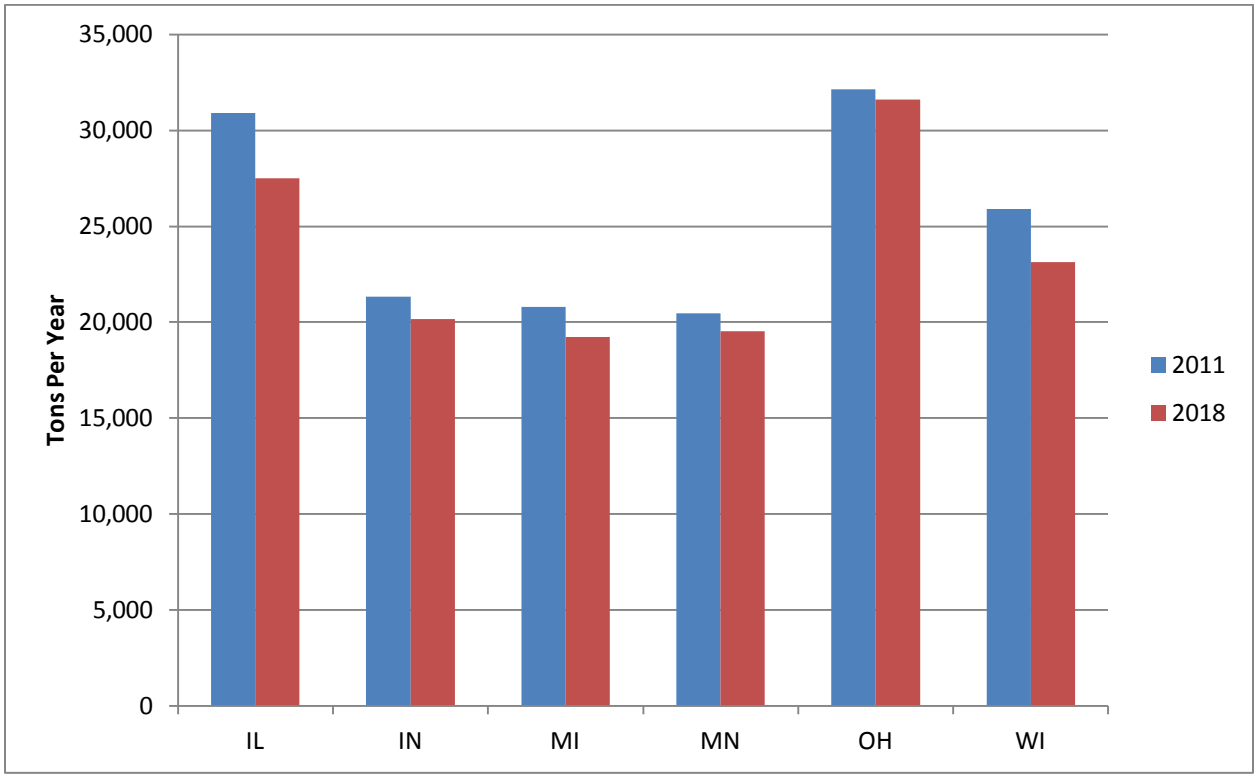
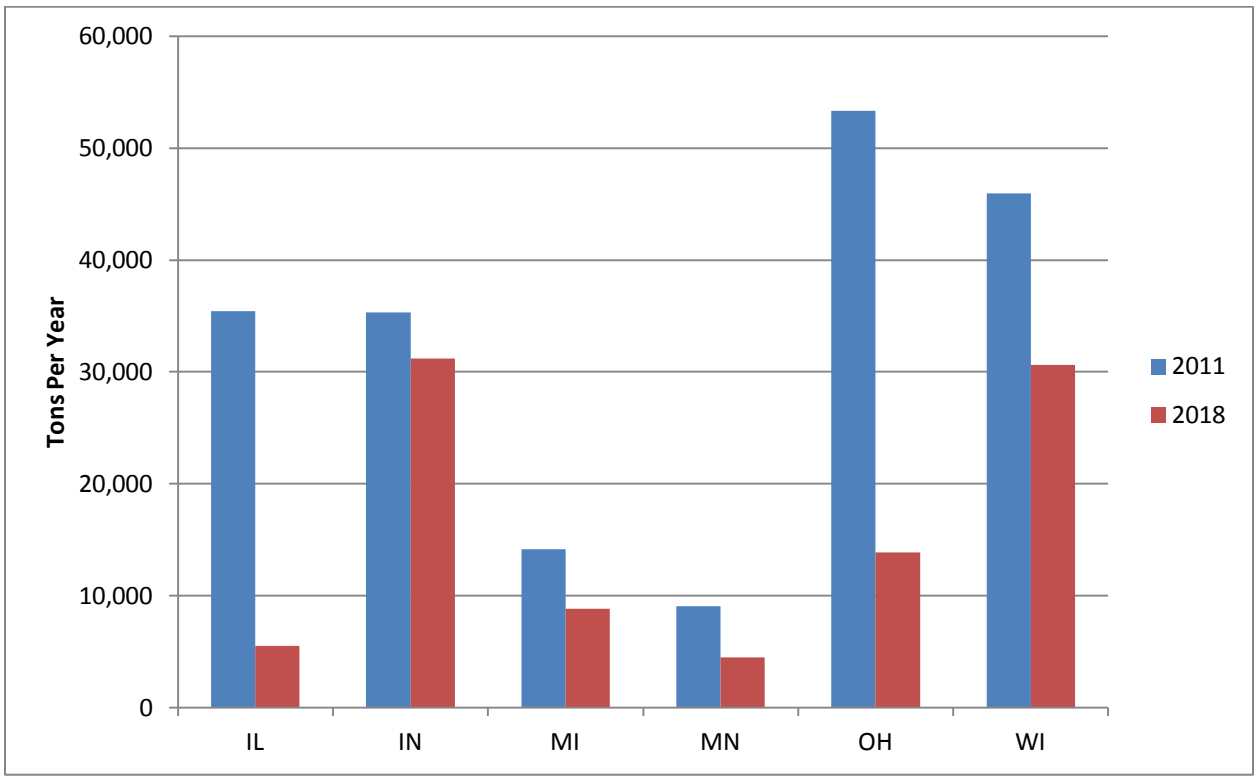


Figure 3-4: 2011 and 2018 ICI Boiler Total SO_2 Emissions for the Midwest States



The numbers in Table 3-3 show that ICI boiler total NOx emissions for the Midwest states decrease by 7% from 151,511 tons per year in 2011 to 141,196 tons per year in 2018. For SO_2, ICI boiler total emissions in the Midwest states decrease 51% from 193,236 tons per year in 2011 to 94,593 tons per year in 2018 (Table 3-4). Note that the reported 2011 and 2018 nonpoint SO_2 values in Table 3-4 for IN, OH, and WI seem suspect. As described in earlier sections, the ICI Boiler Workgroup queried the 2011 emissions inventory from the EIS Gateway as a quality assurance measure. The EMF and the EIS Gateway both showed the same reported values for these states, therefore ruling out an EMF query error.

It can be seen in Figure 3-3 that 2018 ICI boiler total NOx emissions are similar to, but somewhat lower than, the corresponding 2011 emissions for all of the Midwest states. Figure 3-4 shows that substantial reductions in ICI boiler total SO_2 emissions are expected between 2011 and 2018 for all of the Midwest states, particularly OH and WI.

Southeast States

2011 and 2018 ICI boiler NOx and SO_2 emissions for the Southeast states are shown in Tables 3-5 and 3-6 and graphically in Figures 3-5 and 3-6.

Table 3-5: 2011 and 2018 ICI Boiler NOx Emissions for the Southeast States (Tons per Year)

	Point		Nonpoint		Total	
State	**2011**	**2018**	**2011**	**2018**	**2011**	**2018**
AL	14,887	12,034	7,272	7,239	22,159	19,273
GA	15,348	15,144	3,194	3,166	18,542	18,310
KY	5,882	5,813	1,371	1,362	7,254	7,175
MS	5,344	5,323	947	939	6,291	6,261
NC	18,523	12,880	6,918	6,878	25,441	19,757
SC	9,771	8,337	5,230	5,217	15,001	13,553
TN	14,714	14,615	9,768	9,709	24,483	24,325
VA	15,141	10,279	7,099	7,453	22,240	17,732
WV	6,900	4,469	1,940	1,932	8,841	6,401
Total	**106,512**	**88,893**	**43,740**	**43,894**	**150,252**	**132,787**

Table 3-6: 2011 and 2018 ICI Boiler SO_2 Emissions for the Southeast States (Tons per Year)

	Point		Nonpoint		Total	
State	**2011**	**2018**	**2011**	**2018**	**2011**	**2018**
AL	15,979	1,056	23,721	23,721	39,700	24,777
GA	21,225	18,132	4,074	4,037	25,299	22,170
KY	5,707	1,430	96	96	5,803	1,525
MS	5,558	330	16	16	5,573	346
NC	11,580	3,246	11,625	11,039	23,204	14,285
SC	11,446	2,780	3,276	3,276	14,722	6,055
TN	31,337	2,464	1,219	1,219	32,555	3,682
VA	13,222	879	2,741	2,526	15,963	3,406
WV	12,428	346	3,928	3,906	16,356	4,252
Total	**128,481**	**30,663**	**50,694**	**49,836**	**179,175**	**80,499**

Figure 3-5: 2011 and 2018 ICI Boiler Total NOx Emissions for the Southeast States

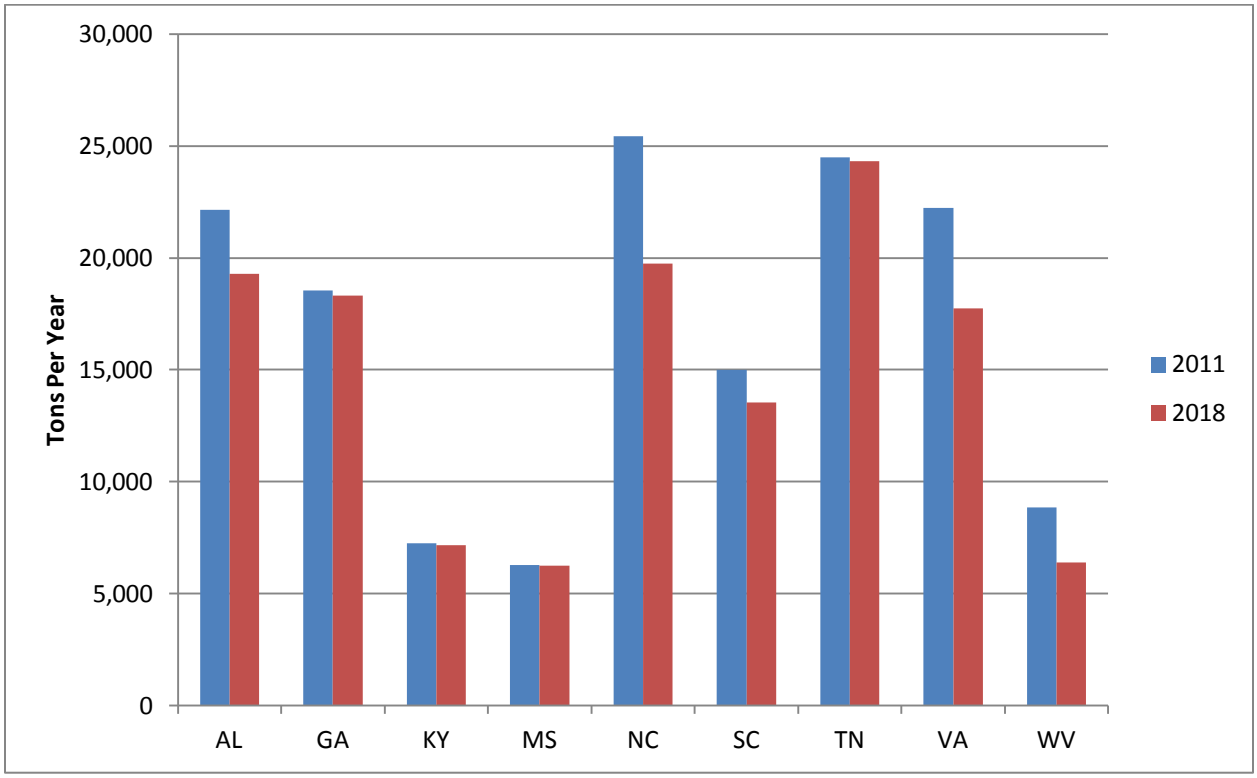


Figure 3-6: 2011 and 2018 ICI Boiler Total SO_2 Emissions for the Southeast States

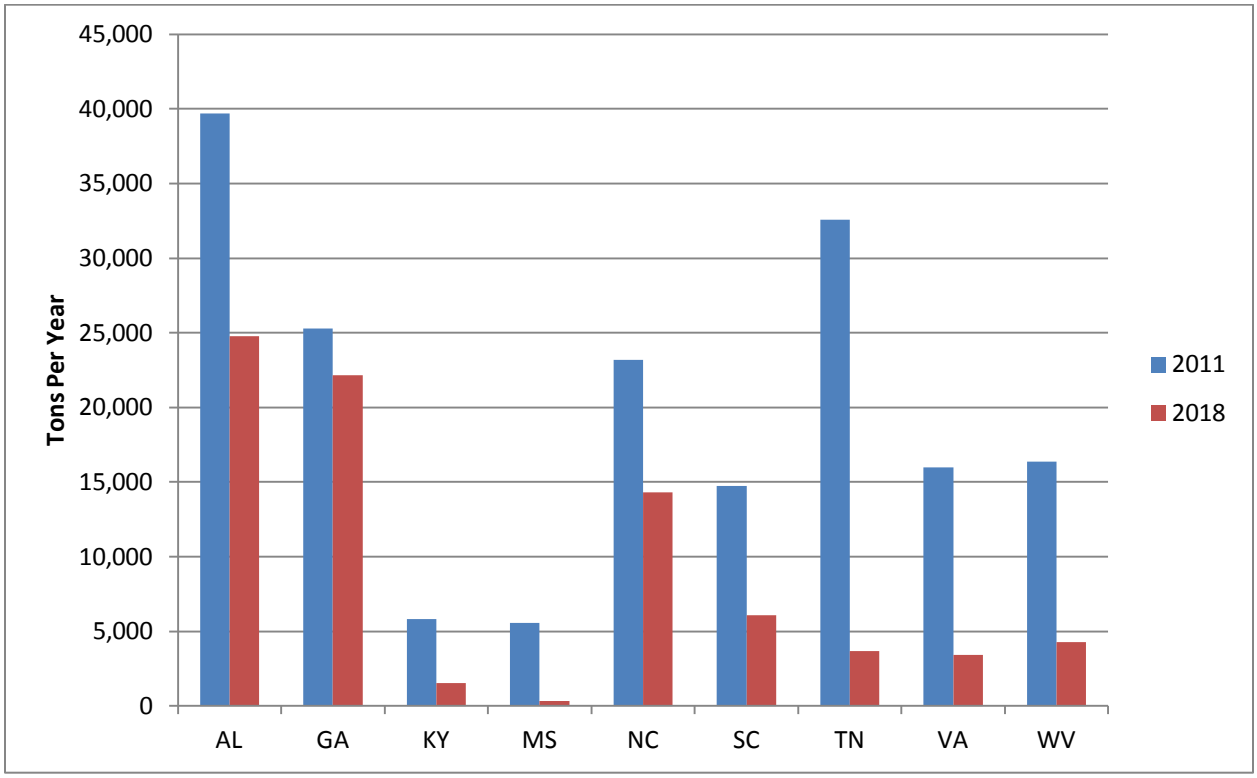


Table 3-5 shows that ICI boiler total NOx emissions for the Southeast states decrease by 12% from 150,252 tons per year in 2011 to 132,787 tons per year in 2018. Table 3-6 shows that ICI boiler total SO_2 emissions for the Southeast states decrease from 179,175 tons per year in 2011 to 80,499 tons per year in 2018 – a 55% decrease. The nonpoint SO_2 values in Table 3-6 for AL, KY, and MS seem suspect.

2018 ICI boiler total NOx emissions are similar to (and somewhat lower than) the corresponding 2011 emissions (Figure 3-5). Figure 3-6 shows that substantial reductions in ICI boiler total SO_2 emissions are expected between 2011 and 2018 for almost all of the Southeast states (with slightly less of a reduction expected for GA, and noting the possible nonpoint anomalies for AL, KY, and MS).

Other Continental U.S. States

2011 and 2018 ICI boiler NOx and SO_2 emissions for states not in the regions described above are shown in Tables 3-7 through 3-10 and graphically in Figures 3-7 through 3-10. For processing convenience, these states were divided into two groups and appear in no particular order.

Table 3-7: 2011 and 2018 ICI Boiler NOx Emissions for Other CONUS States, Group 1 (Tons per Year)

	Point		Nonpoint		Total	
State	**2011**	**2018**	**2011**	**2018**	**2011**	**2018**
AZ	2,373	2,372	2,091	2,012	4,464	4,384
AR	13,417	7,022	1	1	13,418	7,023
CA	8,800	7,941	24,335	24,135	33,134	32,075
CO	4,816	4,749	123	123	4,940	4,872
FL	9,142	8,906	14,740	18,976	23,883	27,882
ID	6,449	5,624	3,433	3,393	9,882	9,017
IA	8,593	8,444	5,517	5,440	14,110	13,884
KS	2,639	2,597	3,725	3,695	6,364	6,292
LA	23,883	24,619	9,454	8,778	33,337	33,397
MT	1,332	1,337	1,317	1,302	2,649	2,639
NE	2,091	2,100	1,530	1,515	3,622	3,615
Total	**83,536**	**75,709**	**66,266**	**69,370**	**149,802**	**145,079**

Table 3-8: 2011 and 2018 ICI Boiler SO_2 Emissions for Other CONUS States, Group 1 (Tons per Year)

	Point		Nonpoint		Total	
State	**2011**	**2018**	**2011**	**2018**	**2011**	**2018**
AZ	2,900	2,900	27	25	2,927	2,925
AR	20,566	3,880	0	0	20,566	3,880
CA	2,009	944	1,519	1,503	3,527	2,447
CO	2,714	742	14	14	2,728	756
FL	7,844	1,803	8,227	20,329	16,071	22,132
ID	3,413	207	1,440	1,417	4,853	1,624
IA	22,971	21,518	196	136	23,167	21,654
KS	176	149	31	31	207	180
LA	13,467	10,975	21,666	20,243	35,134	31,218
MT	197	28	267	267	464	295
NE	453	365	9	9	463	374
Total	**76,711**	**43,510**	**33,396**	**43,974**	**110,107**	**87,484**

Table 3-9: 2011 and 2018 ICI Boiler NOx Emissions for Other CONUS States, Group 2 (Tons per Year)

	Point		Nonpoint		Total	
State	**2011**	**2018**	**2011**	**2018**	**2011**	**2018**
MO	4,160	4,380	4,493	4,420	8,653	8,800
NV	473	386	2,142	1,731	2,616	2,117
NM	374	345	1,129	1,079	1,503	1,424
ND	2,691	2,711	653	574	3,344	3,285
OK	4,394	4,686	13,243	14,195	18,178	18,881
OR	5,117	5,117	6,551	6,456	11,668	11,573
SD	860	873	665	665	1,525	1,538
TX	20,782	23,615	18,966	20,101	39,838	43,716
UT	1,724	804	2,305	2,246	4,029	3,050
WA	7,415	7,364	204	204	7,620	7,569
WY	19,996	5,544	513	508	20,509	6,052
Total	**68,616**	**55,826**	**50,866**	**52,179**	**119,482**	**108,005**

Table 3-10: 2011 and 2018 ICI Boiler SO_2 Emissions for Other CONUS States, Group 2 (Tons per Year)

	Point		Nonpoint		Total	
State	**2011**	**2018**	**2011**	**2018**	**2011**	**2018**
MO	19,339	7,541	360	286	19,699	7,826
NV	120	119	5,149	4,635	5,268	4,754
NM	27	20	824	823	851	842
ND	3,190	1,611	222	220	3,412	1,831
OK	2,703	247	3,428	3,411	6,131	3,658
OR	1,062	92	1,210	1,209	2,272	1,301
SD	299	302	1,034	1,034	1,332	1,336
TX	9,805	6,782	8,858	8,214	18,664	14,997
UT	1,981	151	1,352	1,329	3,333	1,480
WA	2,210	633	23	23	2,233	656
WY	28,815	811	3	3	28,818	814
Total	**69,739**	**18,309**	**22,463**	**21,188**	**92,202**	**39,497**

Figure 3-7: 2011 and 2018 ICI Boiler Total NOx Emissions for Other CONUS States, Group 1

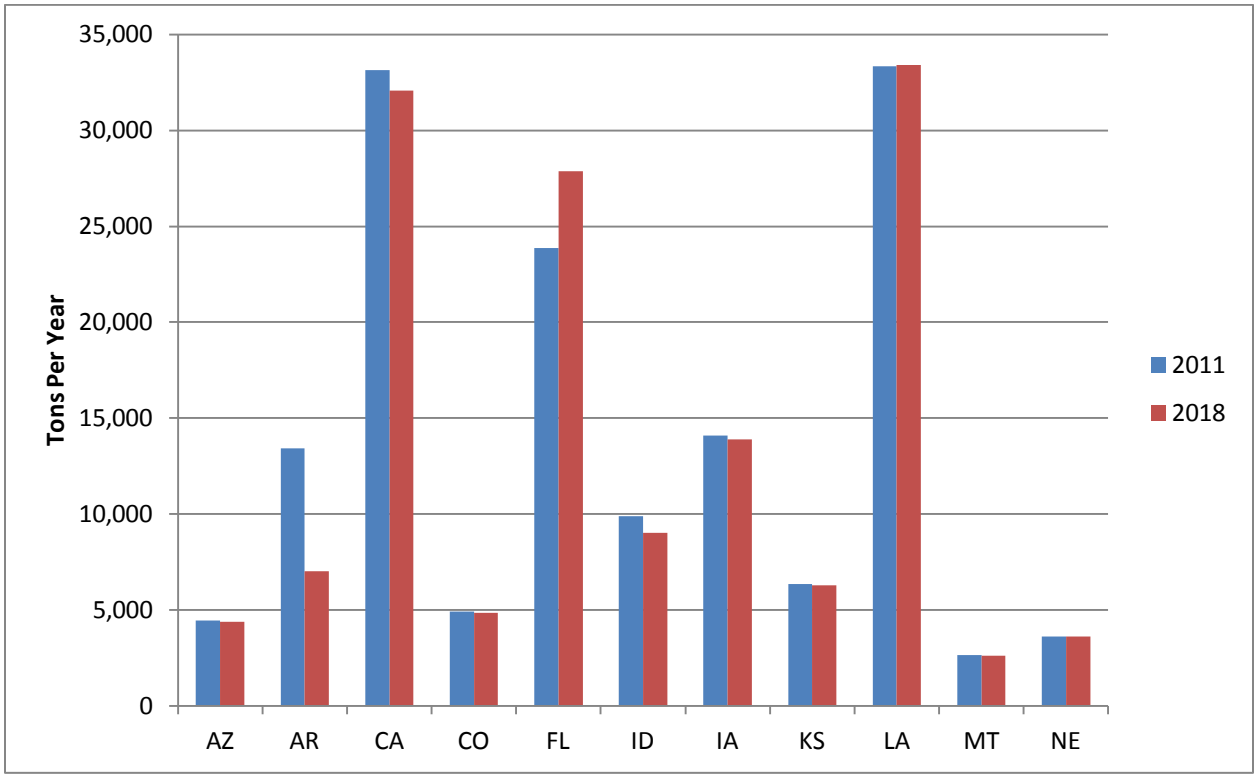


Figure 3-8: 2011 and 2018 ICI Boiler Total SO_2 Emissions for Other CONUS States, Group 1

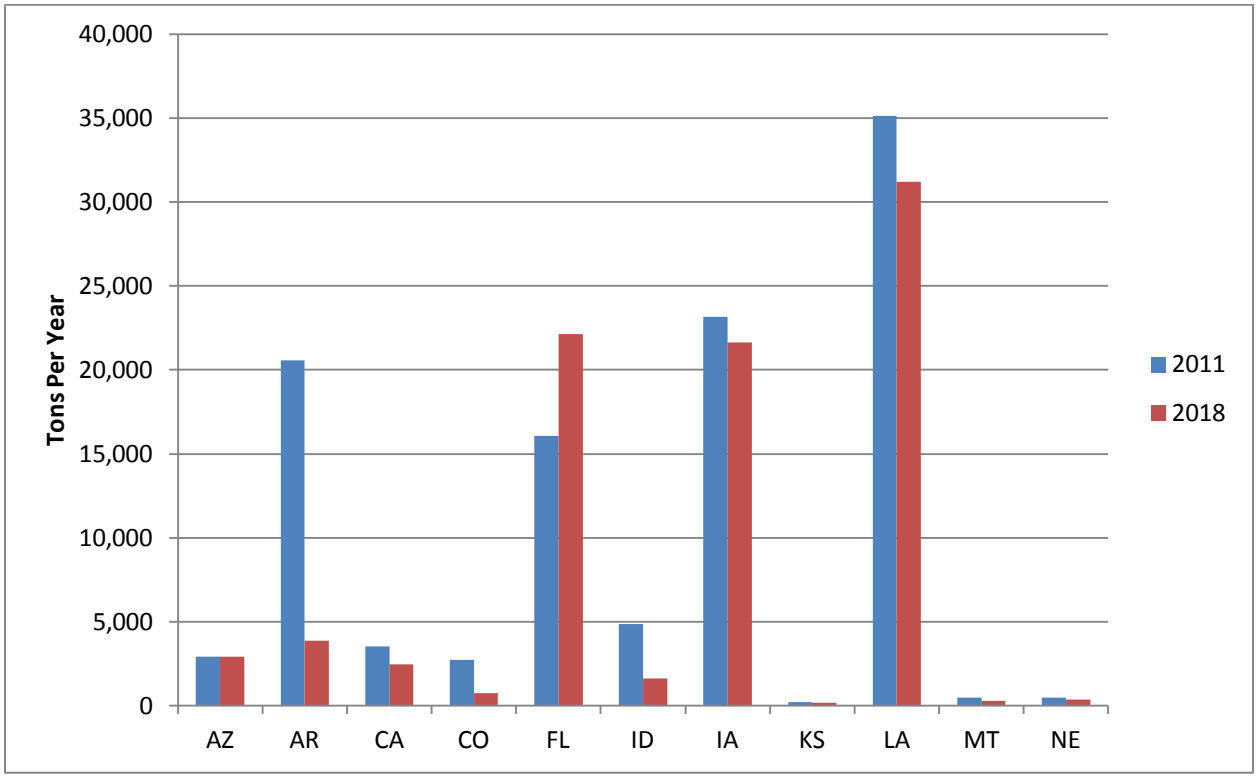


Figure 3-9: 2011 and 2018 ICI Boiler Total NOx Emissions for Other CONUS States, Group 2

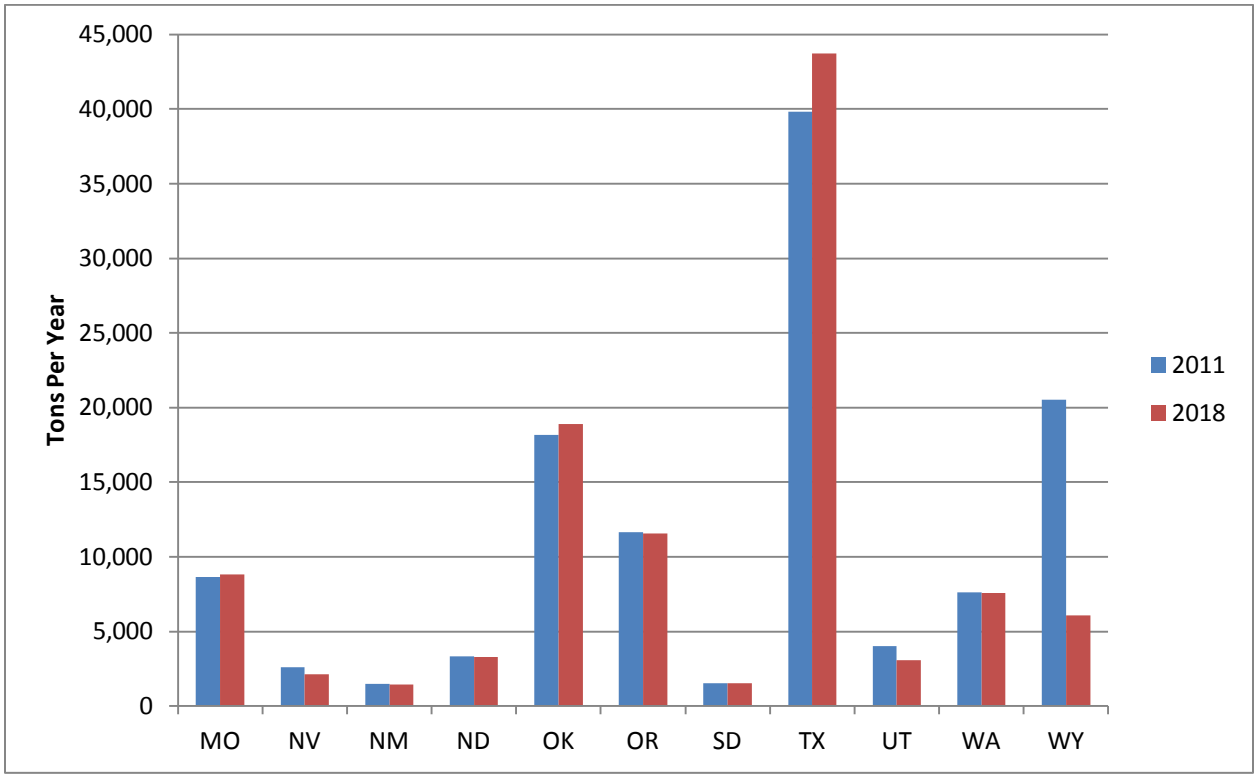
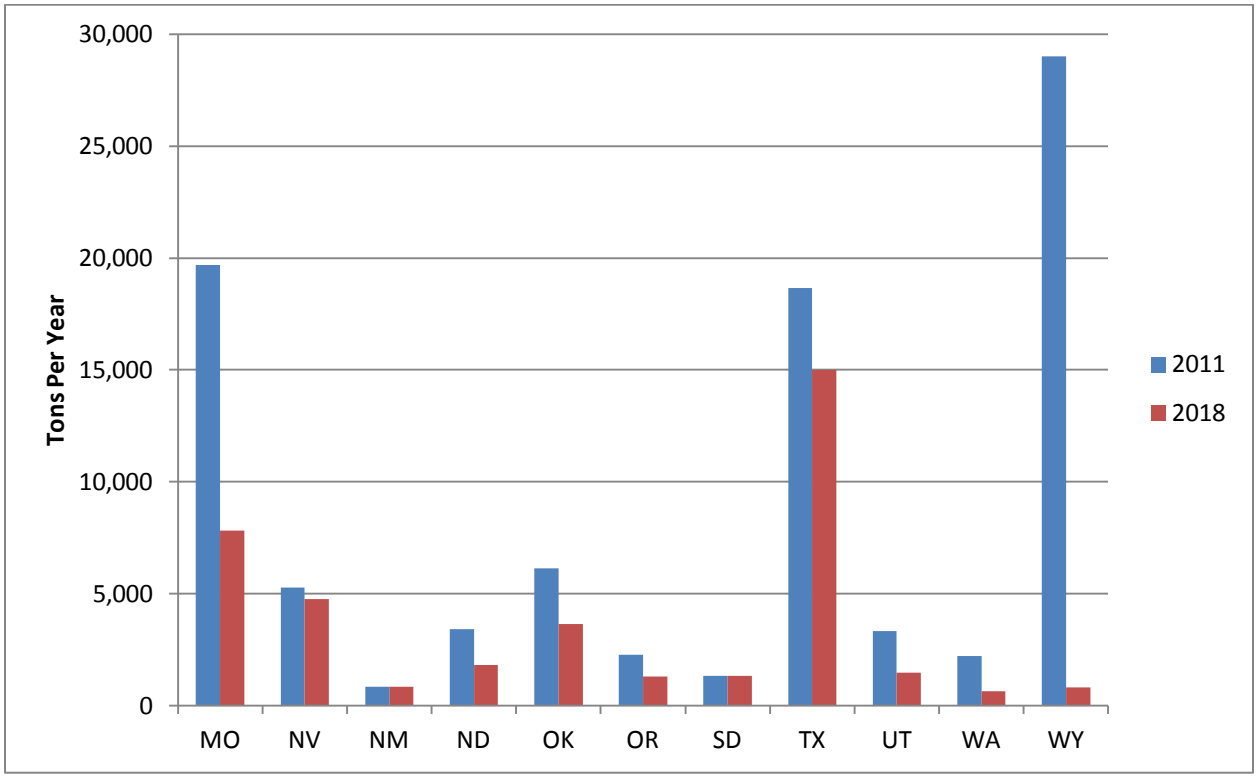


Figure 3-10: 2011 and 2018 ICI Boiler Total SO_2 Emissions for Other CONUS States, Group 2



For the most part, ICI boiler total NOx emissions are similar between 2011 and 2018 for the other CONUS states. AR and WY show substantial decreases in NOx, while NOx in FL, LA, MO, OK, SD, and TX increases somewhat. For all other states, 2018 total NOx emissions are the same or slightly lower than the corresponding 2011 emissions. Except for FL, 2018 ICI boiler total SO_2 emissions are similar to or lower than the corresponding 2011 emissions. Note that AR shows only 1 ton of nonpoint NOx and 0 tons of nonpoint SO_2 (see Tables 3-7 and 3-8). Tables 3-8 and 3-10 show nonpoint SO_2 values that are quite low for other states as well (e.g. CO, NE, and WY). MO and WY also show very high 2011 SO_2 emissions values (see Table 3-10 and Figure 3-10). Some of these values may be suspect. Note for the remainder CONUS states: 2018 emissions for these states are from Version 1 of EPA's modeling inventory. Therefore caution should be used in drawing conclusions from these trends; please see Data Caveats and Limitations in Section 6.

4. ICI Boiler Emissions by Fuel Type

As described in Section 1, the ICI Boiler Workgroup performed an analysis of ICI boiler emissions by fuel type. This was accomplished by sorting the extracted data by SCC and summing the results by fuel category. This analysis was performed for 2011 for the Northeast states, the Midwest states, and the Southeast states. An analysis by fuel type was also performed for 2007 for the Northeast States plus Virginia region. The analysis by fuel type results are described in the subsections below.

Northeast States

2007 ICI boiler NOx and SO_2 emissions by state and fuel type are shown in Tables 4-1 and 4-2 below and graphically in Figures 4-1 and 4-2. Pie charts showing the breakdown of 2007 total ICI boiler NOx and SO_2 emissions for the Northeast states plus Virginia region are shown in Figures 4-3 and 4-4. Note that in these and subsequent tables and figures, the "Other" fuel use category includes petroleum coke, process gas, bagasse, and solid & liquid waste.

Table 4-1: 2007 ICI Boiler NOx Emissions by Fuel Type for the Northeast States plus VA (Tons per Year)

Fuel Type	CT	DE	DC	ME	MD	MA	NH	NJ	NY	PA	RI	VT	VA	Total	% of Total
Coal	6	1,549	182	911	6,703	724	13	17	9,207	15,934	9	0	18,268	53,522	30%
Residual Oil	859	703	0	3,901	908	3,025	712	538	7,228	4,117	741	383	2,698	25,812	14%
Distillate Oil	1,404	71	108	1,188	724	2,016	610	2,084	1,979	2,827	126	529	3,909	17,575	10%
Natural Gas	2,782	1,166	1,140	138	3,472	5,122	573	8,844	5,666	16,601	787	256	5,668	52,215	29%
LPG	485	70	0	66	98	333	261	308	1,074	935	34	103	521	4,288	2%
Wood	0	0	0	4,541	35	415	115	0	1,046	617	9	589	3,145	10,511	6%
Other	18	3,258	0	411	82	147	16	2,184	572	4,820	4	18	2,875	14,406	8%
Total	**5,554**	**6,818**	**1,430**	**11,155**	**12,022**	**11,782**	**2,301**	**13,974**	**26,772**	**45,851**	**1,709**	**1,877**	**37,084**	**178,329**	**100%**

Table 4-2: 2007 ICI Boiler SO_2 Emissions by Fuel Type for the Northeast States plus VA (Tons per Year)

Fuel Type	CT	DE	DC	ME	MD	MA	NH	NJ	NY	PA	RI	VT	VA	Total	% of Total
Coal	12	5,468	333	941	41,781	1,740	41	30	39,907	63,052	35	0	24,849	178,189	59%
Residual Oil	1,892	2,113	0	10,464	2,611	6,692	2,297	721	15,291	18,298	1,565	1,513	12,157	75,614	25%
Distillate Oil	3,007	190	635	2,326	1,413	4,229	1,319	3,076	4,823	6,067	508	755	8,113	36,460	12%
Natural Gas	15	16	6	5	124	31	5	75	36	343	3	2	44	704	0%
LPG	2	0	0	4	1	2	1	5	245	7	0	1	2	268	0%
Wood	0	0	0	1,550	0	45	8	0	84	76	1	64	821	2,649	1%
Other	3	790	3	619	64	110	36	539	332	6,615	9	26	353	9,498	3%
Total	**4,931**	**8,576**	**977**	**15,909**	**45,993**	**12,847**	**3,707**	**4,447**	**60,717**	**94,457**	**2,121**	**2,360**	**46,340**	**303,381**	**100%**

Figure 4-1: 2007 ICI Boiler NOx Emissions by Fuel Type for the Northeast States plus VA

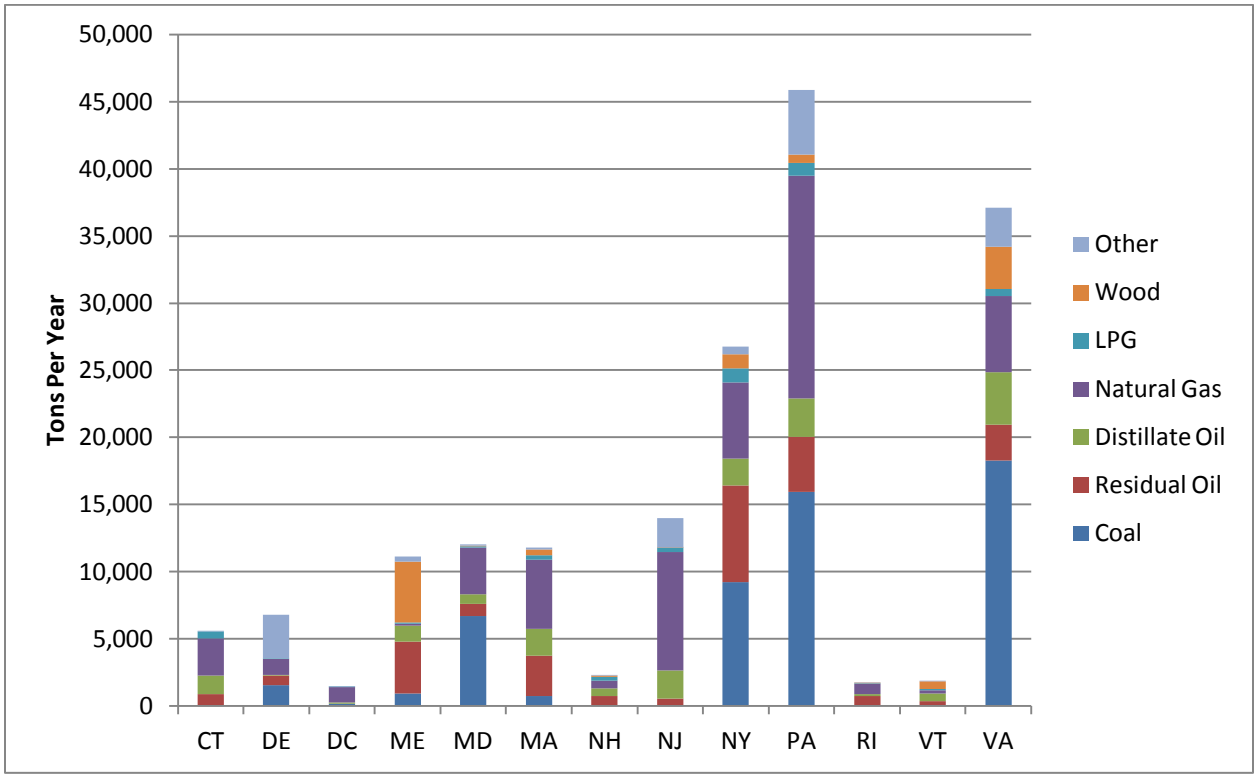


Figure 4-2: 2007 ICI Boiler SO_2 Emissions by Fuel Type for the Northeast States plus VA

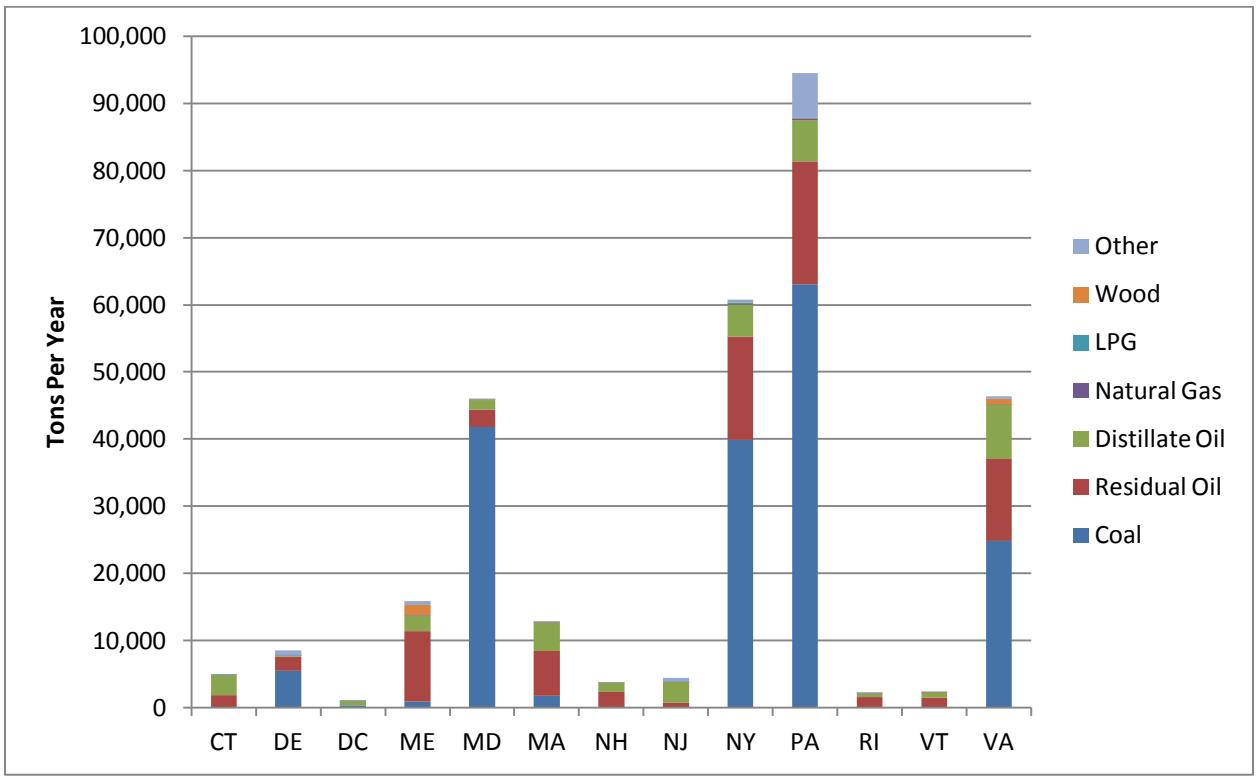


Figure 4-3: Total 2007 ICI Boiler NOx Emissions by Fuel Type for the Northeast States plus VA

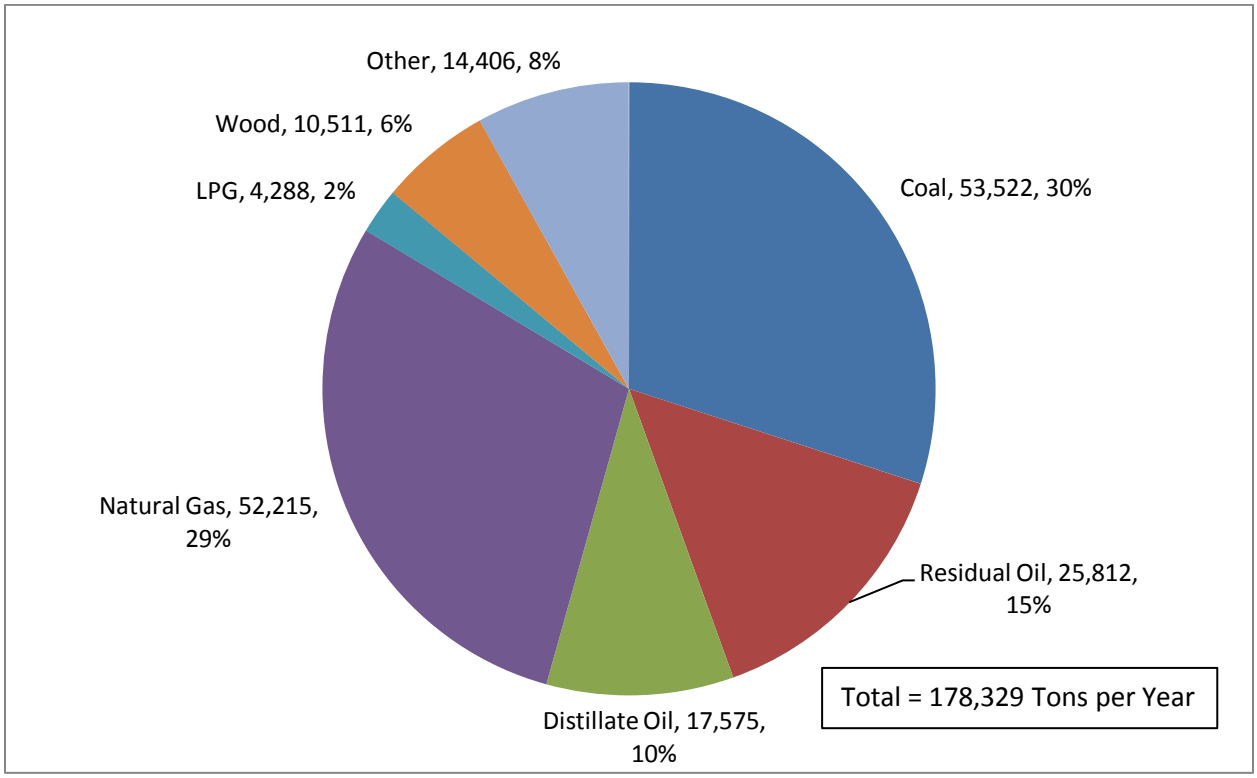
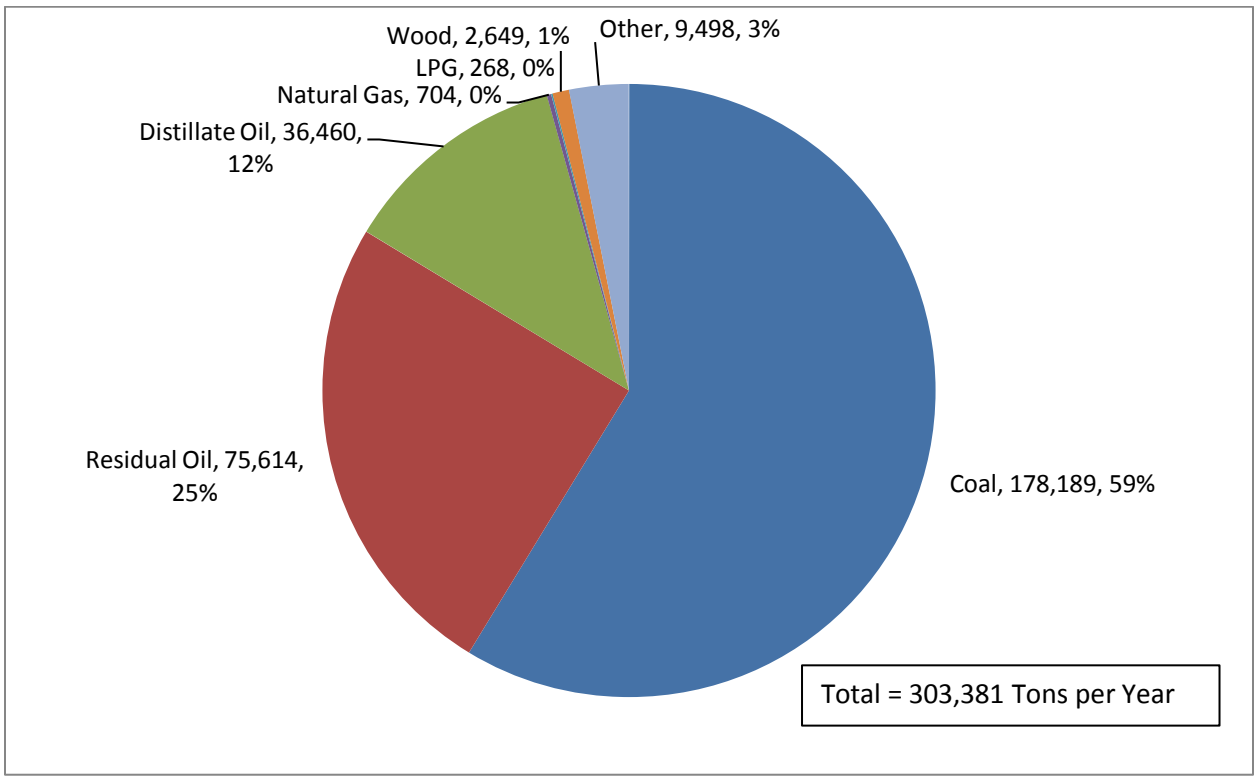


Figure 4-4: Total 2007 ICI Boiler SO_2 Emissions by Fuel Type for the Northeast States plus VA



It can be seen in Table 4-1 and Figure 4-3 that 30% of total 2007 ICI boiler NOx emissions in the Northeast states plus Virginia regional came from coal combustion. Another 29% of total ICI boiler NOx emissions came from natural gas. In addition, 14% of the NOx came from residual oil and 10% came from distillate oil. Table 4-2 and Figure 4-4 show that almost 60% of total 2007 ICI boiler SO_2 emissions in the Northeast states plus Virginia region came from coal combustion, with another 25% coming from residual oil.

It can be seen in Figures 4-1 and 4-2 that ICI boiler fuel use patterns are fairly disparate for the Northeast states plus Virginia region. Figure 4-1 shows that natural gas is an important contributor to NOx emissions for most states, with coal (MD, NY, PA, and VA) and residual oil (NY) also being important contributors. For ME and VT, natural gas is less of a contributor, with wood and oil being important contributors. This is an expected trend because pipeline natural gas is less available to these rural states. Table 4-2 shows that residual and distillate oils are important contributors to ICI boiler SO_2 emissions for most states in this region. Coal is also an important contributor for DE, MD, NY, PA and VA.

2011 ICI boiler NOx emissions for the Northeast states are shown in Table 4-3 by state and fuel type. Table 4-4 shows the corresponding SO_2 emissions by state and fuel type. 2011 ICI boiler NOx and SO_2 emissions by state and fuel type for the Northeast states are shown graphically in Figures 4-5 and 4-6. Pie charts showing the fuel use breakdown of total ICI boiler NOx and SO_2 emissions are shown in Figures 4-7 and 4-8.

Table 4-3: 2011 ICI Boiler NOx Emissions by Fuel Type for the Northeast States (Tons per Year)

Fuel Type	CT	DE	DC	ME	MD	MA	NH	NJ	NY	PA	RI	VT	Total	% of Total
Coal	0	264	10	201	3,184	390	0	0	3,441	6,538	0	0	14,029	13%
Residual Oil	161	247	0	1,719	779	915	483	259	7,239	757	160	409	13,130	12%
Distillate Oil	586	28	66	485	1,024	2,831	581	1,383	5,485	1,246	141	169	14,025	13%
Natural Gas	2,684	1,310	971	381	3,937	5,349	542	8,778	14,132	10,296	251	293	48,924	44%
LPG	243	87	0	205	266	215	277	208	604	1,607	2	128	3,843	3%
Wood	389	14	0	3,534	1,014	575	221	420	1,354	3,762	11	340	11,634	11%
Other	60	806	0	592	87	140	17	480	298	1,905	0	8	4,391	4%
Total	**4,124**	**2,755**	**1,047**	**7,116**	**10,292**	**10,415**	**2,121**	**11,529**	**32,554**	**26,111**	**566**	**1,347**	**109,976**	**100%**

Table 4-4: 2011 ICI Boiler SO_2 Emissions by Fuel Type for the Northeast States (Tons per Year)

Fuel Type	CT	DE	DC	ME	MD	MA	NH	NJ	NY	PA	RI	VT	Total	% of Total
Coal	0	1,274	43	132	22,334	796	0	0	8,622	21,698	0	0	54,899	45%
Residual Oil	957	384	0	5,184	2,627	2,079	1,447	342	16,036	4,214	492	1,958	35,720	29%
Distillate Oil	24	24	382	73	2,053	6,001	1,242	2,173	9,977	2,425	82	4	24,461	20%
Natural Gas	23	29	6	3	42	32	3	131	82	170	2	2	525	0%
LPG	1	0	0	1	1	1	1	4	167	9	0	1	187	0%
Wood	44	2	0	1,014	114	61	12	48	118	437	1	38	1,888	2%
Other	120	183	0	666	59	113	31	40	346	2,462	0	11	4,032	3%
Total	**1,170**	**1,896**	**431**	**7,072**	**27,229**	**9,084**	**2,736**	**2,737**	**35,349**	**31,417**	**578**	**2,014**	**121,711**	**100%**

Figure 4-5: 2011 ICI Boiler NOx Emissions by Fuel Type for the Northeast States (Tons per Year)

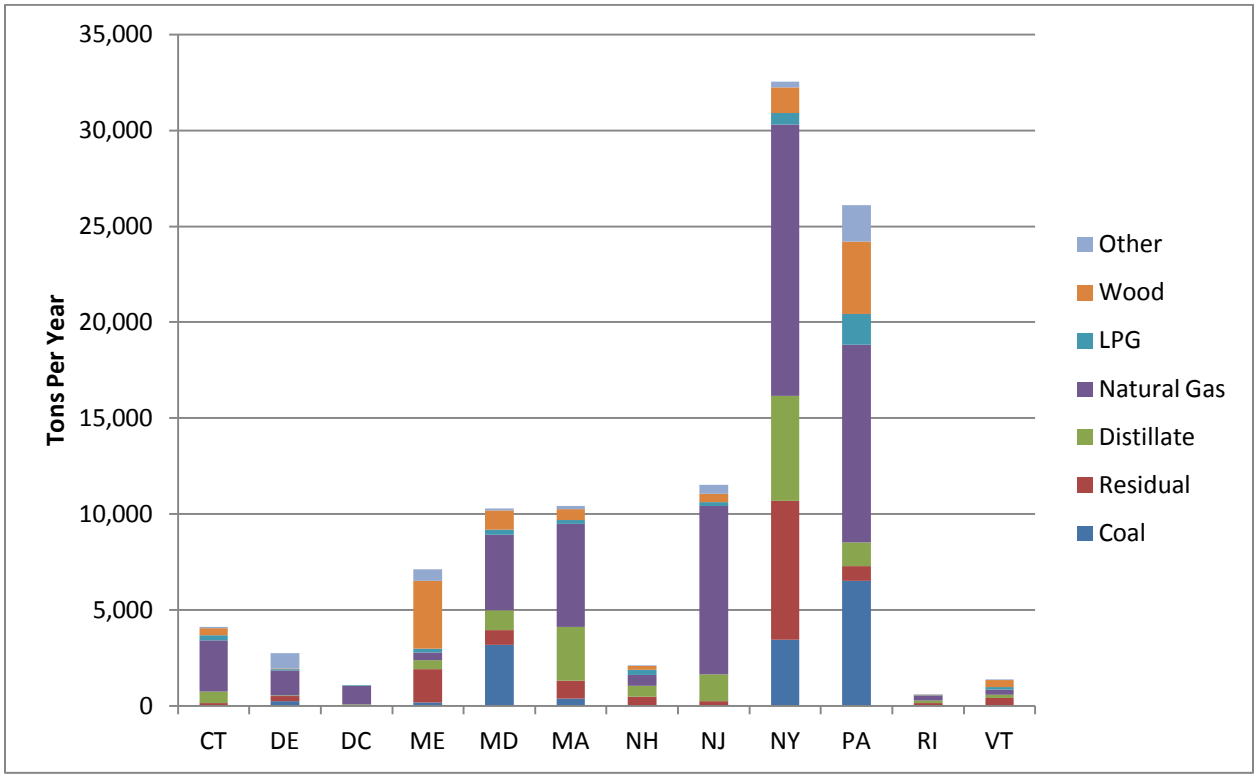


Figure 4-6: 2011 ICI Boiler SO_2 Emissions for the Northeast States (Tons per Year)

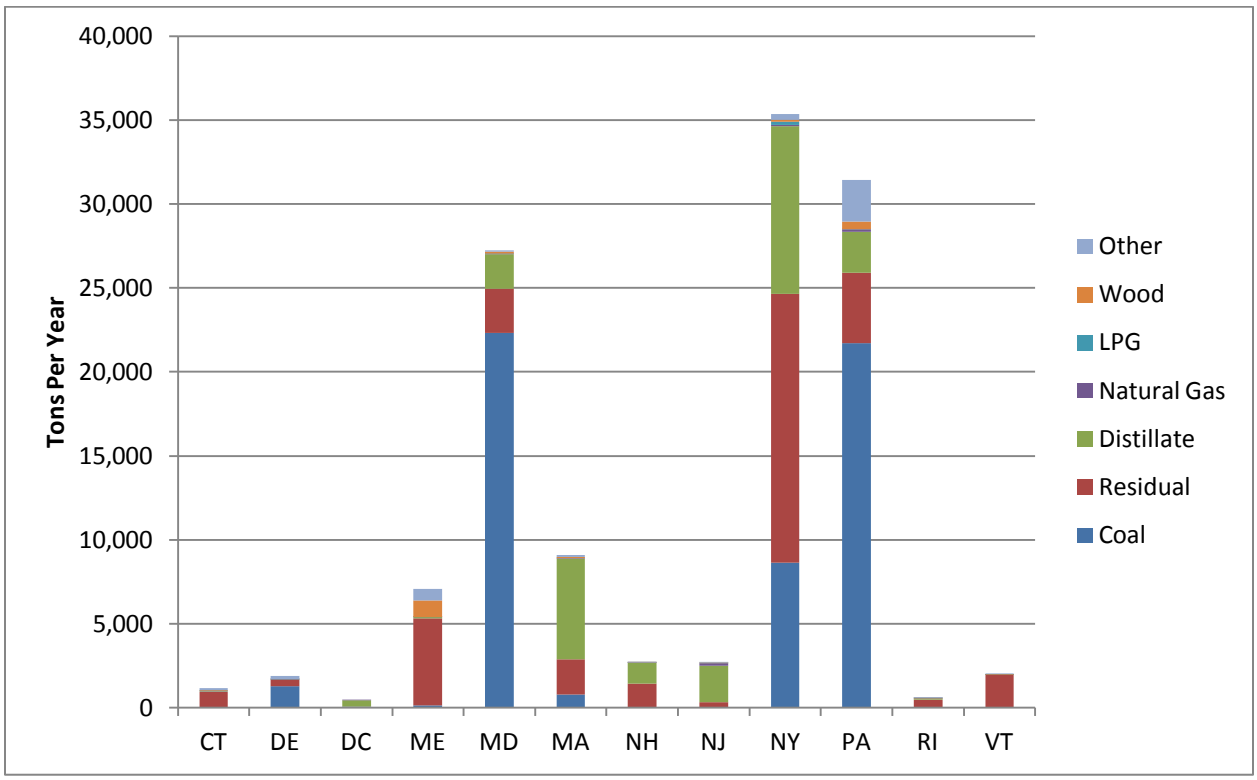


Figure 4-7: 2011 Total ICI Boiler NOx Emissions by Fuel Type for the Northeast States (Tons per Year)

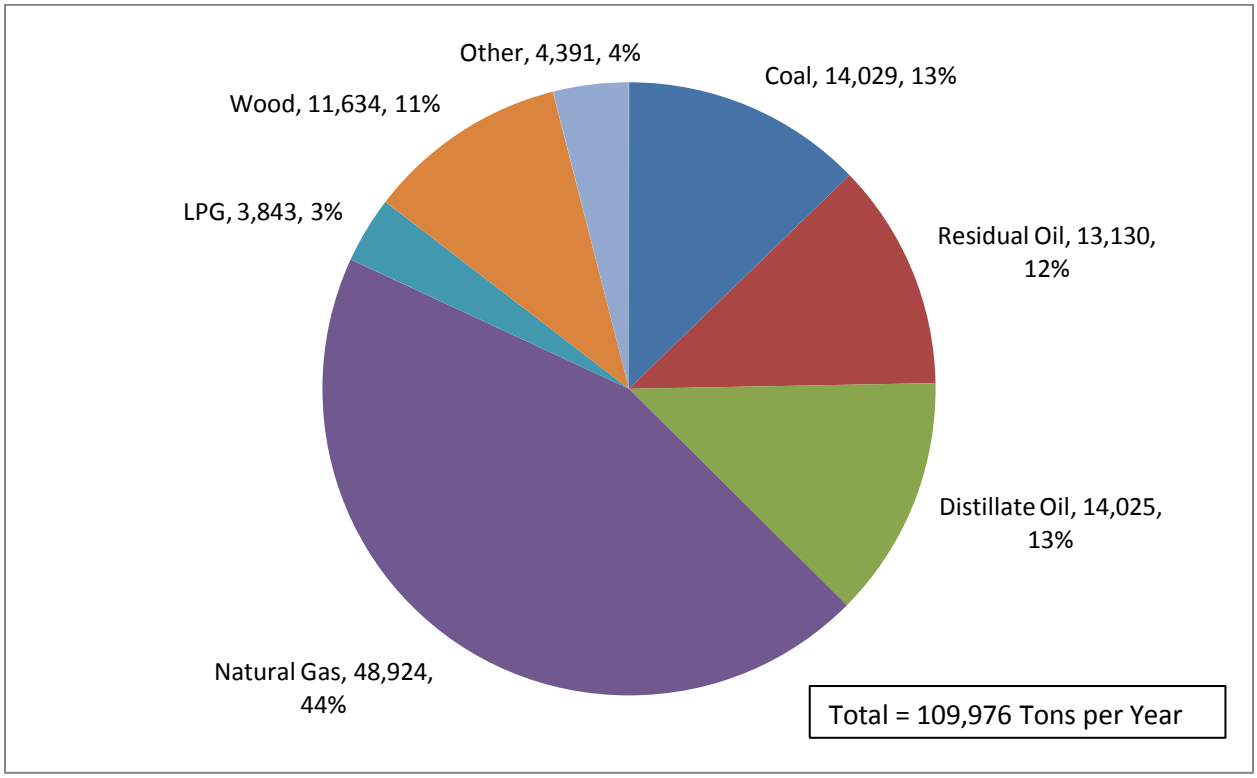


Figure 4-8: 2011 Total ICI Boiler SO_2 Emissions by Fuel Type for the Northeast States (Tons per Year)

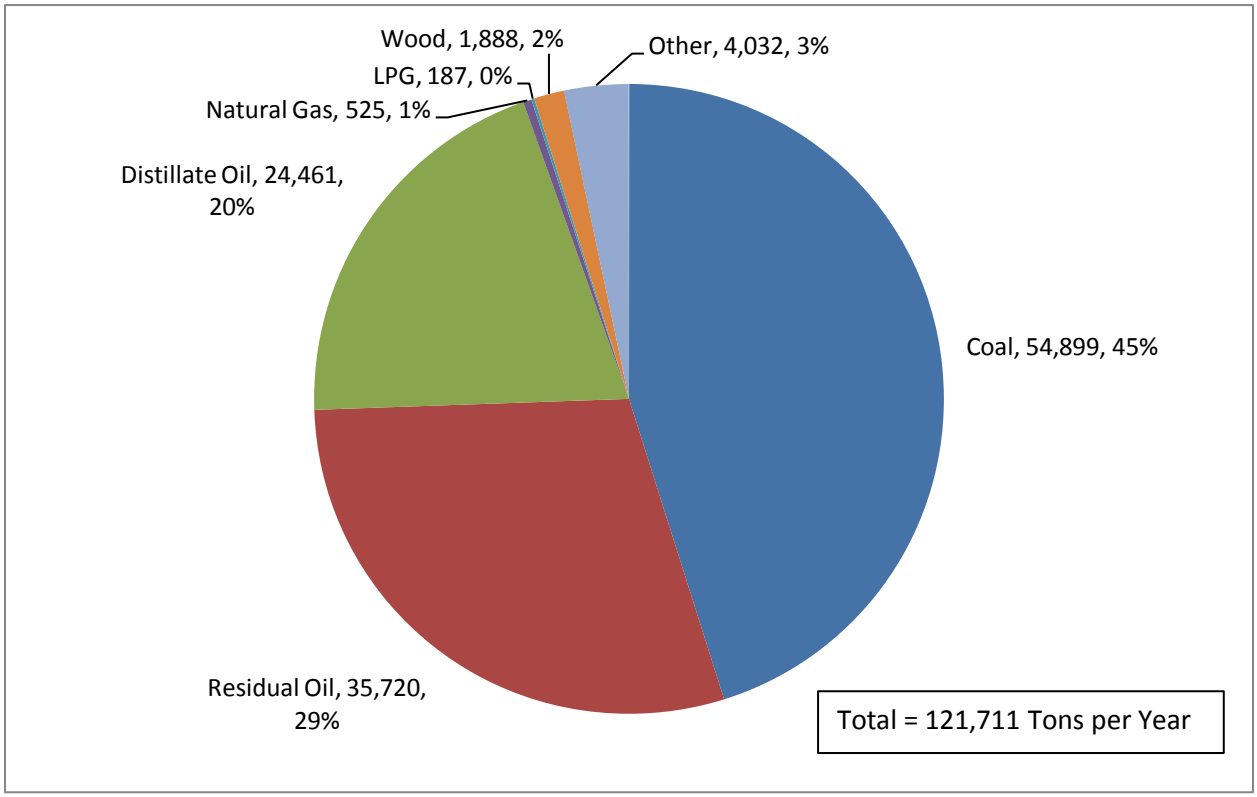


Table 4-3 and Figure 4-7 show that 44% of 2011 ICI boiler NOx emissions in the Northeast states comes from natural gas combustion, with 13% coming from coal, 13% coming from distillate oil, and 12% coming from residual oil. 45% of 2011 ICI boiler SO_2 emissions for the Northeast states comes from coal combustion, with 29% coming from residual oil (Table 4-4 and Figure 4-8). An examination of the bars in Figures 4-5 and 4-6 reveals that the fuel use breakdown by state for 2011 is similar to the pattern in 2007 for the Northeast states. For NOx, natural gas is an important contributor along with coal (MD, NY, and PA) and residual oil (NY). Again, it can be seen that natural gas use is not prominent in ME or VT. Similar to 2007, coal is an important contributor to ICI boiler SO_2 emissions for the Northeast states, particularly for DE, MD, NY, and PA (Figure 4-6). Residual oil is also an important contributor.

Midwest States

ICI boiler NOx and SO_2 emissions by state and fuel type for the Midwest states are shown in Tables 4-5 and 4-6. This data is shown graphically in Figures 4-9 and 4-10, and Figures 4-11 and 4-12 provide pie charts showing the breakout by fuel type of total ICI boiler NOx and SO_2 emissions.

Table 4-5: 2011 ICI Boiler NOx Emissions by Fuel Type for the Midwest States (Tons per Year)

Fuel Type	IL	IN	MI	MN	OH	WI	Total	% of Total
Coal	5,876	7,560	3,062	5,272	8,015	13,812	43,597	29%
Residual Oil	38	29	309	233	128	56	795	1%
Distillate Oil	810	81	213	304	142	266	1,816	1%
Natural Gas	22,865	10,028	13,314	9,903	20,045	8,383	84,539	56%
LPG	178	81	167	114	98	321	958	1%
Wood	17	475	2,201	4,479	2,230	1,606	11,007	7%
Other	1,115	3,078	1,530	148	1,475	1,453	8,799	6%
Total	**30,899**	**21,333**	**20,796**	**20,454**	**32,133**	**25,897**	**151,511**	**100%**

Table 4-6: 2011 ICI Boiler SO_2 Emissions by Fuel Type for the Midwest States (Tons per Year)

Fuel Type	IL	IN	MI	MN	OH	WI	Total	% of Total
Coal	32,962	25,619	8,670	6,475	49,223	41,461	164,410	85%
Residual Oil	173	126	1,142	833	814	152	3,240	2%
Distillate Oil	1,683	67	155	482	65	354	2,805	1%
Natural Gas	160	182	91	215	119	66	832	0%
LPG	1	0	1	1	1	2	6	0%
Wood	1	67	580	754	240	191	1,832	1%
Other	428	9,278	3,533	300	2,858	3,716	20,112	10%
Total	**35,408**	**35,339**	**14,170**	**9,059**	**53,318**	**45,941**	**193,236**	**100%**

Figure 4-9: 2011 ICI NOx Boiler Emissions by Fuel Type for the Midwest States (Tons per Year)

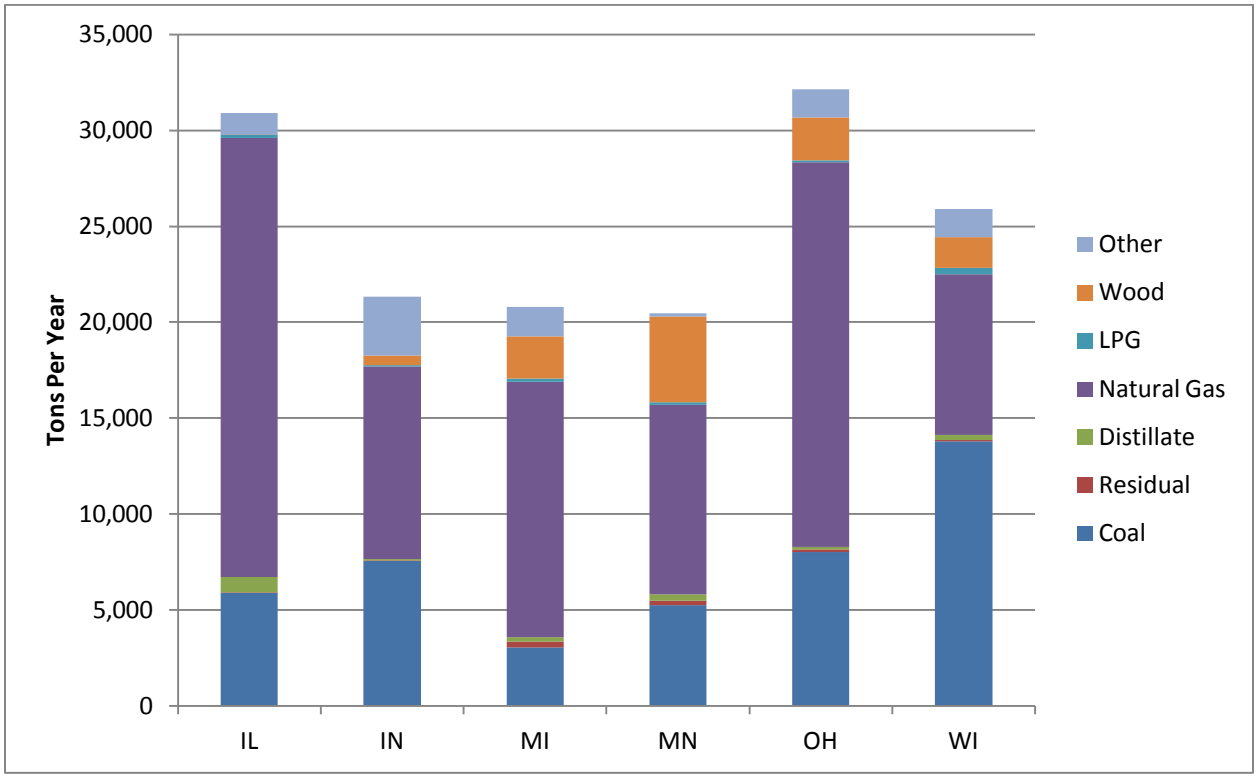


Figure 4-10: 2011 ICI Boiler SO_2 Emissions by Fuel Type for the Midwest States (Tons per Year)

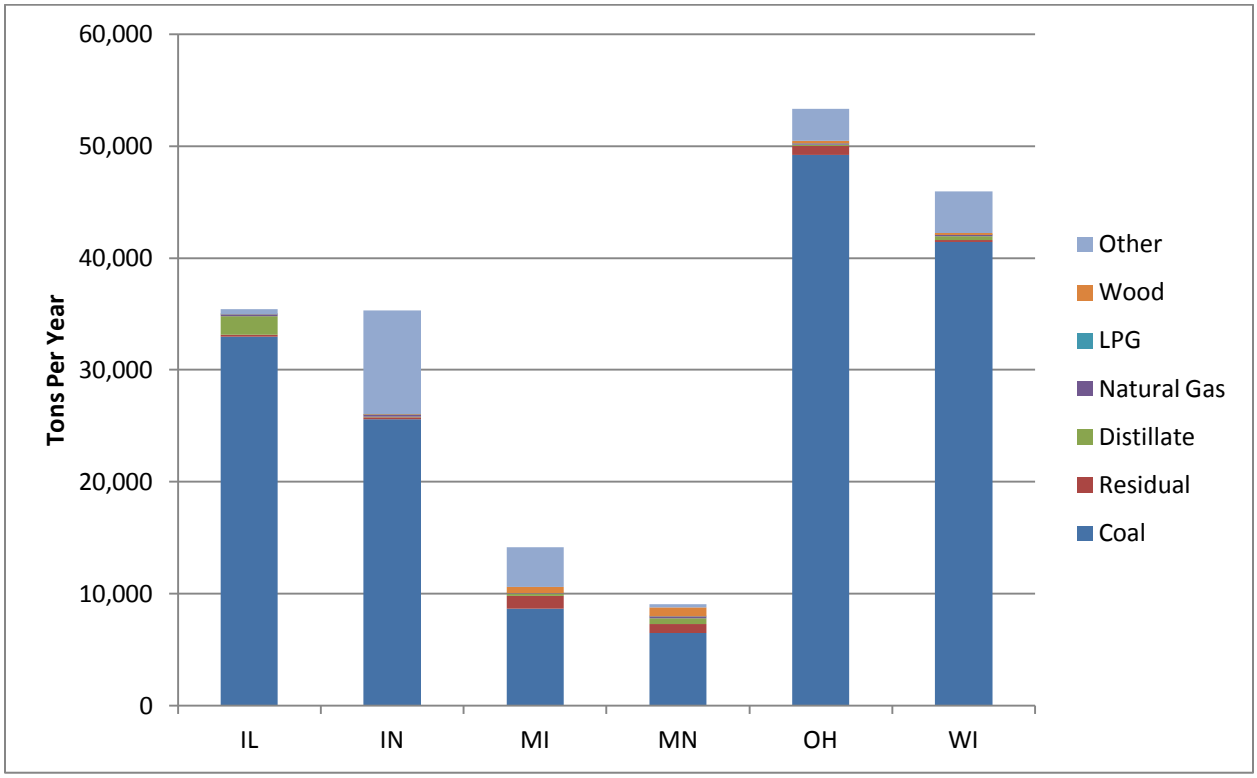


Figure 4-11: 2011 Total ICI Boiler NOx Emissions by Fuel Type for the Midwest States (Tons per Year)

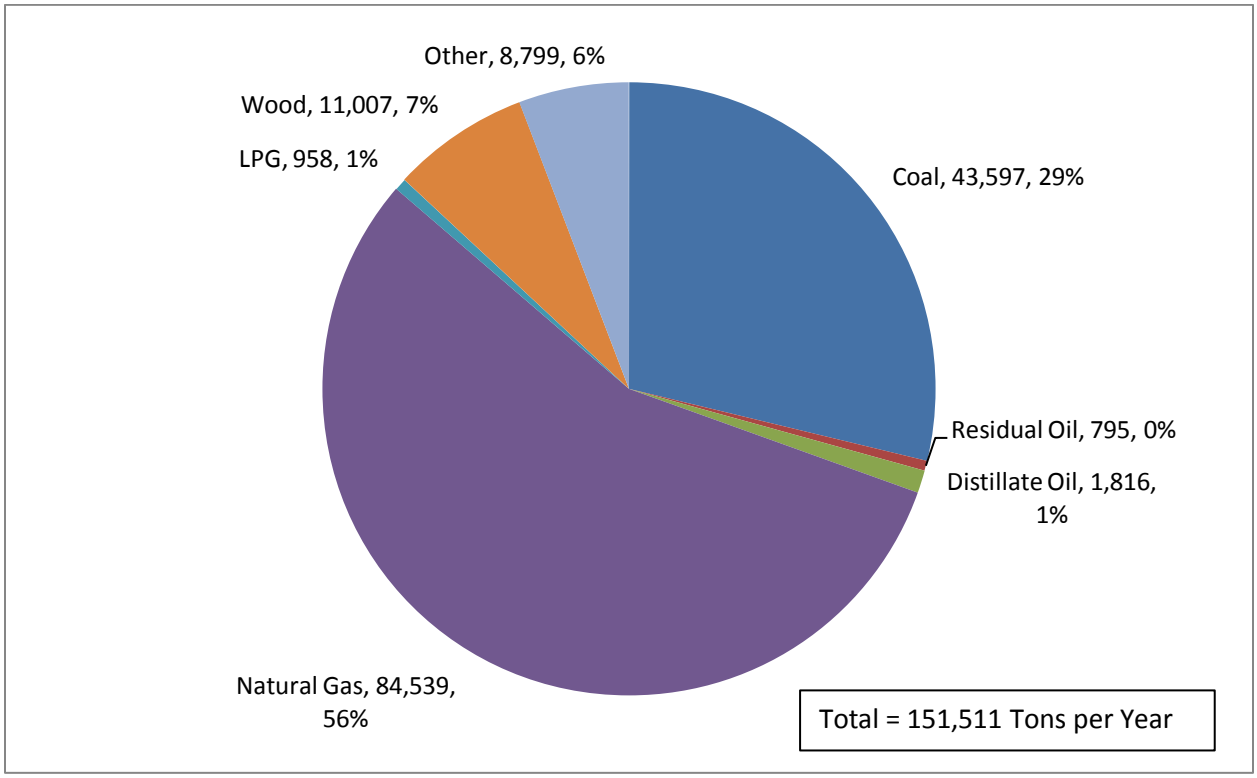


Figure 4-12: 2011 Total ICI Boiler SO_2 Emissions by Fuel Type for the Midwest States (Tons per Year)

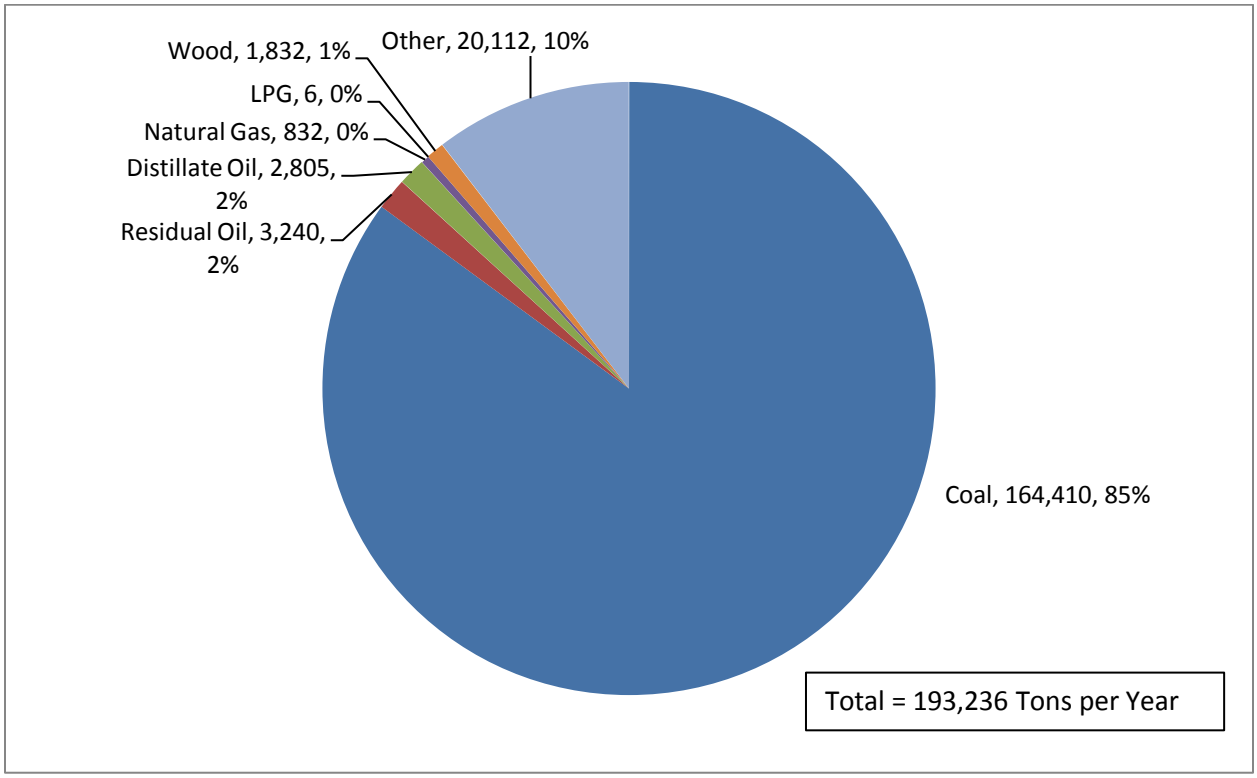


Table 4-5 and Figure 4-11 show that 56% of 2011 ICI boiler NOx emissions in the Midwest states came from natural gas combustion, with 29% coming from coal. Table 4-6 and Figure 4-12 show that 85% of 2011 ICI boiler SO_2 emissions in the Midwest states came from coal combustion, with 10% coming from Other (as mentioned earlier, the Other category includes fuels such as coke, process gas, bagasse, and waste). The colors of the bars in Figures 4-9 and 4-10 indicate that fuel use patterns amongst states are much more homogeneous for the Midwest states than for the Northeast states. For NOx, natural gas and coal were the primary contributors for all of the Midwest states, with wood being a secondary contributor for several states. For SO_2, coal was the dominant contributor for all of the states, with "Other" being a secondary contributor (particularly for IN).

Southeast States

2011 ICI boiler NOx and SO_2 emissions by state and fuel type for the Southeast states are displayed in Tables 4-7 and 4-8. This data is presented graphically in Figures 4-13 and 4-14. Figures 4-15 and 4-16 contain pie charts showing the fuel use breakdown for total ICI boiler NOx and SO_2 emissions for the Southeast states.

Table 4-7: 2011 ICI Boiler NOx Emissions by Fuel Type for the Southeast States (Tons per Year)

Fuel Type	AL	GA	KY	MS	NC	SC	TN	VA	WV	Total	% of Total
Coal	4,392	6,228	1,968	1,028	9,666	4,473	10,876	9,449	5,688	53,767	36%
Residual Oil	542	443	29	0	1,464	286	142	680	98	3,685	2%
Distillate Oil	96	21	51	2	853	24	269	437	95	1,848	1%
Natural Gas	5,692	5,041	3,163	1,926	7,499	2,809	7,438	5,846	2,017	41,433	28%
LPG	6	96	21	0	823	2	2	402	1	1,351	1%
Wood	10,018	5,653	1,113	3,212	3,824	7,034	5,194	3,215	280	39,544	26%
Other	1,414	1,059	909	123	1,313	374	561	2,210	662	8,625	6%
Total	**22,159**	**18,542**	**7,254**	**6,291**	**25,441**	**15,001**	**24,483**	**22,240**	**8,841**	**150,252**	**100%**

Table 4-8: 2011 ICI Boiler SO_2 Emissions by Fuel Type for the Southeast States (Tons per Year)

Fuel Type	AL	GA	KY	MS	NC	SC	TN	VA	WV	Total	% of Total
Coal	30,804	13,950	5,150	5,055	8,505	9,049	30,373	11,461	15,305	129,652	72%
Residual Oil	614	4,180	95	0	6,281	1,772	47	3,204	249	16,443	9%
Distillate Oil	2	390	56	0	6,153	19	92	796	239	7,746	4%
Natural Gas	730	2,220	109	47	277	85	83	37	10	3,598	2%
LPG	0	1	1	0	5	0	0	2	0	9	0%
Wood	4,727	1,500	70	444	993	1,708	1,939	313	34	11,730	7%
Other	2,822	3,059	322	27	990	2,090	21	149	520	9,999	6%
Total	**39,700**	**25,299**	**5,803**	**5,573**	**23,204**	**14,722**	**32,555**	**15,963**	**16,356**	**179,176**	**100%**

Figure 4-13: 2011 ICI Boiler NOx Emissions by Fuel Type for the Southeast States (Tons per Year)

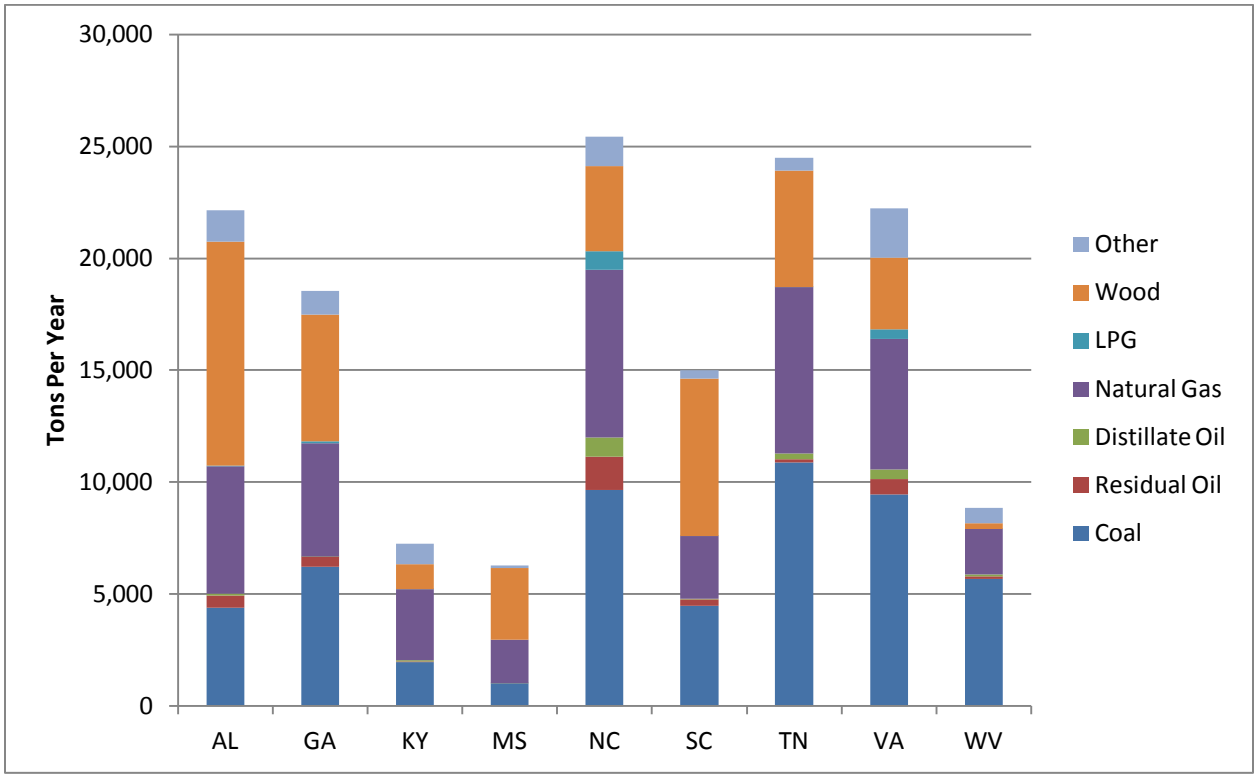


Figure 4-14: 2011 ICI Boiler SO_2 Emissions by Fuel Type for the Southeast States (Tons per Year)

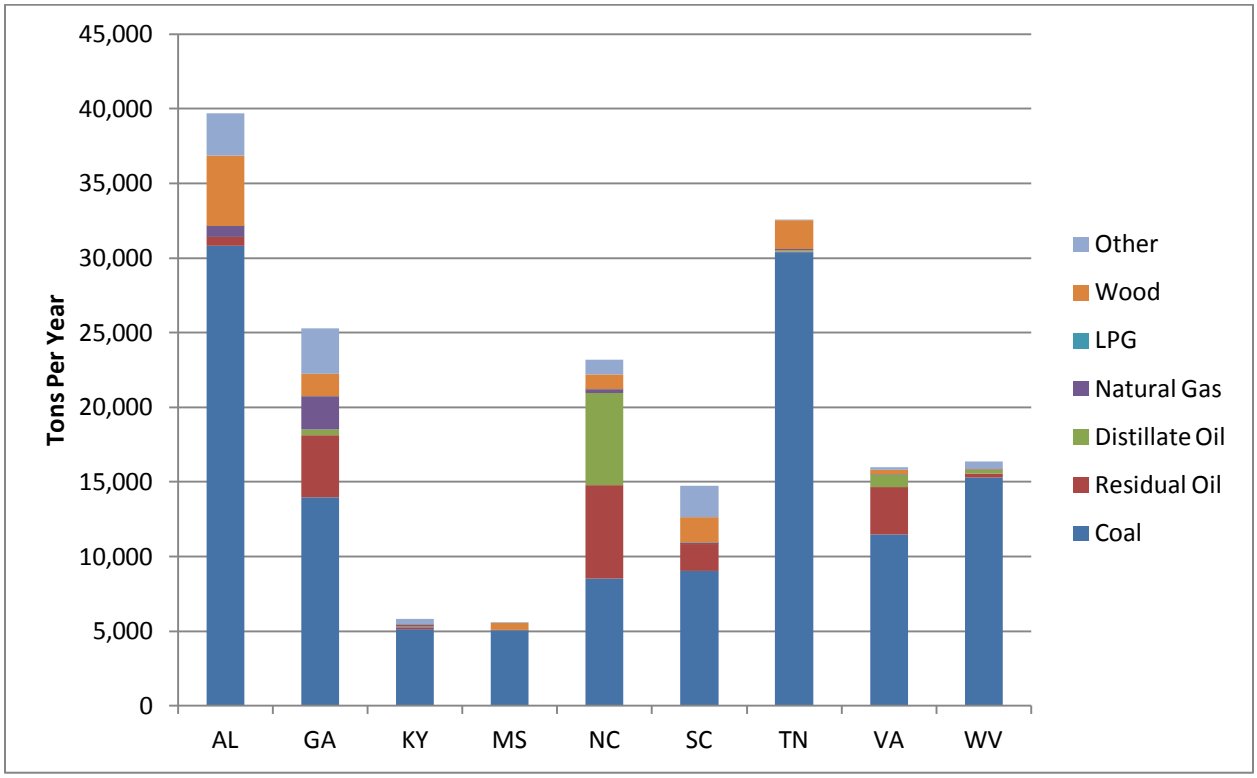


Figure 4-15: 2011 Total ICI Boiler NOx Emissions by Fuel Type for the Southeast States (Tons per Year)

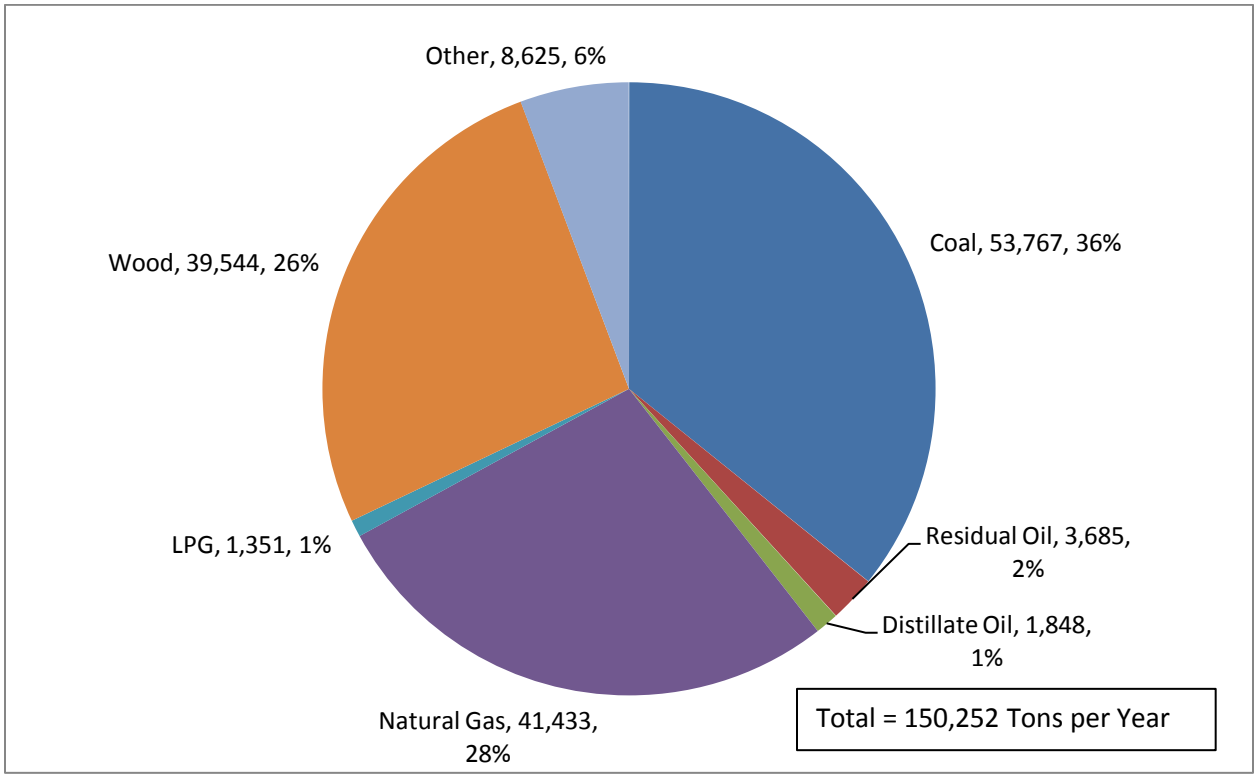


Figure 4-16: 2011 Total ICI Boiler SO_2 Emissions by Fuel Type for the Southeast States (Tons per Year)

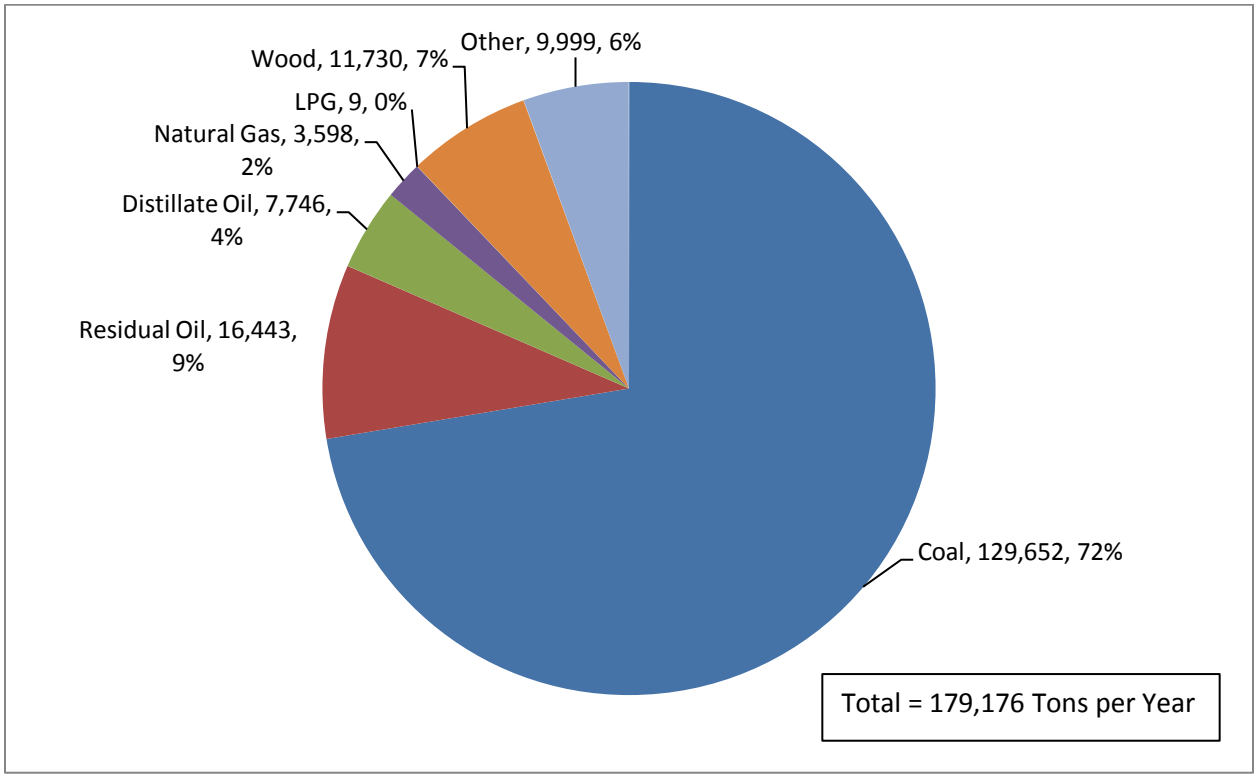


Table 4-7 and Figure 4-15 show that 2011 ICI boiler NOx emissions for the Southeast states are fairly evenly distributed between coal, natural gas, and wood with coal getting the highest percentage at 36%. Over 70% of the 2011 ICI boiler SO_2 emissions for the Southeast states were due to coal combustion, with much of the remainder divided between residual oil, wood, and "Other" (Table 4-8 and Figure 4-16). The colors of the bars in Figures 4-13 and 4-14 suggest that fuel use patterns amongst states in the Southeast region are fairly homogeneous. It can be seen in Figure 4-13 that coal, natural gas, and wood were important contributors to ICI boiler NOx for all of the Southeast States. For SO_2, coal was dominant for all Southeast states (Figure 4-14) with residual oil being a secondary contributor for several states. Wood was a secondary contributor for AL.

5. Comparison of ICI Boiler Emissions with Emissions from Other Sectors

To evaluate whether ICI boiler NOx and SO_2 emissions are substantial enough to warrant further analysis of their impact on ozone and regional haze, ICI boiler emissions were compared to emissions from other sectors of the emissions inventory (e.g. point, area, non-road, and on-road). This analysis was performed for 2011 and 2018 for the Northeast states, the Midwest states, the Southeast states, and the continental U.S. 2011 emissions for point, area, non-road, and on-road sectors are based on the 2011 NEI Version 2 and were downloaded from the EIS Gateway. 2018 emissions for these sectors were taken from the FTP site for EPA's 2011 emissions modeling platform. This analysis is discussed further in the subsections below.

Northeast States

Table 5-1 shows 2011 ICI boiler NOx and SO_2 emissions for the Northeast states compared with emissions from other inventory sectors. This data is shown graphically in Figures 5-1 and 5-2. Table 5-2 and Figures 5-3 and 5-4 show the corresponding data for 2018 for the Northeast states.

Table 5-1: 2011 ICI Boiler NOx and SO_2 Emissions for the Northeast States Compared with Other Inventory Sectors (Tons per Year)

Sector	NOx	SO_2	NOx % of Total	SO_2 % of Total
Point ICI Boilers	39,932	65,571	2%	9%
Other Point	336,619	506,932	20%	68%
Nonpoint ICI Boilers	70,043	56,140	4%	8%
Other Nonpoint	296,677	106,148	18%	14%
Non-Road Mobile	223,656	648	13%	0%
On-Road Mobile	710,215	4,957	42%	1%
Total	**1,677,143**	**740,397**	**100%**	**100%**
Total ICI Boilers	109,976	121,711		
Point ICI Boilers % of Total Point	11%	11%		
Nonpoint ICI Boilers % of Total Nonpoint	19%	35%		
Total ICI Boilers % of Total	7%	16%		

Figure 5-1: 2011 ICI Boiler NOx Emissions for the Northeast States Compared with Other Inventory Sectors (Tons per Year)

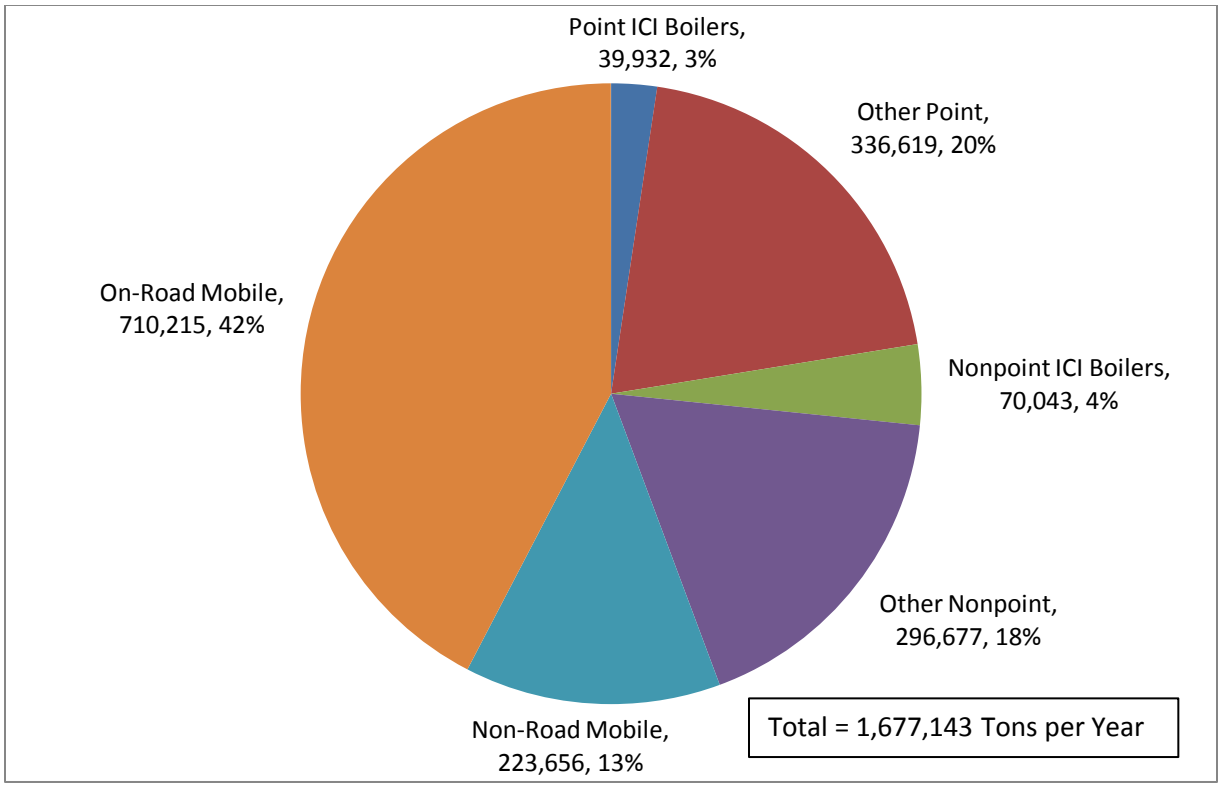


Figure 5-2: 2011 ICI Boiler SO_2 Emissions for the Northeast States Compared with Other Inventory Sectors (Tons per Year)

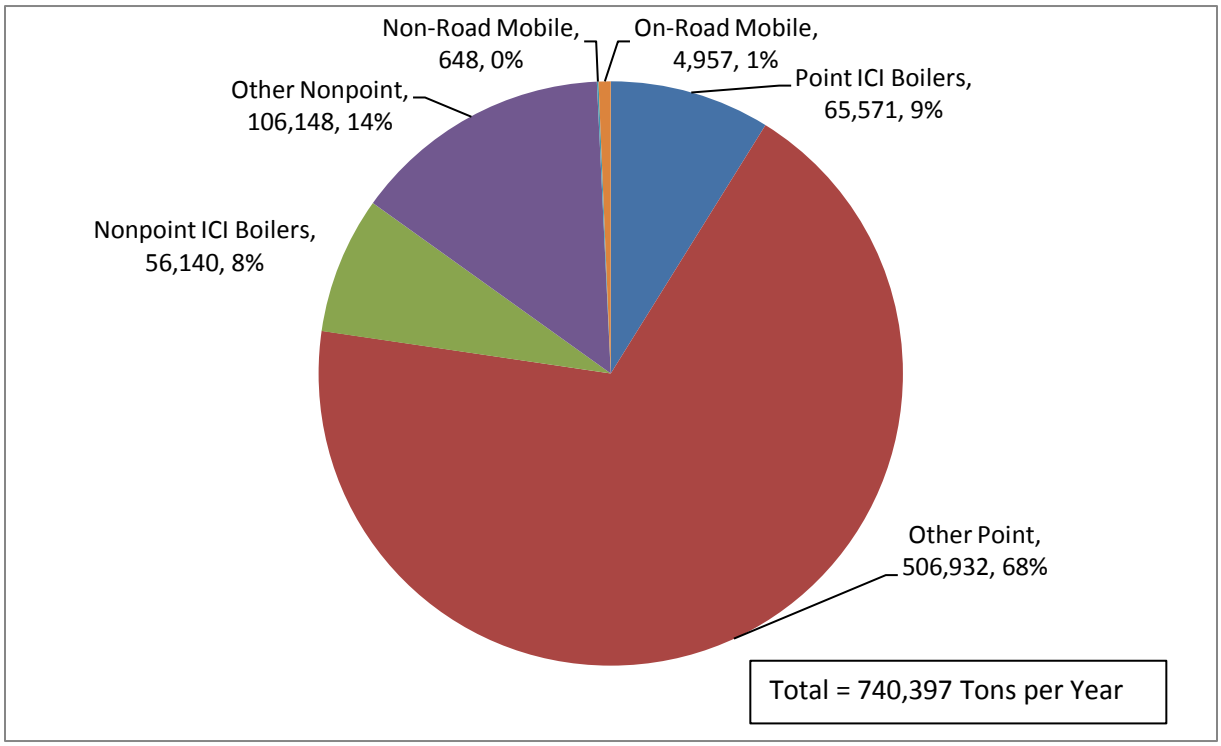


Table 5-2: 2018 ICI Boiler NOx and SO_2 Emissions for the Northeast States Compared with Other Inventory Sectors (Tons per Year)

Sector	NOx	SO_2	NOx % of Total	SO_2 % of Total
Point ICI Boilers	31,561	28,964	3%	12%
Other Point	284,321	120,432	26%	49%
Nonpoint ICI Boilers	70,964	24,833	6%	10%
Other Nonpoint	150,715	65,484	14%	27%
Non-Road Mobile	218,643	2,071	20%	1%
On-Road Mobile	342,828	1,791	31%	1%
Total	**1,099,031**	**243,574**	**100%**	**100%**
Total ICI Boilers	102,524	53,797		
Point ICI Boilers % of Total Point	10%	19%		
Nonpoint ICI Boilers % of Total Nonpoint	32%	27%		
Total ICI Boilers % of Total	9%	22%		

Figure 5-3: 2018 ICI Boiler NOx Emissions for the Northeast States Compared with Other Inventory Sectors (Tons per Year)

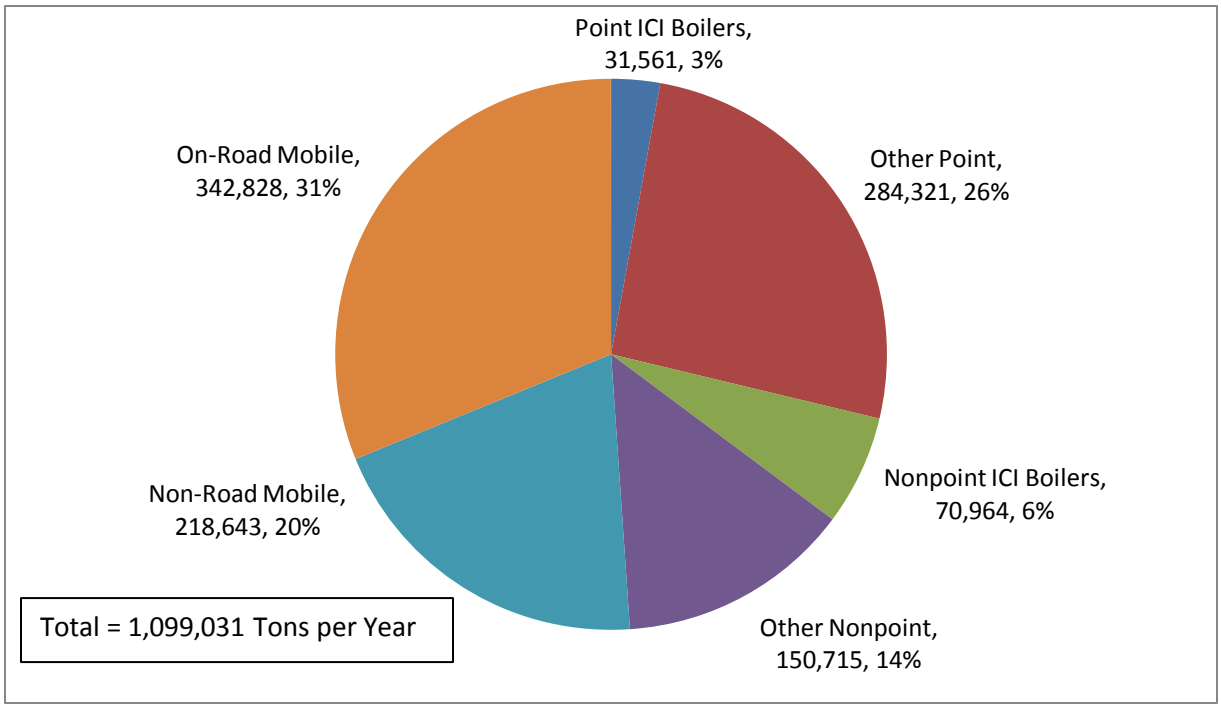


Figure 5-4: 2018 ICI Boiler SO_2 Emissions for the Northeast States Compared with Other Inventory Sectors (Tons per Year)

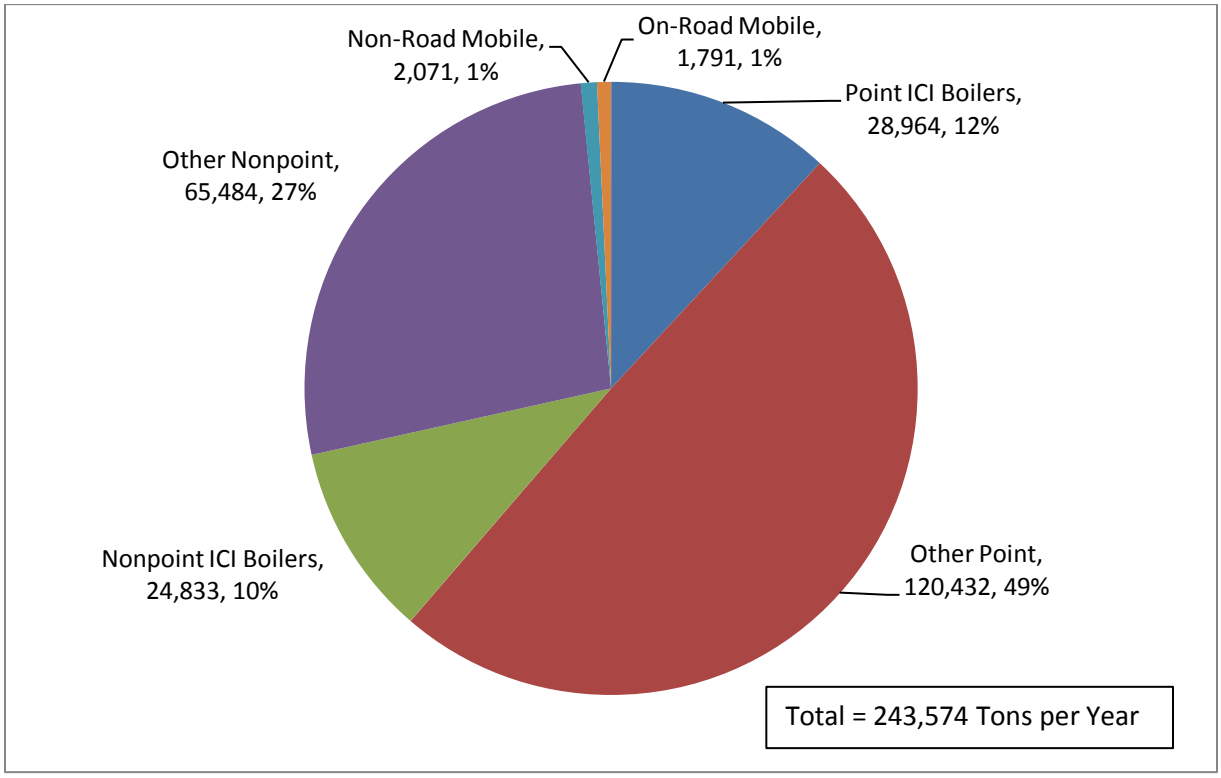


Table 5-1 shows that 2011 point source ICI boiler NOx emissions comprise 2% of total NOx emissions and nonpoint ICI boiler NOx emissions make up 4% of total NOx emissions. Total (point plus nonpoint) 2011 ICI boiler NOx emissions comprise 7% of total NOx emissions. For SO_2, point ICI boiler emissions comprise 9% of the total, nonpoint ICI boilers comprise 8% of the total, and total ICI boilers comprise 16% of the total. It can be seen in Table 5-2 that point source ICI boiler NOx emissions for 2018 comprise 3% of the total and nonpoint ICI boiler NOx emissions are 6% of the total. Total 2018 ICI boiler NOx emissions comprise 9% of total NOx emissions. For SO_2 in 2018, point ICI boiler emissions comprise 12% of the total, nonpoint ICI boilers comprise 10% of the total, and all ICI boiler emissions comprise 22% of the total. These tables and figures show that as emissions are reduced for other sectors of the inventory (e.g. point, non-road, and on-road) between 2011 and 2018, ICI boilers become a larger percentage of the total. Tables 5-1 and 5-2 also show that point ICI boilers and nonpoint ICI boilers make up substantial percentages of the total point and nonpoint categories.

Midwest States

Table 5-3 shows 2011 ICI boiler NOx and SO_2 emissions for the Midwest states compared with emissions from other inventory sectors. This data is shown graphically in Figures 5-5 and 5-6. Table 5-4 and Figures 5-7 and 5-8 show the corresponding data for 2018 for the Midwest states.

Table 5-3: 2011 ICI Boiler NOx and SO_2 Emissions for the Midwest States Compared with Other Inventory Sectors (Tons per Year)

Sector	NOx	SO_2	NOx % of Total	SO_2 % of Total
Point ICI Boilers	83,589	184,231	3%	10%
Other Point	689,530	1,656,330	27%	88%
Nonpoint ICI Boilers	67,922	9,005	3%	0%
Other Nonpoint	294,585	22,446	11%	1%
Non-Road Mobile	346,312	948	14%	0%
On-Road Mobile	1,081,395	5,366	42%	0%
Total	**2,563,333**	**1,878,327**	**100%**	**100%**
Total ICI Boilers	151,511	193,236		
Point ICI Boilers % of Total Point	11%	10%		
Nonpoint ICI Boilers % of Total Nonpoint	19%	29%		
Total ICI Boilers % of Total	6%	10%		

Figure 5-5: 2011 ICI Boiler NOx Emissions for the Midwest States Compared with Other Inventory Sectors (Tons per Year)

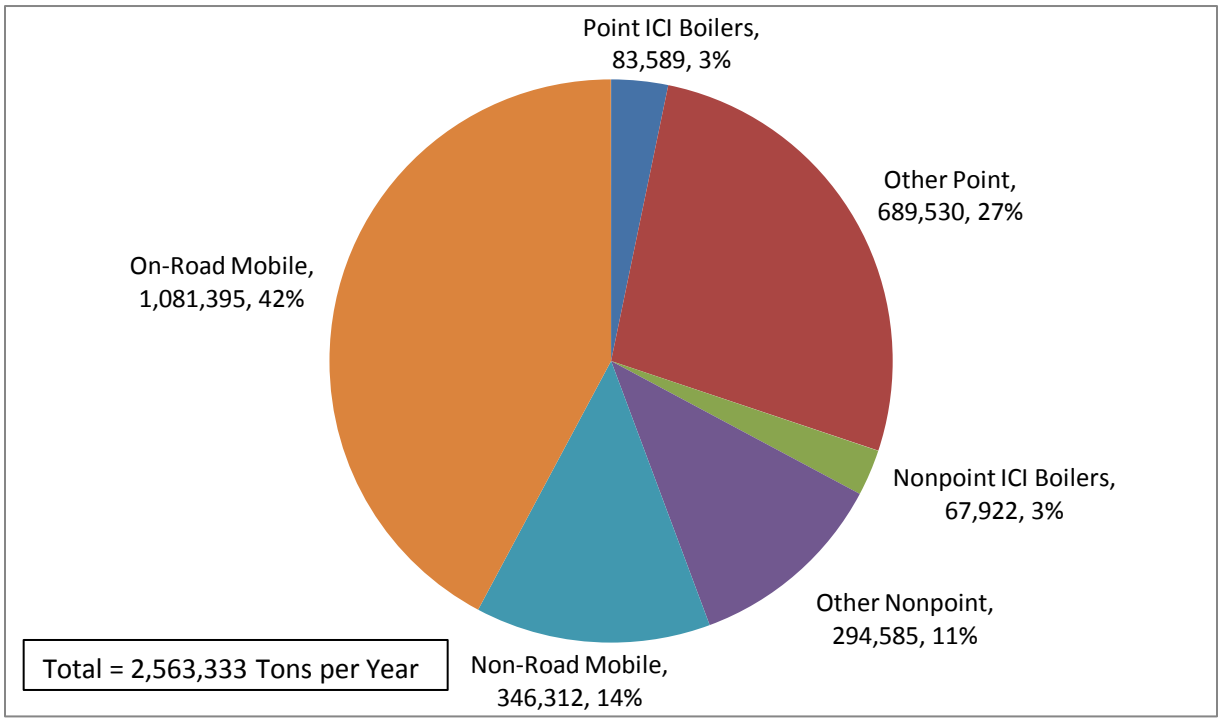


Figure 5-6: 2011 ICI Boiler SO_2 Emissions for the Midwest States Compared with Other Inventory Sectors (Tons per Year)

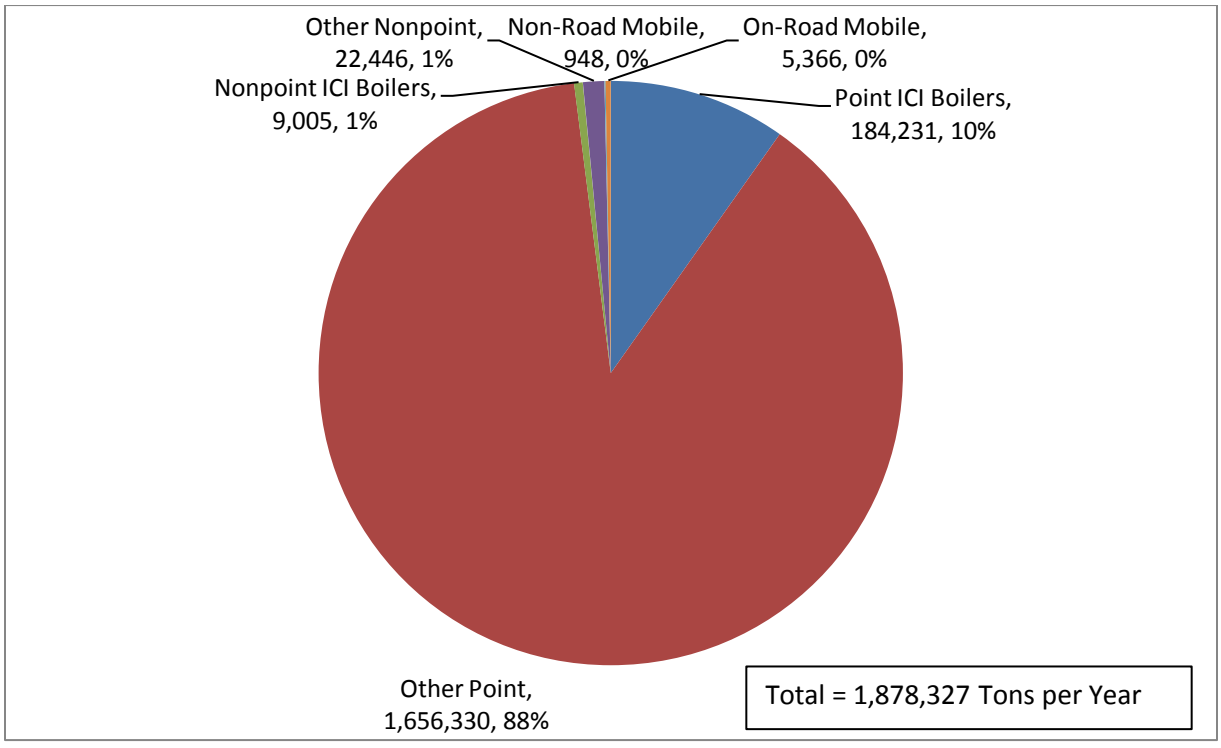


Table 5-4: 2018 ICI Boiler NOx and SO_2 Emissions for the Midwest States Compared with Other Inventory Sectors (Tons per Year)

Sector	NOx	SO_2	NOx % of Total	SO_2 % of Total
Point ICI Boilers	73,843	85,770	4%	13%
Other Point	554,454	527,029	34%	79%
Nonpoint ICI Boilers	67,354	8,823	4%	1%
Other Nonpoint	143,006	39,881	9%	6%
Non-Road Mobile	344,632	1,184	21%	0%
On-Road Mobile	462,778	2,060	28%	0%
Total	**1,646,066**	**664,746**	**100%**	**100%**
Total ICI Boilers	141,196	94,593		
Point ICI Boilers % of Total Point	12%	14%		
Nonpoint ICI Boilers % of Total Nonpoint	32%	18%		
Total ICI Boilers % of Total	9%	14%		

Figure 5-7: 2018 ICI Boiler NOx Emissions for the Midwest States Compared with Other Inventory Sectors (Tons per Year)

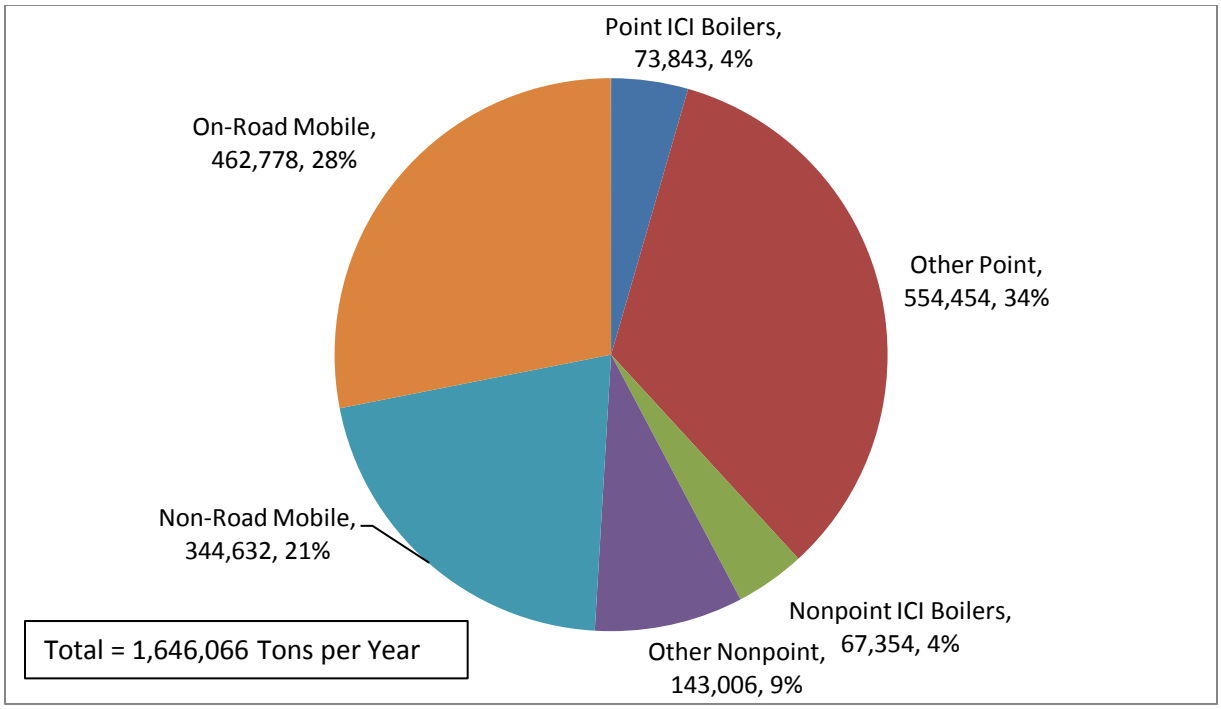


Figure 5-8: 2018 ICI Boiler SO_2 Emissions for the Midwest States Compared with Other Inventory Sectors (Tons per Year)

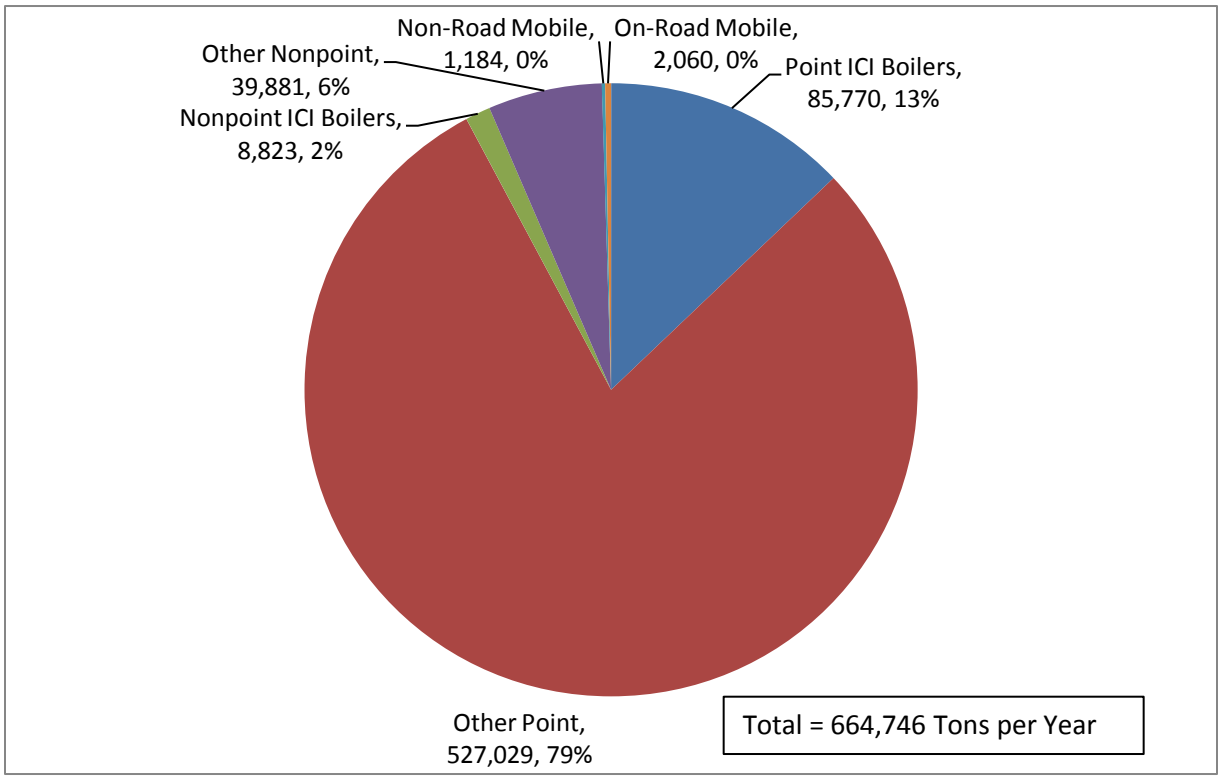


Table 5-3 shows that for 2011 point and nonpoint ICI boiler NOx emissions in the Midwest each comprise 3% of total NOx emissions. Total 2011 ICI boiler NOx emissions comprise 6% of total NOx emissions. For SO_2, point ICI boiler emissions comprise 10% of the total, nonpoint ICI boilers comprise less than 1% of the total, and total ICI boilers comprise 10% of the total. It can be seen in Table 5-4 that Midwest point and nonpoint ICI boiler NOx emissions for 2018 each comprise 4% of the total. Total 2018 ICI boiler NOx emissions comprise 9% of total NOx emissions. For Midwest SO_2 in 2018, point ICI boiler emissions comprise 13% of the total, nonpoint ICI boilers comprise 1% of the total, and all ICI boiler emissions comprise 14% of the total. Similar to the trend in the Northeast, as emissions are reduced for other sectors of the inventory between 2011 and 2018, ICI boilers become a larger percentage of the total. Total nonpoint emissions, and therefore nonpoint ICI boiler emissions, make up a lesser percentage of the total in the Midwest than for the Northeast, particularly for SO_2.

Southeast States

Table 5-5 shows 2011 ICI boiler NOx and SO_2 emissions for the Southeast states compared with emissions from other inventory sectors. This data is shown graphically in Figures 5-9 and 5-10. Table 5-6 and Figures 5-11 and 5-12 show the corresponding data for 2018 for the Southeast states.

Table 5-5: 2011 ICI Boiler NOx and SO_2 Emissions for the Southeast States Compared with Other Inventory Sectors (Tons per Year)

Sector	NOx	SO_2	NOx % of Total	SO_2 % of Total
Point ICI Boilers	106,512	128,481	4%	9%
Other Point	670,250	1,229,617	25%	85%
Nonpoint ICI Boilers	43,740	50,694	2%	4%
Other Nonpoint	346,220	24,293	13%	2%
Non-Road Mobile	251,551	697	9%	0%
On-Road Mobile	1,266,942	5,933	47%	0%
Total	**2,685,215**	**1,439,715**	**100%**	**100%**
Total ICI Boilers	150,252	179,175		
Point ICI Boilers % of Total Point	14%	9%		
Nonpoint ICI Boilers % of Total Nonpoint	11%	68%		
Total ICI Boilers % of Total	6%	12%		

Figure 5-9: 2011 ICI Boiler NOx Emissions for the Southeast States Compared with Other Inventory Sectors (Tons per Year)

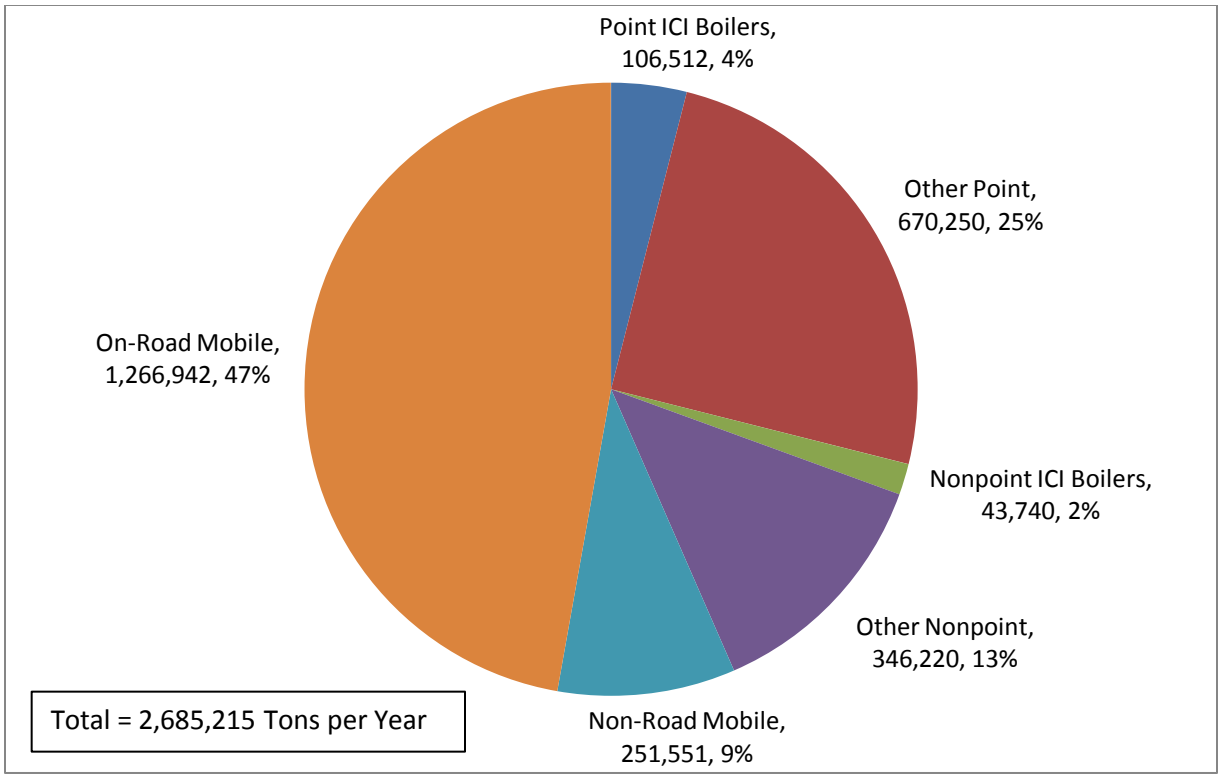


Figure 5-10: 2011 ICI Boiler SO_2 Emissions for the Southeast States Compared with Other Inventory Sectors (Tons per Year)

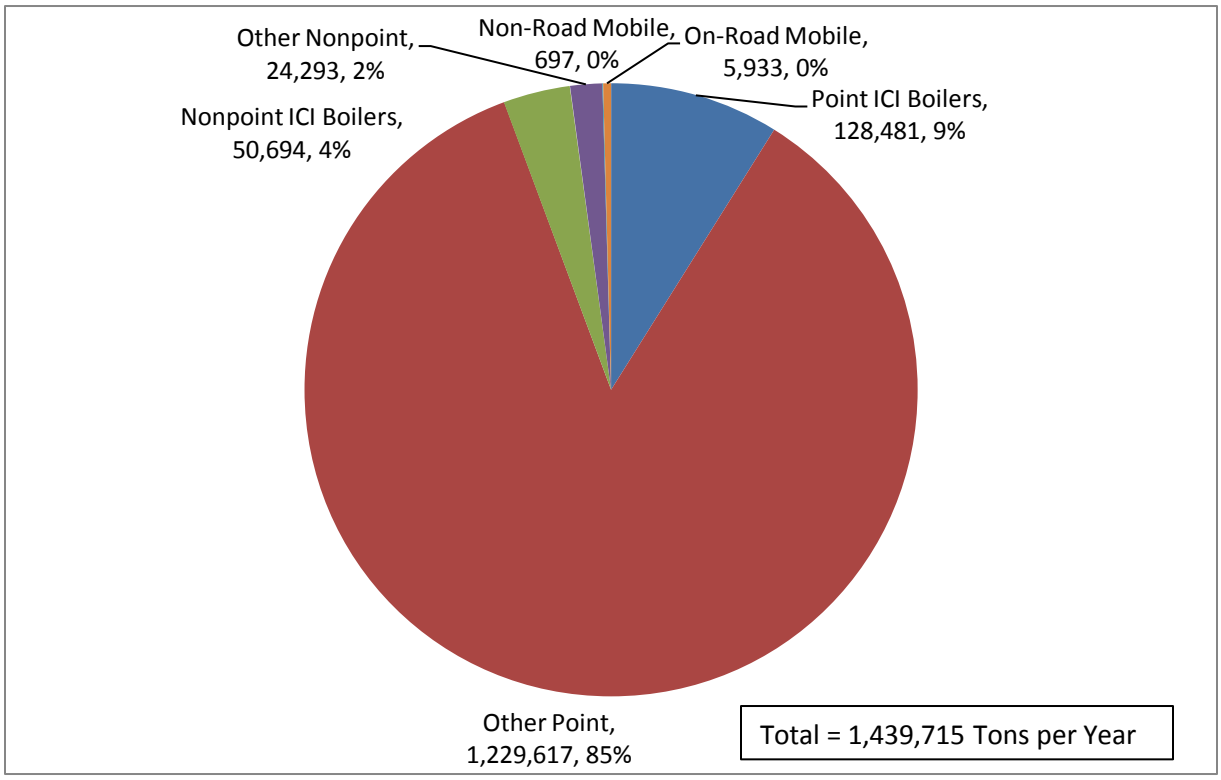


Table 5-6: 2018 ICI Boiler NOx and SO_2 Emissions for the Southeast States Compared with Other Inventory Sectors (Tons per Year)

Sector	NOx	SO_2	NOx % of Total	SO_2 % of Total
Point ICI Boilers	88,893	30,663	5%	4%
Other Point	538,838	528,519	32%	77%
Nonpoint ICI Boilers	43,894	49,836	3%	7%
Other Nonpoint	182,173	77,611	11%	11%
Non-Road Mobile	287,829	1,045	17%	0%
On-Road Mobile	551,348	2,327	33%	0%
Total	**1,692,976**	**690,001**	**100%**	**100%**
Total ICI Boilers	132,787	80,499		
Point ICI Boilers % of Total Point	14%	5%		
Nonpoint ICI Boilers % of Total Nonpoint	19%	39%		
Total ICI Boilers % of Total	8%	12%		

Figure 5-11: 2018 ICI Boiler NOx Emissions for the Southeast States Compared with Other Inventory Sectors (Tons per Year)

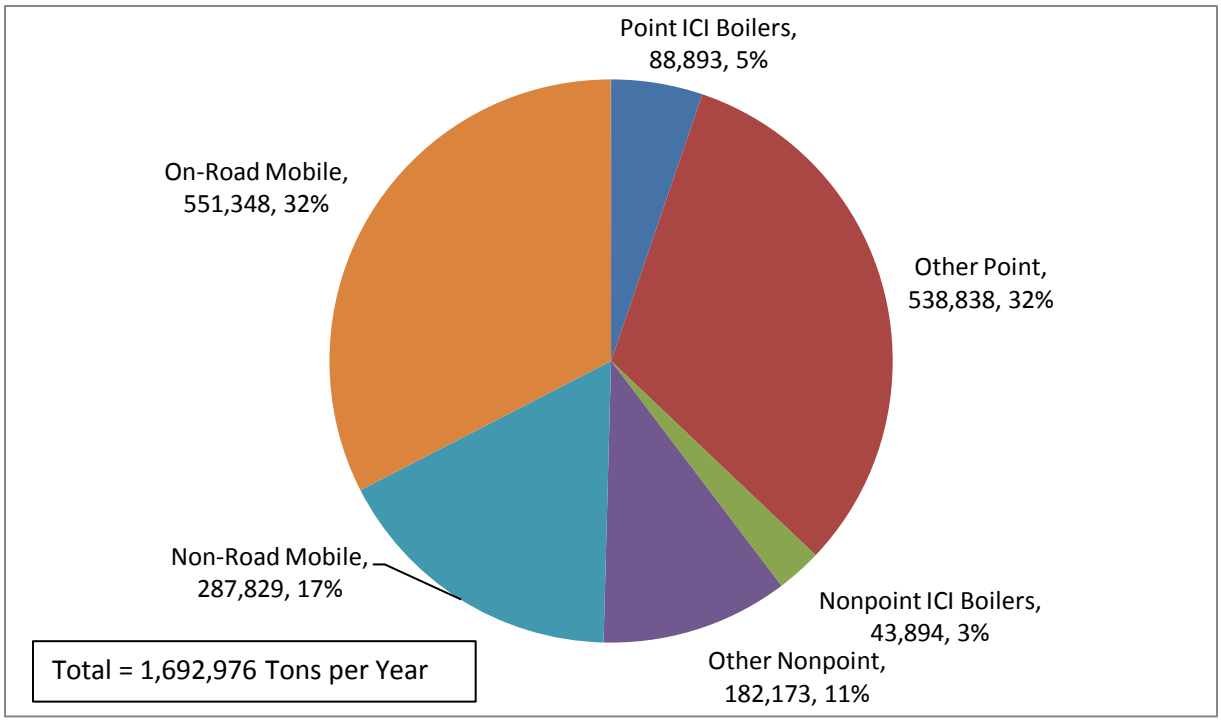


Figure 5-12: 2018 ICI Boiler SO_2 Emissions for the Southeast States Compared with Other Inventory Sectors (Tons per Year)

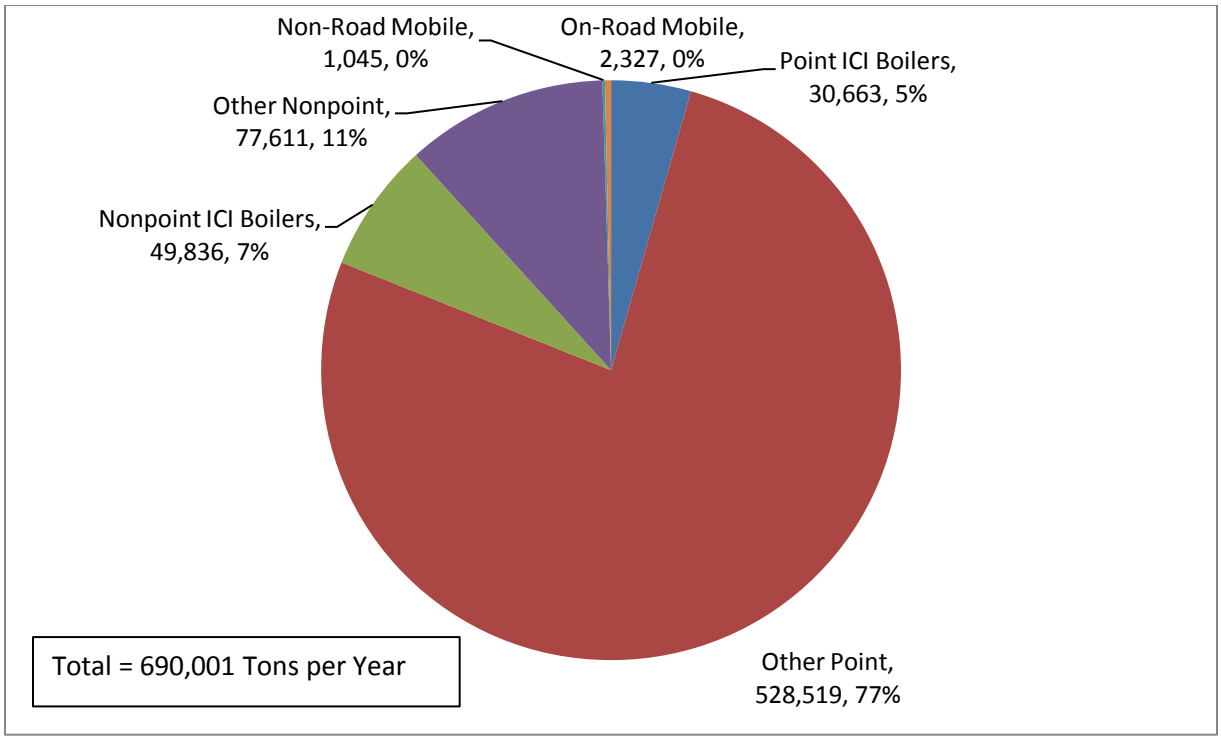


Table 5-5 shows that 2011 point source ICI boiler NOx emissions comprise 4% of total NOx emissions and nonpoint ICI boiler NOx emissions make up 2% of total NOx emissions. Total 2011 ICI boiler NOx emissions comprise 6% of total NOx emissions for the Southeast states. For SO_2, point ICI boiler emissions comprise 9% of the total, nonpoint ICI boilers comprise 4% of the total, and total ICI boilers comprise 12% of the total. It can be seen in Table 5-6 that point source ICI boiler NOx emissions for 2018 comprise 5% of the total and nonpoint ICI boiler NOx emissions are 3% of the total. Total 2018 ICI boiler NOx emissions comprise 8% of total NOx emissions. For SO_2 in 2018, point ICI boiler emissions comprise 4% of the total, nonpoint ICI boilers comprise 7% of the total, and all ICI boiler emissions comprise 12% of the total. Tables 5-5 and 5-6 show that point ICI boilers and nonpoint ICI boilers make up substantial percentages of the total point and nonpoint categories in the Southeast.

Continental U.S.

Table 5-7 shows 2011 ICI boiler NOx and SO_2 emissions for the continental U.S. compared with total emissions for other inventory sectors. Figures 5-13 and 5-14 present this data as pie charts, similar to the other regions described above. Table 5-8 and Figures 5-15 and 5-16 show 2018 ICI boiler NOx and SO_2 emissions for the continental U.S. compared with other sectors of the inventory.

Table 5-7: 2011 ICI Boiler NOx and SO_2 Emissions for the Continental U.S. Compared with Other Inventory Sectors (in Tons per Year)

Sector	NOx	SO_2	NOx % of Total	SO_2 % of Total
Point ICI Boilers	382,186	524,734	3%	8%
Other Point	3,398,810	5,262,598	24%	84%
Nonpoint ICI Boilers	298,838	171,698	2%	3%
Other Nonpoint	2,356,978	251,454	17%	4%
Non-Road Mobile	1,639,130	4,060	12%	0%
On-Road Mobile	5,839,517	29,308	42%	0%
Total	**13,915,458**	**6,243,851**	**100%**	**100%**
Total ICI Boilers	681,024	696,432		
Point ICI Boilers % of Total Point	10%	9%		
Nonpoint ICI Boilers % of Total Nonpoint	11%	41%		
Total ICI Boilers % of Total	5%	11%		

Figure 5-13: 2011 ICI Boiler NOx Emissions for the Continental U.S. Compared with Other Inventory Sectors (Tons per Year)

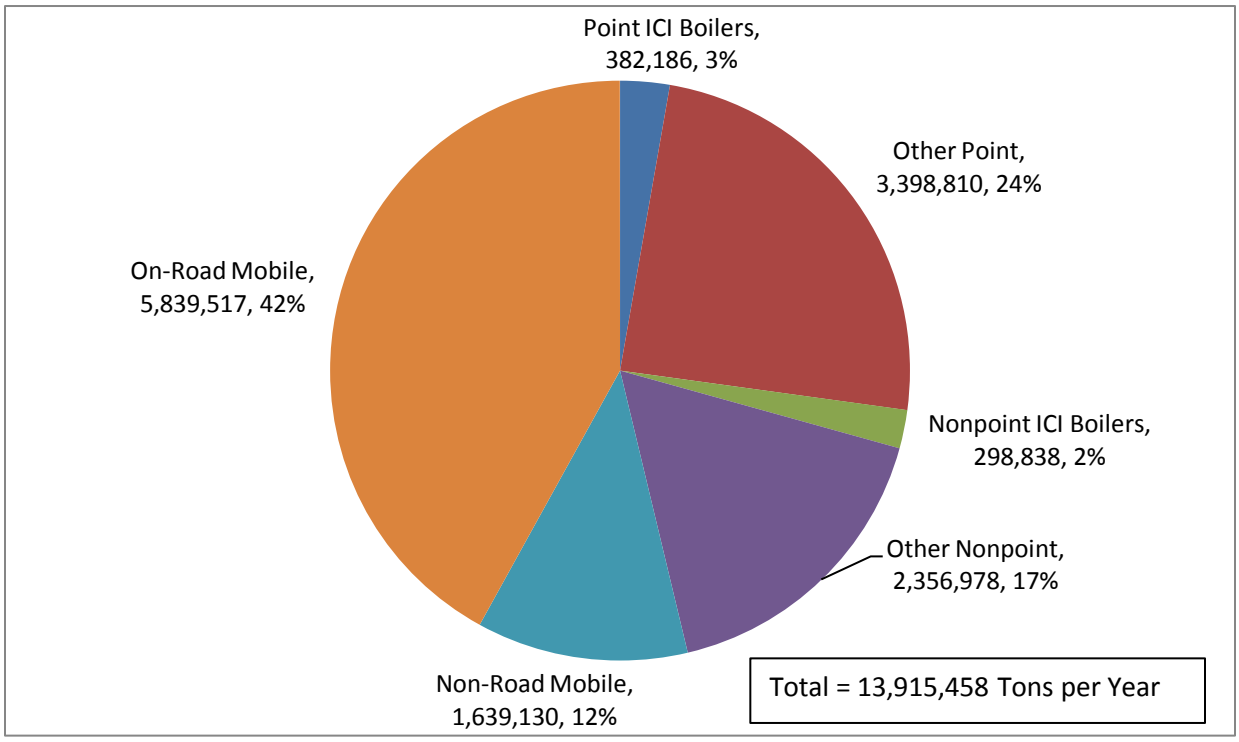


Figure 5-14: 2011 ICI Boiler SO_2 Emissions for the Continental U.S. Compared with Other Inventory Sectors (Tons per Year)

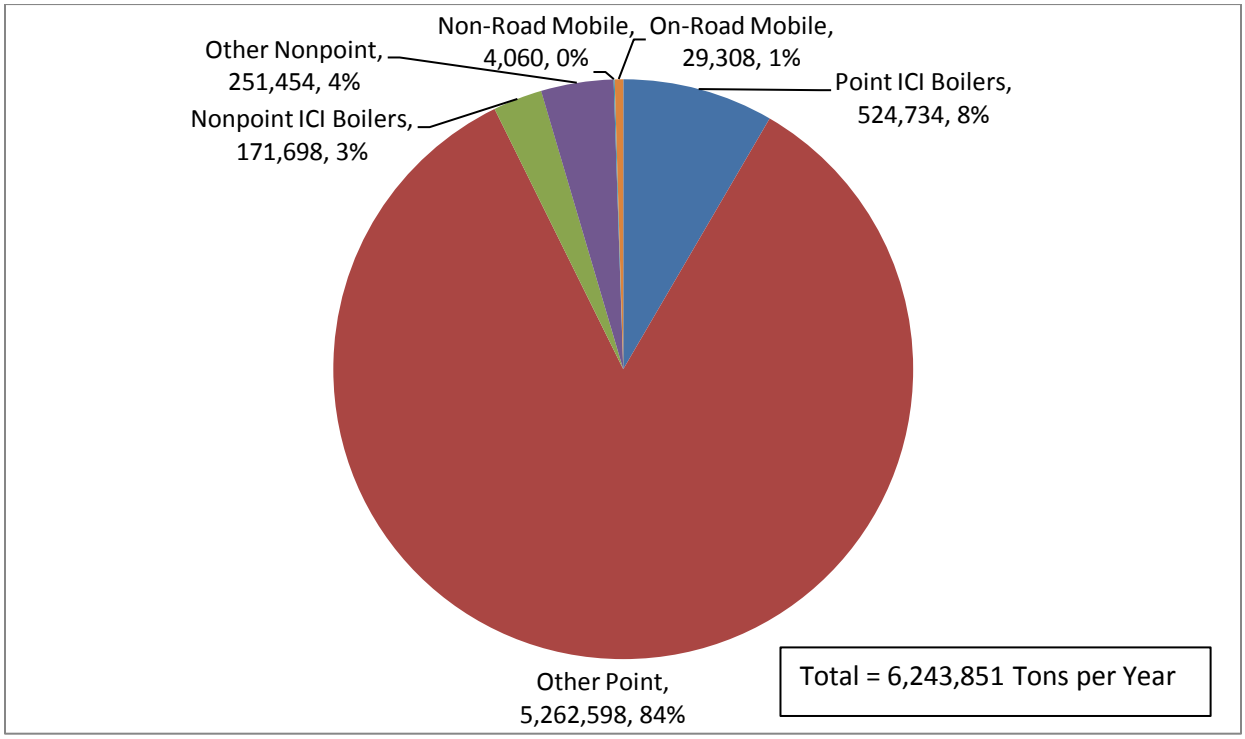


Table 5-8: 2018 ICI Boiler NOx and SO_2 Emissions for the Continental U.S. Compared with Other Inventory Sectors (Tons per Year)

Sector	NOx	SO_2	NOx % of Total	SO_2 % of Total
Point ICI Boilers	325,832	207,216	4%	8%
Other Point	2,921,748	2,005,306	32%	73%
Nonpoint ICI Boilers	303,760	148,654	3%	5%
Other Nonpoint	955,241	368,473	11%	13%
Non-Road Mobile	1,943,039	11,174	21%	0%
On-Road Mobile	2,647,482	12,418	29%	0%
Total	**9,097,101**	**2,753,241**	**100%**	**100%**
Total ICI Boilers	629,592	355,870		
Point ICI Boilers % of Total Point	10%	9%		
Nonpoint ICI Boilers % of Total Nonpoint	24%	29%		
Total ICI Boilers % of Total	7%	13%		

Figure 5-15: 2018 ICI Boiler NOx Emissions for the Continental U.S. Compared with Other Inventory Sectors (Tons per Year)

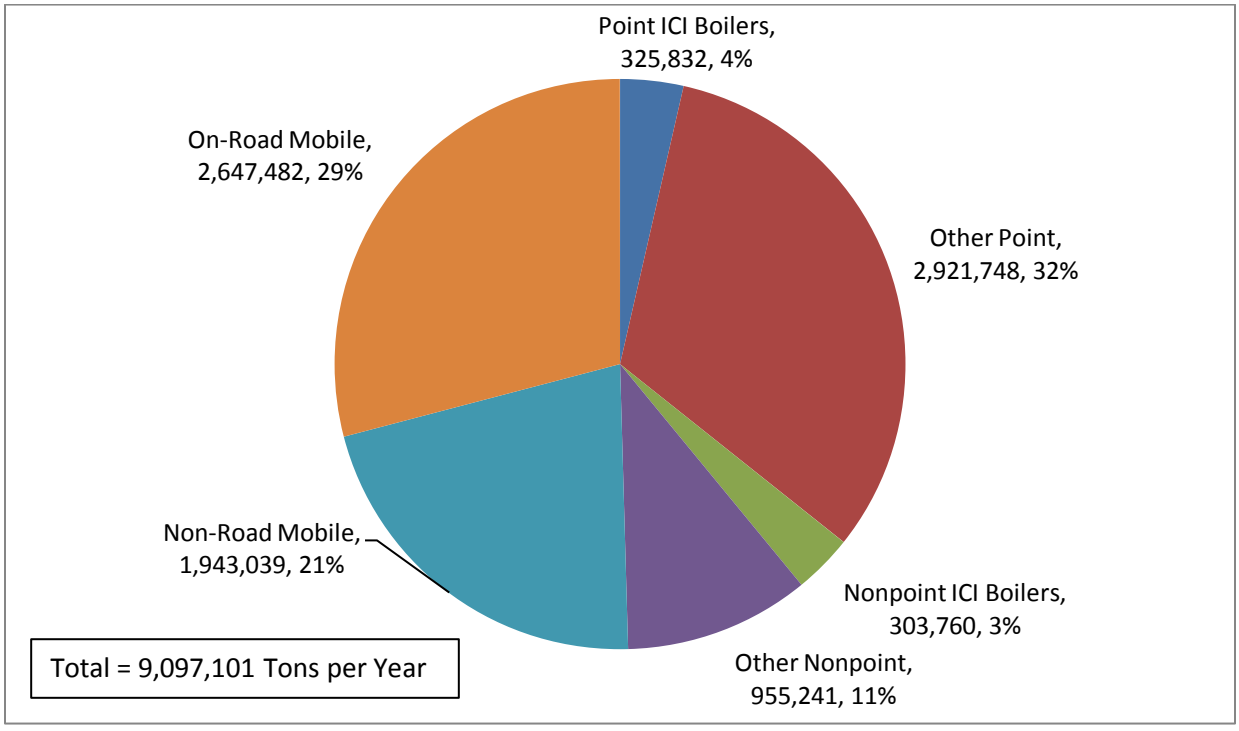


Figure 5-16: 2018 ICI Boiler SO_2 Emissions for the Continental U.S. Compared with Other Inventory Sectors (Tons per Year)

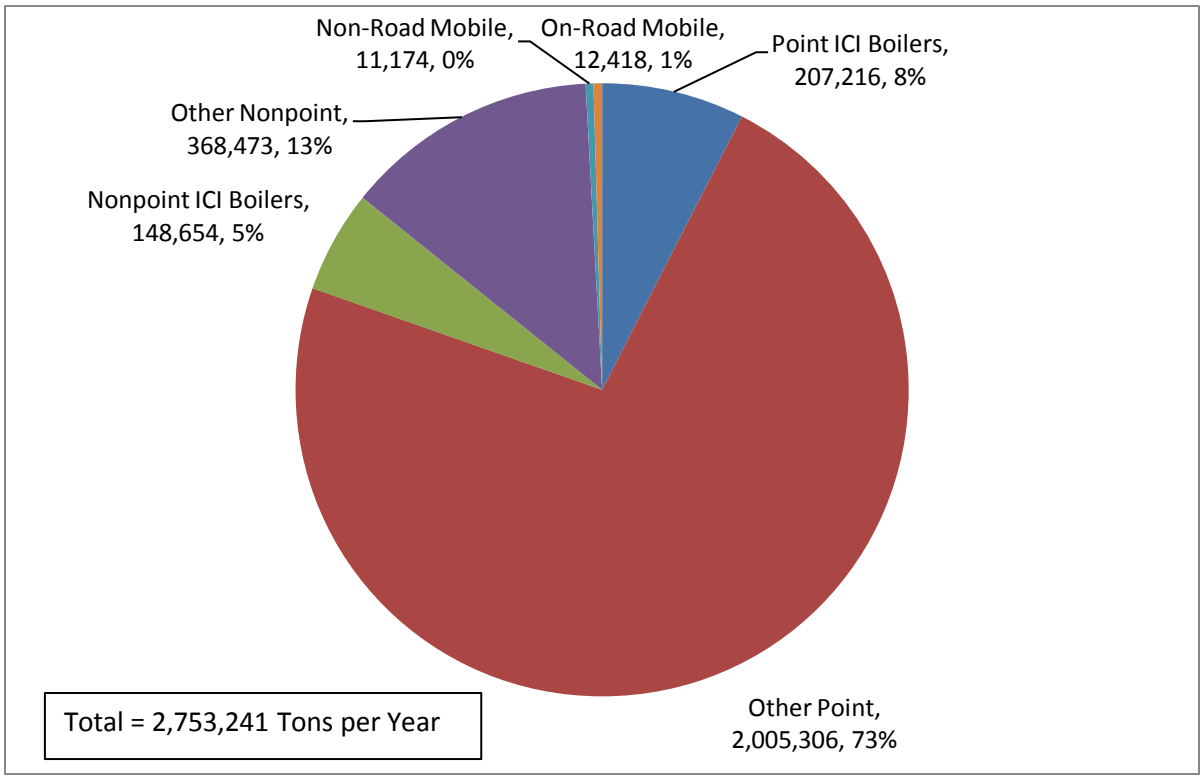


Table 5-7 shows that for 2011 point and nonpoint ICI boiler NOx emissions comprise 3% and 2% of total NOx emissions, respectively. Total ICI boiler NOx emissions make up 5% of total NOx emissions. For 2011 SO_2, point ICI boiler emissions comprise 8% of the total SO_2 emissions, nonpoint ICI boilers comprise 3% of the total, and total ICI boilers comprise 11% of the total SO_2 emissions. It can be seen in Table 5-8 that point and nonpoint ICI boiler NOx emissions for 2018 comprise 4% and 3% of the total NOx emissions, respectively. Total ICI boiler NOx emissions are 7% of the total NOx emissions. For SO_2 in 2018, point ICI boiler emissions comprise 8% of the total SO_2 emissions, nonpoint ICI boilers comprise 5% of the total SO_2 emissions, and all ICI boiler emissions comprise 13% of the total SO_2 emissions. These tables and figures show that as emissions are reduced for other sectors of the inventory between 2011 and 2018, ICI boilers become a larger percentage of the total. Tables 5-7 and 5-8 also show that point ICI boilers and nonpoint ICI boilers make up substantial percentages of the total point and nonpoint categories.

6. Data Caveats and Limitations

As discussed throughout this document (see Section 3 in particular), a number of suspect values were observed in the data. Several of the more obvious examples are summarized again below:

- 2011 and 2018 nonpoint SO_2 seems suspiciously low for IN, OH, and WI (see Table 3-4).

- For 2011 and 2018, AL reports 23,721 tons of nonpoint SO_2 emissions for the SCCs queried by the Workgroup; this seems suspiciously high (see Table 3-6). Also in Table 3-6, 2011 and 2018 nonpoint SO2 emissions seem suspiciously low for KY and MS.
- AR reports only 1 ton of nonpoint NOx for 2011 and 2018 and no nonpoint SO_2 for these years for the set of SCCs queried by the Workgroup (see Tables 3-7 and 3-8). Also in Table 3-8, 2011 and 2018 nonpoint SO_2 seems suspiciously low for a number of states (AZ, CO, IA, KS, and NE).
- 2011 point SO_2 emissions for MO and WY seem suspiciously high (see Table 3-10).

Other anomalies were discovered by the Workgroup and were described in earlier sections. As also discussed in earlier sections, the Workgroup performed queries on the same set of SCCs using the EIS Gateway and uncovered the same set of anomalies described above and throughout this document. This ensured that the anomalies were not the result of process errors in uploading or querying the data with EMF.

In addition to the anomalies just described, the following data caveats and cautions must also be considered:

- The 2018 data for the remainder of the CONUS states (i.e., those states outside of the Northeast, Midwest, and Southeast regions) were based on Version 1 of EPA's 2018 modeling inventory (the MARAMA 2018 Alpha inventory only covers those states in the eastern U.S. modeling domain, and EPA switched to the year 2017 in its Version 2 inventory projections). This introduces some possibly anomalous trends in Tables 3-7 through 3-10 and Figures 3-7 through 3-10, particularly for FL and TX.
- Nonpoint industrial distillate oil emissions may be reported under SCCs 2102004000 (Total: Boilers and IC Engines) or 2102004001 (All Boiler Types). Similarly, nonpoint industrial natural gas emissions may be reported under 2102006000 (Boilers and IC Engines) or 2102006001 (Boilers). Nonpoint commercial distillate oil emissions may be reported under 2103004000 (Boilers and IC Engines) or 2102004001 (Boilers). All nonpoint commercial natural gas emissions are reported under 2103006000 (Boilers and IC Engines). Many states reported the applicable emissions under the composite SCCs. For those emissions that were reported under the composite boiler/IC engine SCCs (i.e. 2102004000, 2102006000, 2103004000, and 2103006000), the split of emissions between boilers and IC engines is not known. Therefore, it is likely that the nonpoint distillate oil and natural gas ICI boiler emissions presented in this white paper are somewhat overstated.
- No attempt was made to adjust or correct the data for the anomalies described earlier. All of the tables and charts presented, and the trends that were discussed, include the suspect data and must be treated with the appropriate caution – especially for the individual states for which the anomalies occur.
- Some of the emissions totals and percentages discussed in this white paper do not appear to add up exactly due to rounding.

7. Summary and Conclusions

The ICI Boiler Workgroup of the OTC SAS Committee performed an analysis of annual ICI boiler NOx and SO_2 emissions using MARAMA's installation of EPA's EMF. The Workgroup's analysis included the years 2007, 2011, and 2018 and the geographic regions included the Northeast, the Midwest, the Southeast, and the remainder of the CONUS states. Analyses were performed on annual ICI boiler emissions by fuel type as well as annual ICI boiler emissions compared to total annual emissions from other inventory sectors. In summary, the Workgroup was trying to answer the following questions:

- How did ICI boiler emissions change between 2007 and 2011?

Section 2 shows that between 2007 and 2011, total ICI boiler NOx and SO_2 annual emissions for the Northeast states plus Virginia region decreased by 29% and 57% respectively.

- What is the expected change in ICI boiler emissions between 2011 and 2018?

In Section 3, it can be seen that modest decreases in annual ICI boiler NOx emissions are expected between 2011 and 2018 (7 to 12%). More substantial decreases in annual ICI boiler SO_2 emissions are expected between 2011 and 2018, ranging from 51 to 56%.

- What is the fuel type breakdown for ICI boiler emissions?

Section 4 presents the analysis of annual ICI boiler emissions by fuel type. The Northeast region displayed a fairly heterogeneous pattern amongst states; that is, each individual state in the Northeast had a unique fuel use makeup. Natural gas, oil, and coal were all important contributors to annual ICI boiler emissions in the Northeast, with coal being prominent in MD, NY, PA, and VA. Residual oil was also prominent for NY. The rural states of ME and VT were dominated by wood and oil. The Midwest states display a much more homogeneous pattern in fuel use, with coal and natural gas being the most important contributors. The Southeast states also displayed a fairly homogeneous pattern of fuel use. Coal, natural gas, and wood were the most important contributors to ICI boiler emissions in the Southeast, with wood being more prominent in this region than the Northeast or the Midwest.

- Are emissions from ICI boilers substantial enough to warrant further analysis of their impact on ozone and regional haze?

A comparison of annual ICI boiler emissions to annual emissions from other sectors was made in Section 5. According to this analysis, 2011 annual ICI boiler NOx emissions ranged from 6 to 7% of total annual emissions from all sectors for the three geographic regions analyzed. 2011 annual ICI boiler SO_2 emissions ranged from 10 to 16% of total annual emissions from all sectors for the three geographic regions. For the continental U.S. as a whole, 2011 annual ICI boiler NOx emissions were 5% of total annual emissions for all sectors, and annual ICI boiler SO_2 emissions were 11% of the total. These results compare well with the findings of the 2006 OTC/LADCO Workgroup, which found that for the 2002 NEI, ICI boilers comprised 6% of total NOx emissions and 13% of total SO_2 emissions (see Section 1). For

2018, as controls on other sectors (e.g. mobile sources) tighten, ICI boiler emissions become a somewhat higher percentage of total annual emissions. 2018 annual ICI boiler NOx emissions range from 8 to 9% of total annual emissions for the three regions (as compared with 6 to 7% for 2011), and 2018 annual ICI boiler SO_2 emissions range from 12 to 22% of total annual emissions (as compared with 10 to 16% for 2011). For the continental U.S., 2018 annual ICI boiler NOx emissions are 7% of total annual emissions and 2018 annual ICI boiler SO_2 emissions are 13% of total annual emissions.

According to this analysis, NOx and SO_2 emissions from ICI boilers are substantial enough to warrant a further analysis of their impact on ozone and regional haze (and other pollutants such as particulate matter and SO_2). Although annual ICI boiler NOx emissions are only a modest portion of total annual NOx emissions (5% of the annual total for 2011 and 7% of the annual total for 2018 in the continental U.S.), the national ambient air quality standard (NAAQS) for ozone continues to be lowered. The final 8-hr NAAQS for ozone will likely be in the range of 60 to 70 parts per billion (ppb). As a result, changes of as little as 1 ppb in ozone design values might mean the difference between attainment and non-attainment of the standard, and therefore even small changes in NOx emissions will have an effect on whether the standard can be met or not. Similarly, states and other agencies are currently implementing their SIPs for meeting regional haze goals, and even modest changes in emissions may help or hurt in meeting those goals. The data from this analysis shows that annual ICI boiler SO_2 emissions are an even bigger portion of the total (11% of the annual total for 2011 and 13% of the annual total for 2018 for the continental U.S.; 16% of the annual total for 2011 and 22% of the annual total for 2018 for the Northeast).

Although there is still work to be done, substantial benefits to air quality have been achieved by improving controls and reducing emissions for inventory sectors such as electric generating units (EGUs) and mobile sources. But as mentioned above, further controls and emissions reductions are needed to meet the soon-to-be-lowered 8-hr ozone NAAQS, the Regional Haze Rule requirements, the $PM_{2.5}$ NAAQS, and the new, more stringent 2010 NAAQS for 1-hr NO_2 and SO_2. As sectors such as EGUs and mobile sources continue to be controlled, it is likely that the needed emissions reductions will have to come from other sectors. Therefore, the ICI boiler Workgroup recommends further analyses of the impact of ICI boiler NOx and SO_2 emissions on ozone, regional haze, and other pollutants using screening-level air quality modeling or other means. Additional ozone season emissions inventory analyses focusing on ICI boiler ozone season NOx emissions are contingent on the further development of a temporalization tool for EMF that is currently under development by the University of North Carolina.

This analysis shows that annual ICI boiler emissions are expected to continue decreasing between 2011 and 2018; however, the Workgroup feels that opportunities exist for further reductions in ICI boiler emissions, particularly in the coal and oil fuel use categories.

APPENDIX A

ICI Boiler Control Options, Excerpted from the OTC/LADCO ICI Boiler Workgroup's Report "Evaluation of Control Options for Industrial, Commercial and Institutional (ICI) Boilers, Technical Support Document (TSD), FINAL, 05/14/10"

NOx control options for **units ≤ 100 MMBtu/hr** consist of:

• Phase I: Combustion tuning for all gas and oil-fired units and for certain coal-fired units 50-100 MMBtu/hr.
• Phase II:
o Low-NOx burners and/or flue gas recirculation (FGR) for all gas- and oil fired units;
o Combustion tuning and/or selective non-catalytic reduction (SNCR) for certain coal-fired units ≥50 MMBtu/hr and ≤ 100 MMBtu/hr; and
o Combustion tuning or SNCR for all wood-fired units and non-fossil solid fuel-fired units ≥ 50 MMBtu/hr and ≤ 100 MMBtu/hr.

NOx control options for **units > 100 MMBtu/hr** consist of:

• Phase I:
o Low-NOx burners (LNB) for all gas- and oil-fired units;
o Low-NOx burners and/or combustion modifications for most coal-fired units;
o Selective catalytic reduction (SCR) or SNCR for certain coal-fired units; and
o Combustion tuning or SNCR for all wood-fired units and non-fossil solid fuel-fired units.
• Phase II: Post-combustion controls for all coal-, wood-, and non-fossil fuel-fired Units.

SO_2 **Control Options:** The control options considered for SO_2 consist of the following
Gaseous Fuels: Gaseous fuels are treated at the source (e.g., coke plant) to remove hydrogen sulfide (H_2S) and mercaptans prior to combustion.
Fuel Oils: Fuel oils are de-sulfurized at the refinery.
Coal: Fuel blending and fuel switching, direct sorbent injection, and post–combustion control, such as dry or wet flue gas desulfurization.

Note: For coal-fired ICI boilers, the Phase I NOx and SO_2 compliance dates evaluated were between 2012-2015, and the Phase II NOx and SO_2 compliance dates evaluated were between 2015-2018. For the low-sulfur fuel-oil strategy, the Phase I SO_2 compliance dates evaluated were 2012-2014, and the Phase II SO_2 compliance dates evaluated were 2014-2018.

Table A-1: NOx Emissions Limitations (in lb/MMBtu or % reduction)

Fuel Type	Phase	Boiler Size (MMBtu/hr)		
		< 50	**50 - 100**	**> 100**
Gaseous Fuels	Phase I	Combustion tuning	Combustion tuning	0.10 or 50%
	Phase II	0.05 – 0.10 or 50%	0.05 – 0.10 or 60%	0.05 – 0.10 or 60%
Distillate Oil (#1, 2)	Phase I	Combustion tuning	Combustion tuning	0.10 or 50%
	Phase II	0.08 – 0.10 or 50%	0.08 – 0.10 or 60%	0.08 – 0.10 or 60%
Residual Oil (#4, 5, 6)	Phase I	Combustion tuning	Combustion tuning	0.20 or 60%
	Phase II	0.20 or 50%	0.20 or 60%	0.20 or 70%
Coal – Wall	Phase I	--	--	0.30
	Phase II	--	--	0.10 – 0.14
Coal - Tangential	Phase I	--	--	0.30
	Phase II	--	--	0.10 – 0.12
Coal – Cyclone	Phase I	--	--	0.19
	Phase II	--	--	0.19
Coal – Stoker	Phase I	--	Combustion tuning	0.30
	Phase II	--	0.30	0.22
Coal – Fluidized Bed Combustion	Phase I	--	Combustion tuning	0.15
	Phase II	--	0.08	0.08
Wood and Non-Fossil Solid Fuel	Phase I	--	Combustion tuning	0.30
	Phase II	--	0.30	0.22

Note: -- = no evaluation was performed due to small or non-existent boiler population in the Northeast and Midwest inventory.

Table A-2: SO_2 Emissions Limitations

Fuel Type	Phase	Boiler Size (MMBtu/hr)			
		< 50	**50-100**	**100-250**	**> 250**
Gaseous Fuels (Coke Oven Gas)		--	--	Treated COG with 95%S compounds removed	
Distillate Oil (#1, 2)	Phase I	0.05%S (500ppm) or 0.05 lb/MMBtu			
	Phase II Northeast States Inner Zone	Further reduce sulfur content to 15ppm by 2016			
	Phase II Elsewhere	Further reduce sulfur content to 15ppm by 2018			
Residual Oil (#4, 5, 6)	Phase I	0.5%S (or 0.54 lb/MMBtu)			
	Phase II Northeast States Inner Zone	#4 fuel oil - 0.25%S no later than 2012			
		#6 fuel oil - 0.3-0.5%S no later than 2012			
	Phase II Elsewhere	#4 fuel oil - 0.25-0.5%S no later than 2018			
		#6 fuel oil - 0.5%S no later than 2018			
Coal (and other solid fuels)	Phase I	--	2.0 lb/MMBtu or 30% reduction*	1.2 lb/MMBtu** or 85% reduction*	0.25 lb/MMBtu or 85% reduction*
	Phase II	--	2.0 lb/MMBtu or 30% reduction*	0.25 lb/MMBtu or 85% reduction*	0.25 lb/MMBtu or 85% reduction*

* = % reduction based on uncontrolled emissions in base year (2002)

** = Limit can be met by a combination of switching to low sulfur coal/fuel blending plus direct sorbent injection (DSI) to achieve additional 40% reduction.

APPENDIX B

List of Source Classification Codes (SCCs) Used in the ICI Boiler Analysis

SCC	Sector	Short Name
10200101	POINT	Ext Comb /Industrial /Anthracite Coal /Pulverized Coal
10200104	POINT	Ext Comb /Industrial /Anthracite Coal /Traveling Grate (Overfeed) Stoker
10200107	POINT	Ext Comb /Industrial /Anthracite Coal /Hand-fired
10200117	POINT	Ext Comb /Industrial /Anthracite Coal /Fluidized Bed Boiler Burning Anthracite-Culm Fuel
10200201	POINT	Ext Comb /Industrial /Bitum/Subbit Coal /Pulverized Coal: Wet Bottom
10200202	POINT	Ext Comb /Industrial /Bitum/Subbit Coal /Pulverized Coal: Dry Bottom
10200203	POINT	Ext Comb /Industrial /Bitum/Subbit Coal /Cyclone Furnace
10200204	POINT	Ext Comb /Industrial /Bitum/Subbit Coal /Spreader Stoker
10200205	POINT	Ext Comb /Industrial /Bitum/Subbit Coal /Overfeed Stoker
10200206	POINT	Ext Comb /Industrial /Bitum/Subbit Coal /Underfeed Stoker
10200210	POINT	Ext Comb /Industrial /Bitum/Subbit Coal /Overfeed Stoker **
10200212	POINT	Ext Comb /Industrial /Bitum/Subbit Coal /Pulverized Coal: Dry Bottom (Tangential)
10200213	POINT	Ext Comb /Industrial /Bitum/Subbit Coal /Wet Slurry
10200217	POINT	Ext Comb /Industrial /Bituminous Coal /Atmospheric Fluidized Bed Combustion: Bubbling Bed
10200218	POINT	Ext Comb /Industrial /Bituminous Coal /Atmospheric Fluidized Bed Combustion: Circulating Bed
10200219	POINT	Ext Comb /Industrial /Bituminous Coal /Cogeneration
10200221	POINT	Ext Comb /Industrial /Subbituminous Coal /Pulverized Coal: Wet Bottom
10200222	POINT	Ext Comb /Industrial /Subbituminous Coal /Pulverized Coal: Dry Bottom
10200223	POINT	Ext Comb /Industrial /Subbituminous Coal /Cyclone Furnace
10200224	POINT	Ext Comb /Industrial /Subbituminous Coal /Spreader Stoker
10200225	POINT	Ext Comb /Industrial /Subbituminous Coal /Traveling Grate (Overfeed) Stoker
10200226	POINT	Ext Comb /Industrial /Subbituminous Coal /Pulverized Coal: Dry Bottom Tangential
10200229	POINT	Ext Comb /Industrial /Subbituminous Coal /Cogeneration
10200300	POINT	Ext Comb /Industrial /Lignite /Pulverized Coal: Wet Bottom
10200301	POINT	Ext Comb /Industrial /Lignite /Pulverized Coal: Dry Bottom, Wall Fired
10200302	POINT	Ext Comb /Industrial /Lignite /Pulverized Coal: Dry Bottom, Tangential Fired
10200303	POINT	Ext Comb /Industrial /Lignite /Cyclone Furnace
10200304	POINT	Ext Comb /Industrial /Lignite /Traveling Grate (Overfeed) Stoker
10200306	POINT	Ext Comb /Industrial /Lignite /Spreader Stoker
10200307	POINT	Ext Comb /Industrial /Lignite /Cogeneration
10200401	POINT	Ext Comb /Industrial /Residual Oil /Grade 6 Oil
10200402	POINT	Ext Comb /Industrial /Residual Oil /10-100 Million Btu/hr **
10200403	POINT	Ext Comb /Industrial /Residual Oil /< 10 Million Btu/hr **
10200404	POINT	Ext Comb /Industrial /Residual Oil /Grade 5 Oil

10200405	POINT	Ext Comb /Industrial /Residual Oil /Cogeneration
10200406	POINT	Ext Comb /Industrial/Residual Oil /> 100 Million Btu/hr
10200501	POINT	Ext Comb /Industrial /Distillate Oil /Grades 1 and 2 Oil
10200502	POINT	Ext Comb /Industrial /Distillate Oil /10-100 Million Btu/hr **
10200503	POINT	Ext Comb /Industrial /Distillate Oil /< 10 Million Btu/hr **
10200504	POINT	Ext Comb /Industrial /Distillate Oil /Grade 4 Oil
10200505	POINT	Ext Comb /Industrial /Distillate Oil /Cogeneration
10200506	POINT	Ext Comb /Industrial /Distillate Oil /> 100 Million Btu/hr
10200601	POINT	Ext Comb /Industrial /Natural Gas /> 100 Million Btu/hr
10200602	POINT	Ext Comb /Industrial /Natural Gas /10-100 Million Btu/hr
10200603	POINT	Ext Comb /Industrial /Natural Gas /< 10 Million Btu/hr
10200604	POINT	Ext Comb /Industrial /Natural Gas /Cogeneration
10200701	POINT	Ext Comb /Industrial /Process Gas /Petroleum Refinery Gas
10200704	POINT	Ext Comb /Industrial /Process Gas /Blast Furnace Gas
10200707	POINT	Ext Comb /Industrial /Process Gas /Coke Oven Gas
10200710	POINT	Ext Comb /Industrial /Process Gas /Cogeneration
10200711	POINT	Ext Comb /Industrial /Process Gas /Landfill Gas
10200799	POINT	Ext Comb /Industrial /Process Gas /Other: Specify in Comments
10200802	POINT	Ext Comb /Industrial /Petroleum Coke /All Boiler Sizes
10200804	POINT	Ext Comb /Industrial /Petroleum Coke /Cogeneration
10200901	POINT	Ext Comb /Industrial /Bark-fired Boiler
10200902	POINT	Ext Comb /Industrial /Wood/Bark-fired Boiler
10200903	POINT	Ext Comb /Industrial /Wood-fired Boiler - Wet Wood (:=20% moisture)
10200904	POINT	Ext Comb /Industrial /Bark-fired Boiler (< 50,000 Lb Steam) **
10200905	POINT	Ext Comb /Industrial /Wood/Bark-fired Boiler (< 50,000 Lb Steam) **
10200906	POINT	Ext Comb /Industrial /Wood-fired Boiler (< 50,000 Lb Steam) **
10200907	POINT	Ext Comb /Industrial /Wood/Bark Waste /Wood Cogeneration
10200908	POINT	Ext Comb /Industrial /Wood-fired Boiler - Dry Wood (<20% moisture)
10200910	POINT	Ext Comb /Industrial /Wood/Bark Waste /Fuel cell/Dutch oven boilers **
10200911	POINT	Ext Comb /Industrial /Wood/Bark Waste /Stoker boilers **
10200912	POINT	Ext Comb /Industrial /Wood/Bark Waste /Fluidized bed combustion boiler
10201001	POINT	Ext Comb /Industrial /LPG /Butane
10201002	POINT	Ext Comb /Industrial /LPG /Propane
10201003	POINT	Ext Comb /Industrial /LPG /Butane/Propane Mixture: Specify Percent Butane in Comments
10201101	POINT	Ext Comb /Industrial /Bagasse /All Boiler Sizes

10201201	POINT	Ext Comb /Industrial /Solid Waste /Specify Waste Material in Comments
10201202	POINT	Ext Comb /Industrial /Solid Waste /Refuse Derived Fuel
10201301	POINT	Ext Comb /Industrial /Liquid Waste /Specify Waste Material in Comments
10201302	POINT	Ext Comb /Industrial /Liquid Waste /Waste Oil
10201303	POINT	Ext Comb /Industrial /Liquid Waste /Salable Animal Fat
10201401	POINT	Ext Comb /Industrial /CO Boiler /Natural Gas
10201402	POINT	Ext Comb /Industrial /CO Boiler /Process Gas
10201403	POINT	Ext Comb /Industrial /CO Boiler /Distillate Oil
10201404	POINT	Ext Comb /Industrial /CO Boiler /Residual Oil
10201601	POINT	Ext Comb /Industrial /Methanol
10201701	POINT	Ext Comb /Industrial /Gasoline
10300101	POINT	Ext Comb /Comm-Inst /Anthracite Coal /Pulverized Coal
10300102	POINT	Ext Comb /Comm-Inst /Anthracite Coal /Traveling Grate (Overfeed) Stoker
10300103	POINT	Ext Comb /Comm-Inst /Anthracite Coal /Hand-fired
10300203	POINT	Ext Comb /Comm-Inst /Bituminous Coal /Cyclone Furnace
10300205	POINT	Ext Comb /Comm-Inst /Bituminous Coal /Pulverized Coal: Wet Bottom
10300206	POINT	Ext Comb /Comm-Inst /Bituminous Coal /Pulverized Coal: Dry Bottom
10300207	POINT	Ext Comb /Comm-Inst /Bituminous Coal /Overfeed Stoker
10300208	POINT	Ext Comb /Comm-Inst /Bituminous Coal /Underfeed Stoker
10300209	POINT	Ext Comb /Comm-Inst /Bituminous Coal /Spreader Stoker
10300211	POINT	Ext Comb /Comm-Inst /Bitum/Subbit Coal /Overfeed Stoker **
10300214	POINT	Ext Comb /Comm-Inst /Bituminous Coal /Hand-fired
10300216	POINT	Ext Comb /Comm-Inst /Bituminous Coal /Pulverized Coal: Dry Bottom (Tangential)
10300217	POINT	Ext Comb /Comm-Inst /Bituminous Coal /Atmospheric Fluidized Bed Combustion: Bubbling Bed
10300218	POINT	Ext Comb /Comm-Inst /Bituminous Coal /Atmospheric Fluidized Bed Combustion: Circulating Bed
10300221	POINT	Ext Comb /Comm-Inst /Subbituminous Coal /Pulverized Coal: Wet Bottom
10300222	POINT	Ext Comb /Comm-Inst /Subbituminous Coal /Pulverized Coal: Dry Bottom
10300223	POINT	Ext Comb /Comm-Inst /Subbituminous Coal /Cyclone Furnace
10300224	POINT	Ext Comb /Comm-Inst /Subbituminous Coal /Spreader Stoker
10300225	POINT	Ext Comb /Comm-Inst /Subbituminous Coal /Traveling Grate (Overfeed) Stoker
10300226	POINT	Ext Comb /Comm-Inst /Subbituminous Coal /Pulverized Coal: Dry Bottom Tangential
10300300	POINT	Ext Comb /Comm-Inst /Lignite /Pulverized Coal: Wet Bottom
10300305	POINT	Ext Comb /Comm-Inst /Lignite /Pulverized Coal: Dry Bottom, Wall Fired
10300306	POINT	Ext Comb /Comm-Inst /Lignite /Pulverized Coal: Dry Bottom, Tangential Fired
10300307	POINT	Ext Comb /Comm-Inst /Lignite /Traveling Grate (Overfeed) Stoker

10300309	POINT	Ext Comb /Comm-Inst /Lignite /Spreader Stoker
10300401	POINT	Ext Comb /Comm-Inst /Residual Oil /Grade 6 Oil
10300402	POINT	Ext Comb /Comm-Inst /Residual Oil /10-100 Million Btu/hr **
10300403	POINT	Ext Comb /Comm-Inst /Residual Oil /< 10 Million Btu/hr **
10300404	POINT	Ext Comb /Comm-Inst /Residual Oil /Grade 5 Oil
10300405	POINT	Ext Comb /Comm-Inst /Residual Oil /> 100 Million Btu/hr
10300501	POINT	Ext Comb /Comm-Inst /Distillate Oil /Grades 1 and 2 Oil
10300502	POINT	Ext Comb /Comm-Inst /Distillate Oil /10-100 Million Btu/hr **
10300503	POINT	Ext Comb /Comm-Inst /Distillate Oil /< 10 Million Btu/hr **
10300504	POINT	Ext Comb /Comm-Inst /Distillate Oil /Grade 4 Oil
10300505	POINT	Ext Comb /Comm-Inst /Distillate Oil /> 100 Million Btu/hr
10300601	POINT	Ext Comb /Comm-Inst /Natural Gas /> 100 Million Btu/hr
10300602	POINT	Ext Comb /Comm-Inst /Natural Gas /10-100 Million Btu/hr
10300603	POINT	Ext Comb /Comm-Inst /Natural Gas /< 10 Million Btu/hr
10300701	POINT	Ext Comb /Comm-Inst /Process Gas /POTW Digester Gas-fired Boiler
10300799	POINT	Ext Comb /Comm-Inst /Process Gas /Other Not Classified
10300811	POINT	Ext Comb /Comm-Inst /Landfill Gas
10300901	POINT	Ext Comb /Comm-Inst /Bark-fired Boiler
10300902	POINT	Ext Comb /Comm-Inst /Wood/Bark-fired Boiler
10300903	POINT	Ext Comb /Comm-Inst /Wood-fired Boiler - Wet Wood (:=20% moisture)
10300908	POINT	Ext Comb /Comm-Inst /Wood-fired Boiler - Dry Wood (<20% moisture)
10300910	POINT	Ext Comb /Comm-Inst /Wood/Bark Waste /Fuel cell/Dutch oven boilers **
10300911	POINT	Ext Comb /Comm-Inst /Wood/Bark Waste /Stoker boilers **
10300912	POINT	Ext Comb /Comm-Inst /Wood/Bark Waste /Fluidized bed combustion boilers
10301001	POINT	Ext Comb /Comm-Inst /LPG /Butane
10301002	POINT	Ext Comb /Comm-Inst /LPG /Propane
10301003	POINT	Ext Comb /Comm-Inst /LPG /Butane/Propane Mixture: Specify Percent Butane in Comments
10301101	POINT	Ext Comb /Comm-Inst /Biomass /Boiler, Stoker
10301102	POINT	Ext Comb /Comm-Inst /Biomass /Boiler, Non-Stoker
10301201	POINT	Ext Comb /Comm-Inst /Solid Waste /Specify Waste Material in Comments
10301202	POINT	Ext Comb /Comm-Inst /Solid Waste /Refuse Derived Fuel
10301301	POINT	Ext Comb /Comm-Inst /Liquid Waste /Specify Waste Material in Comments
10301302	POINT	Ext Comb /Comm-Inst /Liquid Waste /Waste Oil
10301303	POINT	Ext Comb /Comm-Inst /Liquid Waste /Sewage Grease Skimmings
10500102	POINT	Ext Comb /Space Heater /Industrial /Coal **

10500105	POINT	Ext Comb /Space Heater /Industrial /Distillate Oil
10500106	POINT	Ext Comb /Space Heater /Industrial /Natural Gas
10500110	POINT	Ext Comb /Space Heater /Industrial /Liquified Petroleum Gas (LPG)
10500113	POINT	Ext Comb /Space Heater /Industrial /Waste Oil: Air Atomized Burner
10500114	POINT	Ext Comb /Space Heater /Industrial /Waste Oil: Vaporizing Burner
10500202	POINT	Ext Comb /Space Heater /Comm-Inst /Coal **
10500205	POINT	Ext Comb /Space Heater /Comm-Inst /Distillate Oil
10500206	POINT	Ext Comb /Space Heater /Comm-Inst /Natural Gas
10500209	POINT	Ext Comb /Space Heater /Comm-Inst /Wood
10500210	POINT	Ext Comb /Space Heater /Comm-Inst /Liquified Petroleum Gas (LPG)
10500213	POINT	Ext Comb /Space Heater /Comm-Inst /Waste Oil: Air Atomized Burner
10500214	POINT	Ext Comb /Space Heater /Comm-Inst /Waste Oil: Vaporizing Burner
2102001000	NONPOINT	Stationary Fuel Comb /Industrial /Anthracite Coal /Total: All Boiler Types
2102002000	NONPOINT	Stationary Fuel Comb /Industrial /Bituminous/Subbituminous Coal /Total: All Boiler Types
2102004000	NONPOINT	Stationary Fuel Comb /Industrial /Distillate Oil /Total: Boilers and IC Engines
2102004001	NONPOINT	Stationary Fuel Comb /Industrial /Distillate Oil /Total: All Boiler Types
2102005000	NONPOINT	Stationary Fuel Comb /Industrial /Residual Oil /Total: All Boiler Types
2102006000	NONPOINT	Stationary Fuel Comb /Industrial /Natural Gas /Total: Boilers and IC Engines
2102006001	NONPOINT	Stationary Fuel Comb /Industrial /Natural Gas /All Boiler Types
2102007000	NONPOINT	Stationary Fuel Comb /Industrial /Liquified Petroleum Gas /Total: All Boiler Types
2102008000	NONPOINT	Stationary Fuel Comb /Industrial /Wood /Total: All Boiler Types
2102009000	NONPOINT	Stationary Fuel Comb /Industrial /Petroleum Coke /Total: All Boiler Types
2102010000	NONPOINT	Stationary Fuel Comb /Industrial /Process Gas /Total: All Boiler Types
2102011000	NONPOINT	Stationary Fuel Comb /Industrial /Kerosene /Total: All Boiler Types
2102012000	NONPOINT	Stationary Fuel Comb /Industrial /Waste oil /Total
2103001000	NONPOINT	Stationary Fuel Comb /Commercial/Institutional /Anthracite Coal /Total: All Boiler Types
2103002000	NONPOINT	Stationary Fuel Comb /Commercial/Institutional /Bituminous/Subbituminous Coal /Total: All Boiler Types
2103004000	NONPOINT	Stationary Fuel Comb /Commercial/Institutional /Distillate Oil /Total: Boilers and IC Engines
2103004001	NONPOINT	Stationary Fuel Comb /Commercial/Institutional /Distillate Oil /Total: All Boiler Types
2103005000	NONPOINT	Stationary Fuel Comb /Commercial/Institutional /Residual Oil /Total: All Boiler Types
2103006000	NONPOINT	Stationary Fuel Comb /Commercial/Institutional /Natural Gas /Total: Boilers and IC Engines
2103007000	NONPOINT	Stationary Fuel Comb /Commercial/Institutional /Liquified Petroleum Gas /Total: All Combustor Types
2103007005	NONPOINT	Stationary Fuel Comb /Commercial/Institutional /Liquified Petroleum Gas /All Boiler Types
2103008000	NONPOINT	Stationary Fuel Comb /Commercial/Institutional /Wood /Total: All Boiler Types
2103011000	NONPOINT	Stationary Fuel Comb /Commercial/Institutional /Kerosene /Total: All Combustor Types

2103011005	NONPOINT	Stationary Fuel Comb /Commercial/Institutional /Kerosene /All Boiler Types
2199001000	NONPOINT	Stationary Fuel Comb /Total Area Source /Anthracite Coal /Total: All Boiler Types
2199002000	NONPOINT	Stationary Fuel Comb /Total Area Source /Bituminous/Subbituminous Coal /Total: All Boiler Types
2199003000	NONPOINT	Stationary Fuel Comb /Total Area Source /Lignite Coal /Total: All Boiler Types
2199004000	NONPOINT	Stationary Fuel Comb /Total Area Source /Distillate Oil /Total: Boilers and IC Engines
2199004001	NONPOINT	Stationary Fuel Comb /Total Area Source /Distillate Oil /All Boiler Types
2199005000	NONPOINT	Stationary Fuel Comb /Total Area Source /Residual Oil /Total: All Boiler Types
2199006000	NONPOINT	Stationary Fuel Comb /Total Area Source /Natural Gas /Total: Boilers and IC Engines
2199006001	NONPOINT	Stationary Fuel Comb /Total Area Source /Natural Gas /All Boiler Types
2199007000	NONPOINT	Stationary Fuel Comb /Total Area Source /Liquified Petroleum Gas /Total: All Boiler Types
2199008000	NONPOINT	Stationary Fuel Comb /Total Area Source /Wood /Total: All Boiler Types
2199009000	NONPOINT	Stationary Fuel Comb /Total Area Source /Petroleum Coke /Total: All Boiler Types
2199010000	NONPOINT	Stationary Fuel Comb /Total Area Source /Process Gas /Total: All Boiler Types
2199011000	NONPOINT	Stationary Fuel Comb /Total Area Source /Kerosene /Total: All Heater Types

APPENDIX C

Example SQL Queries Used in the EMF ICI Boiler Analysis

```
select FIPS,SCC,POLL,ANN_EMIS,PLANT from $TABLE[1] e where SCC
in('10200101','10200104','10200107','10200117','10200201','10200202','10200203','10200204','10200205',
'10200206','10200210','10200212','10200213','10200217','10200218','10200219','10200221','10200222',
'10200223','10200224','10200225','10200226','10200229','10200300','10200301','10200302','10200303',
'10200304','10200306','10200307','10200401','10200402','10200403','10200404','10200405',’10200406’,
'10200501','10200502','10200503','10200504','10200505',’10200506’,'10200601','10200602','10200603',
'10200604','10200701','10200704','10200707','10200710','10200711','10200799','10200802','10200804',
'10200901','10200902','10200903','10200904','10200905','10200906','10200907','10200908','10200910',
'10200911','10200912','10201001','10201002','10201003','10201101','10201201','10201202','10201301',
'10201302','10201303','10201401','10201402','10201403','10201404','10201601','10201701','10300101',
'10300102','10300103','10300203','10300205','10300206','10300207','10300208','10300209','10300211',
'10300214','10300216','10300217','10300218','10300221','10300222','10300223','10300224','10300225',
'10300226','10300300','10300305','10300306','10300307','10300309','10300401','10300402','10300403',
'10300404',’10300405’,'10300501','10300502','10300503','10300504',’10300505’,'10300601','10300602',
'10300603','10300701','10300799','10300811','10300901','10300902','10300903','10300908','10300910',
'10300911','10300912','10301001','10301002','10301003',’10301101’,’10301102’,'10301201','10301202',
'10301301','10301302','10301303','10500102','10500105','10500106','10500110','10500113','10500114',
'10500202','10500205','10500206','10500209','10500210','10500213','10500214') and POLL in ('NOX','SO2')
and substring(FIPS,1,2) in ('09')


select FIPS,SCC,POLL,ANN_EMIS from $TABLE[1] e where SCC
in('2102001000','2102002000','2102004000',’2102004001’,'2102005000','2102006000','2102006001',
'2102007000','2102008000','2102009000','2102010000','2102011000','2102012000','2103001000',
'2103002000','2103004000',’2103004001’,'2103005000','2103006000','2103007000','2103007005',
'2103008000','2103011000','2103011005','2199001000','2199002000','2199003000','2199004000',
'2199004001','2199005000','2199006000','2199006001','2199007000','2199008000',
'2199009000','2199010000','2199011000') and POLL in ('NOX','SO2') and FIPS like '09%'
```

APPENDIX D

Comparison of EMF Query Results with EIS Gateway Query Results

(Note: yellow shaded cells in the tables indicate possible data anomalies)

2011 ICI Boiler Emissions for the Northeast States (in Tons Per Year)

Version 2

		Point		Nonpoint		Total	
FIPS	**State**	**NOx**	**SO2**	**NOx**	**SO2**	**NOx**	**SO2**
09	CT	586	34	3,538	1,136	4,124	1,170
10	DE	1,588	1,868	1,168	28	2,755	1,896
11	DC	426	57	622	374	1,047	431
23	ME	5,971	4,513	1,144	2,559	7,116	7,072
24	MD	4,652	22,961	5,639	4,268	10,292	27,229
25	MA	2,607	2,029	7,808	7,055	10,415	9,084
33	NH	499	1,038	1,622	1,698	2,121	2,736
34	NJ	1,606	279	9,922	2,458	11,529	2,737
36	NY	8,639	10,780	23,915	24,569	32,554	35,349
42	PA	12,681	21,254	13,431	10,163	26,111	31,417
44	RI	411	343	155	235	566	578
50	VT	267	415	1,080	1,598	1,347	2,014
	Total	39,932	65,571	70,043	56,140	109,976	121,711

Difference (EMF minus EIS Gateway)

		Point		Nonpoint		Total	
FIPS	**State**	**NOx**	**SO2**	**NOx**	**SO2**	**NOx**	**SO2**
09	CT	0	0	0	0	0	0
10	DE	0	0	0	0	0	0
11	DC	0	0	0	0	0	0
23	ME	0	0	0	0	0	0
24	MD	0	0	0	0	0	0
25	MA	0	0	0	0	0	0
33	NH	0	0	0	0	0	0
34	NJ	0	0	0	0	0	0
36	NY	0	0	0	0	0	0
42	PA	0	0	0	0	0	0
44	RI	0	0	0	0	0	0
50	VT	0	0	0	0	0	0
	Total	0	0	0	0	0	0

EMF datasets
used:
Point = 2011NEIv2_Point_20140808_20aug2014_v0.csv (queried 2/23/15)
Nonpoint = nonpt_2011NEIv2_NONPOINT_20141108_11nov2014_v1.csv (queried 3/20/15)
List of SCCs from "Revised Appendices B & C"

Version 2 Query from the EIS Gateway for Comparison

FIPS	State	Point NOx	Point SO2	Nonpoint NOx	Nonpoint SO2	Total NOx	Total SO2
09	CT	586	34	3,538	1,136	4,124	1,170
10	DE	1,588	1,868	1,168	28	2,755	1,896
11	DC	426	57	622	374	1,047	431
23	ME	5,971	4,513	1,144	2,559	7,116	7,072
24	MD	4,652	22,961	5,639	4,268	10,292	27,229
25	MA	2,607	2,029	7,808	7,055	10,415	9,084
33	NH	499	1,038	1,622	1,698	2,121	2,736
34	NJ	1,606	279	9,922	2,458	11,529	2,737
36	NY	8,639	10,780	23,915	24,569	32,554	35,349
42	PA	12,681	21,254	13,431	10,163	26,111	31,417
44	RI	411	343	155	235	566	578
50	VT	267	415	1,080	1,598	1,347	2,014
	Total	39,932	65,571	70,043	56,140	109,976	121,711

Percent Difference (EMF minus EIS Gateway/EMF)

FIPS	State	Point NOx	Point SO2	Nonpoint NOx	Nonpoint SO2	Total NOx	Total SO2
09	CT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
10	DE	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
11	DC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
23	ME	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
24	MD	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
25	MA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
33	NH	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
34	NJ	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
36	NY	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
42	PA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
44	RI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
50	VT	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Total	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Queried from the EIS Gateway on 1/22/15 (Request Reports -> Emissions Summaries by Geography)

2011 ICI Boiler Emissions for the Midwest States (in Tons Per Year)

Version 2

FIPS	State	Point NOx	Point SO2	Nonpoint NOx	Nonpoint SO2	Total NOx	Total SO2
17	IL	12,913	33,516	17,986	1,892	30,899	35,408
18	IN	15,542	35,227	5,791	112	21,333	35,339
26	MI	9,986	12,335	10,810	1,835	20,796	14,170
27	MN	9,254	5,254	11,200	3,805	20,454	9,059
39	OH	15,807	52,534	16,326	784	32,133	53,318
55	WI	20,087	45,365	5,810	576	25,897	45,941
	Total	83,589	184,231	67,922	9,005	151,511	193,236

Difference (EMF minus EIS Gateway)

FIPS	State	Point NOx	Point SO2	Nonpoint NOx	Nonpoint SO2	Total NOx	Total SO2
17	IL	0	0	0	0	0	0
18	IN	0	0	0	0	0	0
26	MI	0	0	0	0	0	0
27	MN	0	0	0	0	0	0
39	OH	0	0	0	0	0	0
55	WI	0	0	0	0	0	0
	Total	0	0	0	0	0	0

EMF datasets used:
Point = 2011NEIv2_Point_20140808_20aug2014_v0.csv (queried 2/23/15)
Nonpoint = nonpt_2011NEIv2_NONPOINT_20141108_11nov2014_v1.csv (queried 3/20/15)
List of SCCs from "Revised Appendices B & C"

Version 2 Query from EIS Gateway for Comparison

		Point		Nonpoint		Total	
FIPS	**State**	**NOx**	**SO2**	**NOx**	**SO2**	**NOx**	**SO2**
17	IL	12,913	33,516	17,986	1,892	30,899	35,408
18	IN	15,542	35,227	5,791	112	21,333	35,339
26	MI	9,986	12,335	10,810	1,835	20,796	14,170
27	MN	9,254	5,254	11,200	3,805	20,454	9,059
39	OH	15,807	52,534	16,326	784	32,133	53,318
55	WI	20,087	45,365	5,810	576	25,897	45,941
	Total	83,589	184,231	67,922	9,005	151,511	193,236

Percent Difference (EMF minus EIS Gateway/EMF)

		Point		Nonpoint		Total	
FIPS	**State**	**NOx**	**SO2**	**NOx**	**SO2**	**NOx**	**SO2**
17	IL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
18	IN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
26	MI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
27	MN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
39	OH	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
55	WI	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Total	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%

Queried from the EIS Gateway on 1/22/15 (Request Reports -> Emissions Summaries by Geography)

2011 ICI Boiler Emissions for the Southeast States (in Tons Per Year)

Version 2

		Point		Nonpoint		Total	
FIPS	**State**	**NOx**	**SO2**	**NOx**	**SO2**	**NOx**	**SO2**
01	AL	14,887	15,979	7,272	23,721	22,159	39,700
13	GA	15,348	21,225	3,194	4,074	18,542	25,299
21	KY	5,882	5,707	1,371	96	7,254	5,803
28	MS	5,344	5,558	947	16	6,291	5,573
37	NC	18,523	11,580	6,918	11,625	25,441	23,204
45	SC	9,771	11,446	5,230	3,276	15,001	14,722
47	TN	14,714	31,337	9,768	1,219	24,483	32,555
51	VA	15,141	13,222	7,099	2,741	22,240	15,963
54	WV	6,900	12,428	1,940	3,928	8,841	16,356
	Total	106,512	128,481	43,740	50,694	150,252	179,175

Difference (EMF minus EIS Gateway)

		Point		Nonpoint		Total	
FIPS	**State**	**NOx**	**SO2**	**NOx**	**SO2**	**NOx**	**SO2**
01	AL	0	0	0	0	0	0
13	GA	0	0	0	0	0	0
21	KY	0	0	0	0	0	0
28	MS	0	0	0	0	0	0
37	NC	0	0	782	5,021	782	5,021
45	SC	0	0	0	0	0	0
47	TN	0	0	0	0	0	0
51	VA	0	0	0	0	0	0
54	WV	0	0	0	0	0	0
	Total	0	0	782	5,021	782	5,021

EMF datasets
used:
Point = 2011NEIv2_Point_20140808_20aug2014_v0.csv (queried 2/23/15)
Nonpoint = nonpt_2011NEIv2_NONPOINT_20141108_11nov2014_v1.csv (queried 3/20/15)
List of SCCs from "Revised Appendices B & C"

Version 2 Query from the EIS Gateway for Comparison

		Point		Nonpoint		Total	
FIPS	**State**	**NOx**	**SO2**	**NOx**	**SO2**	**NOx**	**SO2**
01	AL	14,887	15,979	7,272	23,721	22,159	39,700
13	GA	15,348	21,225	3,194	4,074	18,542	25,299
21	KY	5,882	5,707	1,371	96	7,254	5,803
28	MS	5,344	5,558	947	16	6,291	5,573
37	NC	18,523	11,580	6,136	6,604	24,660	18,183
45	SC	9,771	11,446	5,230	3,276	15,001	14,722
47	TN	14,714	31,337	9,768	1,219	24,483	32,555
51	VA	15,141	13,222	7,099	2,741	22,240	15,963
54	WV	6,900	12,428	1,940	3,928	8,841	16,356
	Total	106,512	128,481	42,959	45,673	149,470	174,154

Percent Difference (EMF minus EIS Gateway/EMF)

		Point		Nonpoint		Total	
FIPS	**State**	**NOx**	**SO2**	**NOx**	**SO2**	**NOx**	**SO2**
01	AL	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
13	GA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
21	KY	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
28	MS	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
37	NC	0.0%	0.0%	11.3%	43.2%	3.1%	21.6%
45	SC	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
47	TN	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
51	VA	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
54	WV	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Total	0.0%	0.0%	11.3%	43.2%	3.1%	21.6%

Queried from the EIS Gateway on 1/22/15 (Request Reports -> Emissions Summaries by Geography)