Upstate SC

2011 Emissions Inventory

BY
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COUNTY OF GREENVILLE, SOUTH CAROLINA

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Office of the County Administrator

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Dear Greenville County Residents:

Greenville County is committed to increasing the quality of life and public health of its residents through various programs including the Breathe Better program (an anti-idling) campaign. This program has been in place since 2006 at certain schools to educate parents, faculty, staff, and visitors about things and behaviors that improve or impair the air we breathe.

Our collaborative efforts with other Upstate South Carolina organizations continue and are reflected with our current area attainment designation from the U.S. Environmental Protection Agency (EPA) with respect to ground level ozone and particulate matter 2.5. The current ozone National Ambient Air Quality Standard (NAAQS) is 0.075 ppm. On November 25, 2014, EPA announced that it is proposing a new Ozone standard within the range of 0.065 ppm to 0.070 ppm with a final Ozone standard determination to be made by October 1, 2015. As the time comes closer for EPA to make a final standard determination in 2015, we need to be vigilant of our collective efforts and behavior affecting air quality.

This report provides a summary of the emissions inventory in six Upstate South Carolina counties for 2010 and 2011. Data from the South Carolina Department of Health and Environmental Control (SCDHEC) shows no ground level ozone exceedances in 2013 (the latest data available). However, depending on what the new ozone standard falls in EPA's recommended range and using the 2011-2013 Current 3-Year Average data, at least one monitor would be equal or exceed a new standard in the proposed range (it is expected that SCDHEC will update the data in January 2015, which will include the 2014 design values).

Greenville County encourages schools to participate in SCDHEC's Breathe Better program. If your school is interested in participating please do not hesitate to contact my assistant, Sandra Yúdice at syudice@greenvillecounty.org or (864) 467-7409 or Ms. Debra Briggs-Monroe at SCDHEC at briggsmd@dhec.sc.gov or (803) 898-3752.

Sincerely,

Joseph M. Kernell
County Administrator

BACKGROUND

In December 2002 and with a pending designation of non-attainment with the 1997 ground level ozone standard of 0.08 parts per million (ppm), the counties of Anderson, Greenville, and Spartanburg entered into an Early Action Compact (EAC) with the S.C. Department of Health and Environmental Control (DHEC) and the U.S. Environmental Protection Agency (EPA). The goal was to develop and implement a series of strategies aiming to obtain cleaner air sooner than federally mandated and attain the 8-hour ozone standard by December 31, 2007. The other pollutant that was a concern was particulate matter with a diameter less than 2.5 micrometers ($PM_{2.5}$). In December 2008, the EPA issued its final designation for the entire state as an attainment area with the 2006 24-hour $PM_{2.5}$ standards.

With the assistance of private sector's environmental engineers and experts, the 2002 EAC allowed the counties to conceive, evaluate, and implement several strategies to reach attainment by the 2007 pre-determined date. Many of the strategies were and continue to be successfully implemented by both the public and private sectors. For example, voluntarily, Duke Energy installed additional nitrogen oxide (NOx) emission controls at the Lee Steam Plant located on the Saluda River in Anderson County in support of the EAC to reduce emissions contributing to the formation of ground level ozone (Duke, 2011). With DHEC approving a permit in April 2004, Transcontinental Gas Pipeline Co. Station 140 in Moore, SC, (Spartanburg County) also installed NOx controls and replaced outdated "uncontrolled" compressors located in Duncan, SC, (EPA, 2006). Additionally, Greenville County's clean air public awareness campaign proved to be successful as more people became aware of these issues and began changing personal habits and advocating for clean air initiatives. The Breathe Better (*B^2 – B Square*) program, an anti-idling campaign, is another success story with more schools requesting information or becoming *B^2 Schools*.

In early 2008, EPA designated 13 areas in the country (Greenville-Spartanburg-Anderson included) as attaining the 1997 8-hour ground level ozone standard under the EAC. EPA proposed "this action because each of the areas has demonstrated that they attained the standard by Dec. 31, 2007."

In March 2008, the Administrator announced that EPA strengthened the 8-hour ozone standard from 0.08 ppm to 0.075 ppm for both the primary and secondary standards. EPA reconsidered this level in 2010 but it was ultimately upheld.

On November 25, 2014, EPA announced that it is proposing a new Ozone standard within the range of 0.065 to 0.070 ppm with a final Ozone standard determination to be made on October 1, 2015 (Environmental Protection Agency, 2014). The true test for the Upstate SC will be when EPA designates our region as an "attainment" or "nonattainment" area for ground level ozone upon final determination in 2015. When EPA announces the new standard, it will also determine when the new designations will become in effect.

Upstate SC Air Quality Monitors

Since 1959, DHEC or its predecessors have monitored air quality through a network of monitors in the state. In its 2014 Network Description and Ambient Air Network Monitoring Draft Plan, DHEC included a description of the network which includes "the State and Local Air Monitoring Station (SLAMS), special purpose monitoring (SPM) and the National Core Monitoring Network (NCore). The SLAMS air monitoring network is specific for the criteria pollutants, those pollutants for which the National Ambient Air Quality Standards (NAAQS) have been established. In addition to SLAMS network, the air monitoring network includes SPM for air toxics, particulate, mercury, criteria pollutants, precipitation and meteorology" (DHEC, 2011). The criteria pollutants include ozone, particulate matter, carbon monoxide, nitrogen oxide, sulfur dioxide, and lead.

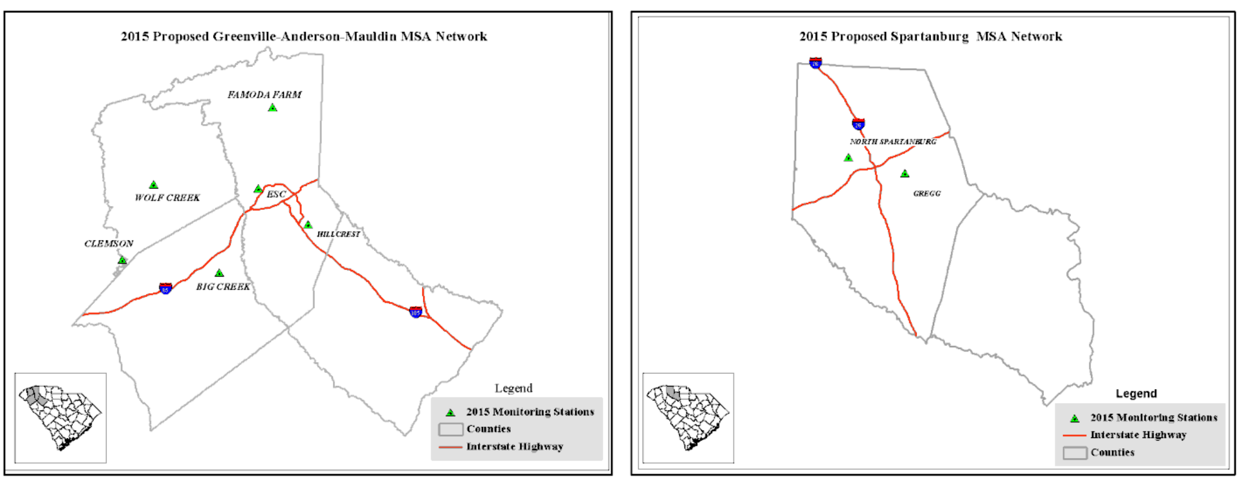


Figure 1. 2015 Proposed Greenville-Anderson-Mauldin MSA and Spartanburg MSA Networks.

DHEC proposed the 2015 Network Description and Ambient Air Network Monitoring Plan. Figure 1 shows the locations of monitoring sites in the Greenville-Anderson-Mauldin MSA and Spartanburg MSA Networks. Table

1 provides a list of the current sites and their respective location, pollutant (ozone and/or $PM_{2.5}$) identification number, and date established.

Table 1. Upstate South Carolina Ambient Air Monitoring Network

County	Name	Pollutant	CSA/MSA	AQS Site ID	Location	Date Established
Anderson	Big Creek	Ozone	GSA CSA/Greenville-Anderson-Mauldin MSA	45-007-0005	215 McAlister Road	6/6/2008
Cherokee	Cowpens	Ozone	GSA CSA	45-021-0002	McGinnis Road (Old SC 110)	3/25/1988
Greenville	ESC	$PM_{2.5}$	GSA CSA/ Greenville-Anderson-Mauldin MSA	45-045-0015	101 Perry Avenue	4/11/2008
Greenville	Hillcrest	Ozone $PM_{2.5}$	GSA CSA/ Greenville-Anderson-Mauldin MSA	45-045-0016	510 Garrison Road	2/17/2009
Greenville	Famoda Farm	Ozone	GSA CSA/ Greenville-Anderson-Mauldin MSA	45-045-1003	7560 Mountain View Road	8/7/2008
Oconee	Long Creek	Ozone $PM_{2.5}$	GSA CSA	45-073-0001	Round Mt. Fire Tower	8/1/1983
Pickens	Clemson	Ozone	GSA CSA/ Greenville-Anderson-Mauldin MSA	45-077-0002	106 Hope Well Road	7/14/1979
Pickens	Wolf Creek	Ozone	GSA CSA/ Greenville-Anderson-Mauldin MSA	45-077-0003	901 Allgood Bridge Road	8/10/2010
Spartanburg	North Spartanburg	Ozone	GSA CSA/ Spartanburg MSA	45-083-0009	1556 John Dodd Road	4/4/1990
Spartanburg	T. K. Gregg	$PM_{2.5}$	GSA CSA/ Spartanburg MSA	45-083-0011	267 Northview Street	12/29/2008

The NAAQS use the "annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years, as the form of the standard" (Environmental Protection Agency, 2014, n.p.) and are locally represented by the design value, which is "a statistic that describes the air quality status of a given location relative to the level of the NAAQS" (Environmental Protection Agency, 2014). According to SCDHEC data, there were no ground level ozone exceedances in 2013 (the latest data available) under the current ozone standard, which is 0.075 ppm. Table 2 provides SCDHEC's 2013 air quality monitoring data from the Upstate's site. The gray column (4th 8-hr Average) is the data included in the 3-year average calculation to determine attainment/non-attainment status.

Table 2. 2013 Air Quality Monitoring Data for Ground Level Ozone

County/Monitoring Site	Total Hits	Date	1st 8-hr Average	Date	2nd 8-hr Average	Date	3rd 8-hr Average	Date	4th 8-hr Average	Date	5th 8-hr Average
Anderson: Big Creek	0	Apr-6	0.064	Apr-3	0.055	Apr-7	0.053	Apr-2	0.051	Apr-5	0.051
Cherokee: Cowpens	0	Apr-6	0.066	Apr-2	0.055	Apr-7	0.055	Apr-3	0.054	Apr-5	0.052
Greenville: Famoda Farm	0	Apr-6	0.068	Apr-7	0.058	Apr-3	0.057	Apr-2	0.055	Apr-5	0.055
Greenville: Hillcrest	0	Apr-6	0.063	Apr-7	0.053	Apr-3	0.051	Apr-5	0.051	Apr-2	0.050
Oconee: Long Creek	0	Apr-14	0.000	Apr-15	0.000	May-19	0.000	Apr-10	0.000	May-25	0.000
Pickens: Clemson	0	Apr-6	0.064	Apr-7	0.055	Apr-2	0.051	Apr-3	0.051	Apr-5	0.050
Pickens: Wolf Creek	0	Apr-6	0.069	Apr-7	0.059	Apr-8	0.053	Apr-5	0.052	Apr-3	0.049
Spartanburg: N Spartanburg FD	0	Apr-6	0.068	Apr-7	0.060	Apr-2	0.056	Apr-3	0.056	Apr-5	0.053

(Source: SCDHEC, Current Ozone Monitoring Data: http://www.scdhec.gov/HomeAndEnvironment/Air/MostCommonPollutants/Ozone/DataReports/)

Table 3 summarizes the 2011-2013 Current 3-Year Average for the Upstate's monitors. None of those monitors exceeded the current ozone standard. The highest 3-year average reading was on the N Spartanburg FD monitor (0.070 ppm), which is below the current 0.075 ppm ozone standard.

Table 3. 2011-2013 Data: 3-Year Average

County	Monitoring Site	2010 4th 8-hr Average (ppm)	2011 4th 8-hr Average (ppm)	2012 4th 8-hr Average (ppm)	2013 4th 8-hr Average (ppm)	2008-2010 3 Year Average (ppm)	2009-2011 3 Year Average (ppm)	2010-2012 3 Year Average (ppm)	**2011-2013 Current 3-Year Average** (ppm)
Anderson	Big Creek	0.072	0.076	0.071	0.051	0.066	0.069	0.073	0.067
Cherokee	Cowpens	0.072	0.070	0.070	0.054	0.069	0.066	0.070	0.066
Greenville	Famoda Farm	0.070	0.066	0.063	0.055	0.066	0.067	0.066	0.063
Greenville	Hillcrest	0.069	0.068	0.070	0.051	0.068	0.068	0.069	0.064
Oconee	Long Creek	0.069	0.061	0.063	0.000	0.069	0.065	0.064	0.048
Pickens	Clemson	0.072	0.075	0.068	0.051	0.072	0.071	0.071	0.066
Pickens	Wolf Creek		0.074	0.063	0.053	0.065	0.069	0.068	0.063
Spartanburg	N. Spartanburg FD	0.076	0.081	0.070	0.056	0.076	0.074	0.075	0.070

(Source: SCDHEC, Current Ozone Monitoring Data: http://www.scdhec.gov/HomeAndEnvironment/Air/MostCommonPollutants/Ozone/DataReports/)

In November 2014, EPA announced that it is proposing a new ozone standard within the range of 0.065 to 0.070 ppm. Depending on where the new ozone standard falls in that range and using the 2011-2013 Current 3-Year Average data, four Upstate SC monitors would fall in that range as shown in Table 4. If the standard is within the 0.065 to 0.066 ppm range four monitors would fail to meet the standard. If the standard is at 0.067 ppm, two monitors would fail. At a standard within the 0.068 to 0.070 ppm range, only one monitor would fail.

Table 4. 2011-2013 Current 3-Year Average for Upstate South Carolina Monitors and Recommended Ozone Standard Range

County	Monitoring Site	Proposed Ozone Standard Range: 0.065 to 0.070 ppm						**2011-2013 Current 3-Year Average (ppm)**
		At 0.065 ppm	At 0.066 ppm	At 0.067 ppm	At 0.068 ppm	At 0.069 ppm	At 0.070 ppm	
Anderson	Big Creek	0.067	0.067	0.067				0.067
Cherokee	Cowpens	0.066	0.066					0.066
Greenville	Famoda Farm							0.063
Greenville	Hillcrest							0.064
Oconee	Long Creek							0.048
Pickens	Clemson	0.066	0.066					0.066
Pickens	Wolf Creek							0.063
Spartanburg	N. Spartanburg FD	0.070	0.070	0.070	0.070	0.070	0.070	0.070

(Source: SCDHEC, Current Ozone Monitoring Data: http://www.scdhec.gov/HomeAndEnvironment/Air/MostCommonPollutants/Ozone/DataReports/). This chart is for illustration purposes only if the ozone standard is set at these values. Based on historical ozone standards, EPA might set the standard at either 0.065 ppm or 0.070 ppm.

How is Ground Level Ozone Formed?

Ground level ozone is not a pollutant that is emitted. Rather, it is produced in the atmosphere by a combination of precursor sources through chemical reactions "driven by a complex nonlinear photochemistry" (Sillman, n.d., p. 4; Congress of the United States: Office of Technology Assessment, 1989): nitrogen oxides (NOx) and volatile organic compounds (VOCs). According to EPA, "O_3 [ozone] concentrations are influenced by complex interactions between precursor emissions, meteorological conditions, and surface characteristics" (Environmental

Protection Agency, 2014). Fossil fuel combustion produces NOx. VOCs comprise a wide range of organic gases including solvents and gasoline vapors and naturally occurring emissions from vegetation, which tend to be high in rural areas in the Southeast (Congress of the United States: Office of Technology Assessment, 1989; Sillman, n.d.). Concentrations of ozone tend to be higher during hot, sunny days because the chemical reaction depends on the temperature and sunlight, outdoor temperature increase emissions from certain sources, and air stagnation does not allow the dispersion of pollutants (Congress of the United States: Office of Technology Assessment, 1989). According to EPA, “NOx causes both the formation and destruction of VOC. The net impact of NOx emissions on O_3 concentrations depends on the local quantities of NOx, VOC, and sunlight which interact in a set of complex chemical reactions” (Environmental Protection Agency, 2014).

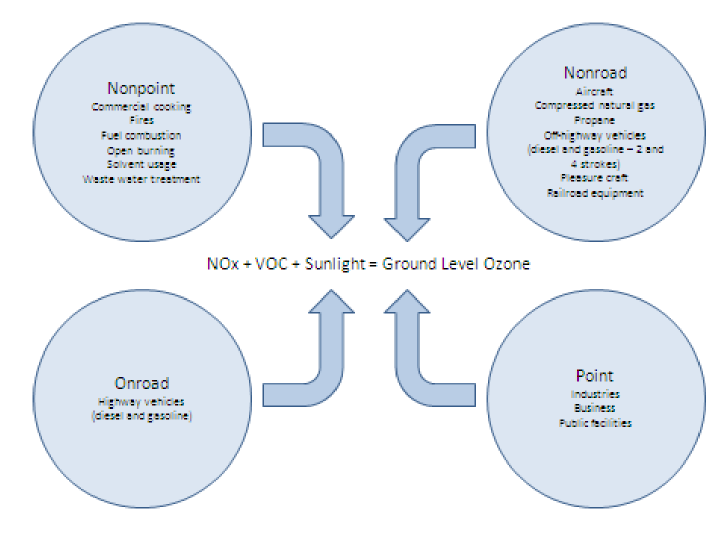


Figure 2. Sources of Upstate SC NOx and VOC Emissions

The ozone-NOx-VOC sensitivity presents two scenarios: one with low NOx and high VOC called the NOx-sensitive or NOx-limited and another one with high NOx and low VOC called VOC-sensitive or VOC-limited (Sillman, n.d.; Schwartz, 2006). In a NOx-sensitive or NOx-limited scenario (i.e., high VOC/NOx ratios), ozone formation depends on the amount of NOx available: ozone rises with increases in NOx; it drops with decreases in NOx; and changes little with changes in VOC emissions. In a VOC-sensitive or VOC-limited scenario (i.e., low VOC/NOx ratios), the amount of VOC availability limits ozone formation: ozone rises with NOx decreases or VOC increases and it drops with NOx increases or VOC decreases (Congress of the United States: Office of Technology Assessment, 1989; Schwartz, 2006; Sillman, n.d.). According to the defunct Office of Technology Assessment of the US Congress, “[a]lthough measurements are sparse, conditions in rural areas tend to be NOx-limited” (U.S. Congress, Office of Technology Assessment, 1989, p. 98). Table 5 summarizes ozone, NOx, and VOC relationships.

Table 5. Ozone, NOx, and VOC Relations

NOx-Sensitive or NOx-Limited Scenario (Low NOx, High VOC)		Ozone	VOC-Sensitive or VOC-Limited Scenario (High NOx, Low VOC)		Ozone
NOx increase	→	Increase	NOx increase	→	Decrease
NOx decrease	→	Decrease	NOx decrease	→	Increase
VOC increase	→	Little Change or No effect	VOC increase	→	Increase
VOC decrease	→	Little Change or No effect	VOC decrease	→	Decrease

Note: Adapted from Overview: Tropospheric Ozone, Smog and Ozone-NOx-VOC sensitivity, Sanford Sillman, http://www-personal.umich.edu/~sillman/ozone.htm; How Ozone is Formed, Joel Schwartz, http://news.heartland.org/newspaper-article/2006/05/01/how-ozone-formed; and Catching Our Breath: Next Steps for Reducing Urban Ozone, Congress of the United States, Office of Technology Assessment, https://www.princeton.edu/~ota/disk1/1989/8906_n.html.

According to Sillman (n.d.), factors affecting the ozone-NOx-VOC sensitivity include VOC/NOx ratios, the reactivity and availability of biogenic VOC, and downwind distance. High VOC/NOx ratios are found in NOx-sensitive conditions and low VOC/NOx ratios, under VOC-sensitive conditions. Highly reactive VOC (e.g., biogenic VOC) are found in NOx-sensitive areas. Naturally occurring VOC emissions (i.e., biogenic VOC) such as those produced by deciduous trees is a substantial portion of locally produced VOC in suburban and rural areas. High rates for biogenic VOC increases the "ratio of reactivity-weighted VOC to NOx and makes NOx-sensitive conditions more likely" (Sillman, n.d., p. 5). Fast reacting VOCs produce more ozone (Congress of the United States: Office of Technology Assessment, 1989).

According to the six counties aggregated 2010 NOx-VOC emissions inventory, the region was a NOx-limited with VOC emissions totaling 59% (48,986 tpy) of total emissions and NOx, 41% (34,746 tpy). The 2011 inventory, however, indicates that VOC emissions decreased to 51% (40,257 tpy) and NOx emissions increased to 49% (38,652 tpy) of total emissions.

What are the Next Steps in the Upstate South Carolina?

On November 25, 2014, EPA announced that it is proposing to a new Ozone standard within the range of 0.065 ppm to 0.070 ppm with a final Ozone standard determination to be made on October 1, 2015 (Environmental Protection Agency, 2014). In its announcement, EPA noted that "climate change has the potential to cause increases in summertime O_3 concentrations over substantial regions of the country, with increases tending to occur during higher peak pollution episodes in the summer, if offsetting emissions reductions are not made" (Environmental Protection Agency, 2014, n.p.).

Anticipating a more stringent ozone standard, public and private organizations, non-profit, businesses, and industries in the Upstate decided to renew discussions to keep the region in attainment status for this air pollutant with Ten at the Top (TATT) acting as facilitator. The working group received the 2010 and 2011 emissions inventory (tons per year-tpy) for Anderson, Cherokee, Greenville, Oconee, Pickens, and Spartanburg counties from DHEC to evaluate the information. This report will assist the group to determine what else could be done to reduce ground level ozone precursors. The emissions inventory discussed in this summary includes NOx and volatile organic compounds (VOC) emissions only (ground level ozone precursors) from nonpoint, nonroad, onroad, and point sources. Table 6 provides a summary of emissions sources by category.

According to DHEC, emissions figures included in the nonroad, and onroad sources are based on models and nonpoint source emissions are based on using state or county level data and emission factors. Point sources consist of Title V permitted sources but the emissions are calculated using actual process data and emission factors.

Table 6. Emissions: Source Categories and Description

Source Category	Source Description	
Events	• Fires: prescribed and wildfires	
Nonpoint	• Commercial cooking • Fires- Agricultural Field Burning • Fuel Combustion Commercial/Institutional • Fuel Combustion- Industrial • Fuel Combustion- Residential	• Miscellaneous Activities • Open Burning • Petroleum Products- Storage/Transport • Solvent Usage • Wastewater Treatment
Nonroad	• Compressed Natural Gas • Line Haul Railroads • Liquid Propane Gas • Off-highway Vehicle Diesel	• Off-highway Vehicle Gasoline, 2-Stroke • Off-highway Vehicle Gasoline, 4-Stroke • Pleasure Craft
Onroad Mobile	• Mobile - On-Road Diesel Heavy Duty Vehicles • Mobile - On-Road Diesel Light Duty Vehicles	• Mobile: On-Road Gasoline Heavy Duty Vehicles • Mobile: On-Road Gasoline Light Duty Vehicles
Point	• Industries • Business	• Private and public facilities

What follow is a summary and comparison of the 2010 and 2011 emissions inventory for six Upstate SC counties, Anderson, Cherokee, Greenville, Oconee, Pickens, and Spartanburg. Several charts are included as appendices showing detailed NOx and VOC emissions by county, source, industries, etc. These charts could assist each county in determining the best way to address its emissions.

Summary and Comparison of 2010 and 2011 Upstate SC Emissions

According to the NOx and VOC emissions inventory, the total 2011 emissions in Upstate SC decreased to 78,909 tpy, a reduction of 4,823 tpy (5.76%) compared to the 2010 total emissions of 83,732 tpy. Additionally, in 2010, VOC emissions accounted for 59% of total NOx and VOC emissions, while 41% came from NOx sources. In

2011, VOC emissions accounted for 51% of total emissions, while 49% came from NOx sources. The higher the ratio of VOCs to NOx, the more NOx-limited is the area in question (U.S. Congress, Office of Technology Assessment, 1989). The 2010 VOC to NOx ratio (higher VOC than NOx) made the Upstate SC a NOx limited area. As noted before, in a NOx limited area, NOx availability controls ozone formation. Hence, reducing NOx emissions would lower ground level ozone and reducing VOC would be ineffective in lowering ozone (Scwartz, 2006). The lower the VOCs to NOx ratio, it is less likely that reducing NOx will produce a positive effect on ozone (U.S. Congress, Office of Technology Assessment, 1989). Figure 3 shows a graphic distribution of total 2010 and 2011 VOC and NOx emissions.

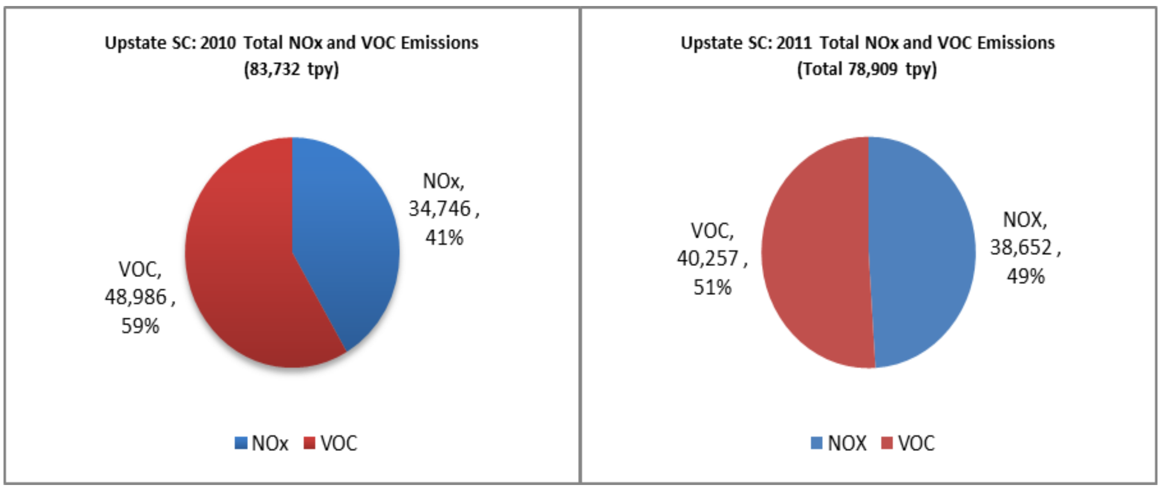
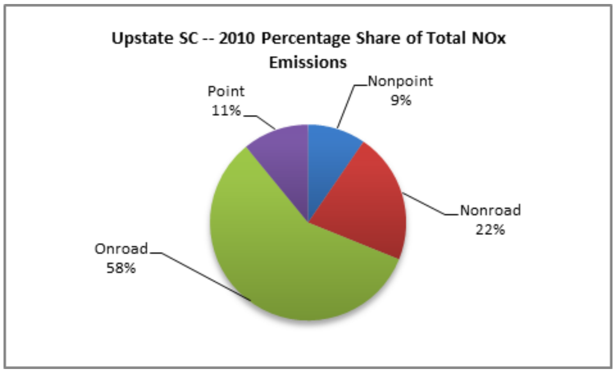


Figure 3. Upstate SC: 2010 and 2011 Total NOx and VOC Emissions

Note: These graphs do not include biogenic emissions data. The formation of ozone depends on a complicated chemistry reaction of its precursors—VOC and NOx emissions—and other factors such as geography, other chemical compounds reactions, pollutants concentrations, meteorological and atmospheric conditions such as wind direction and speed, temperature, transported pollution, humidity levels, cloudiness etc. (U.S. Congress, Office of Technology Assessment, 1989).

In 2010, the largest source of NOx emissions in the Upstate was onroad vehicles with 58%, followed by nonroad with 22%, point with 11%, and nonpoint sources with 9%. The largest contributor of VOC emissions was nonpoint sources with 47%, followed by onroad with 29%, nonroad with 16%, and point with 8%. Figure 4 shows the percentage source share of total NOx and VOC emissions for 2010.



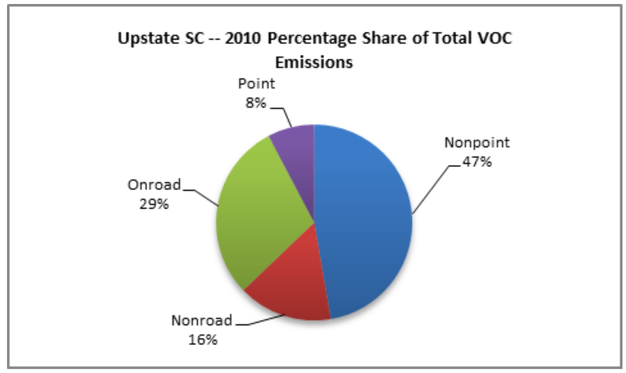
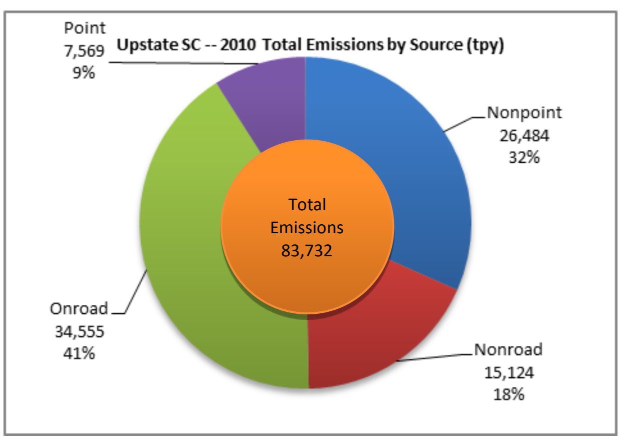


Figure 4. Upstate SC: 2010 Percentage Share of NOx and VOC Emissions

In 2010, the highest source of total emissions was onroad with 41%, followed by nonpoint with 32%, nonroad with 18%, and point with 9%. NOx emissions were the highest contributor of onroad emissions and VOC emissions were the highest contributor of nonpoint emissions. Again, in 2010, being the Upstate a NOx limited area, it made sense to invest efforts in reducing onroad NOx emissions, which is one of the two precursors to the formation of ground level ozone. Figure 5 provides a summary of 2010 NOx and VOCs emissions in the Upstate SC by source.



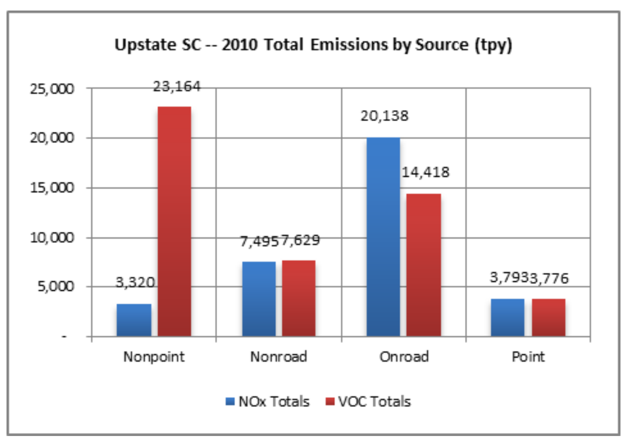


Figure 5. Upstate SC: 2010 Total Emissions by Source

In 2011, the largest source of NOx emissions in the Upstate still was onroad mobile with 64%, followed by nonroad with 17%, point with 11%, nonpoint sources with 8%, and events 0.40%. Also, the largest contributor of VOC emissions was nonpoint sources with 44%, followed by onroad mobile with 25%, nonroad with 16%, point with 11%, and events with 4%. Figure 6 shows the percentage source share of total 2011 NOx and VOC emissions.

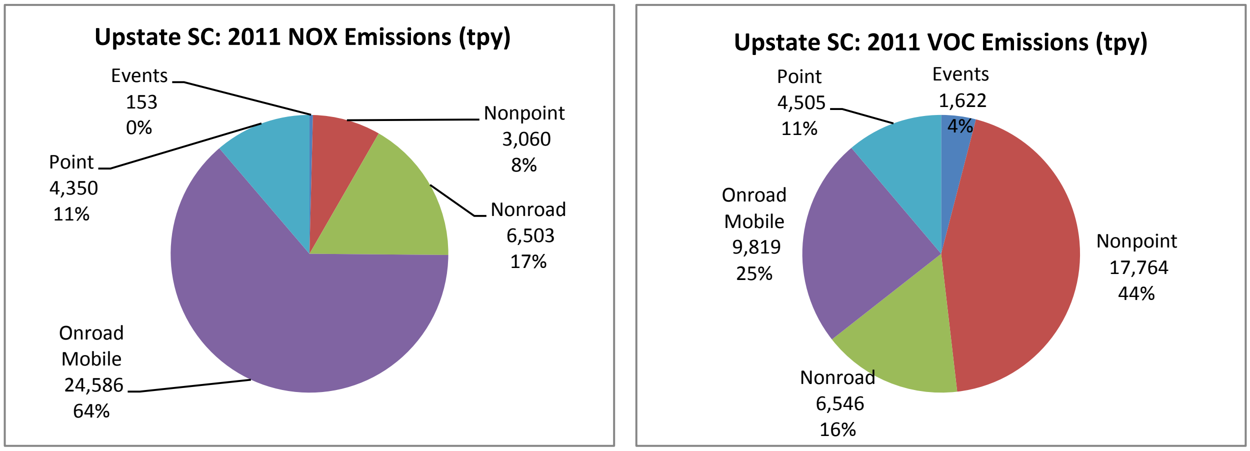


Figure 6. Upstate SC: 2011 Percentage Share of NOx and VOC Emissions

In 2011, the highest source of total emission was onroad mobile with 44%, followed by nonpoint with 26%, nonroad with 17%, point with 11%, and events with 2%. Again, NOx emissions were the highest contributor of onroad mobile sources and VOC emissions were the highest contributor of nonpoint sources. Figure 7 provides a summary of 2011 NOx and VOCs emissions in the Upstate SC by source.

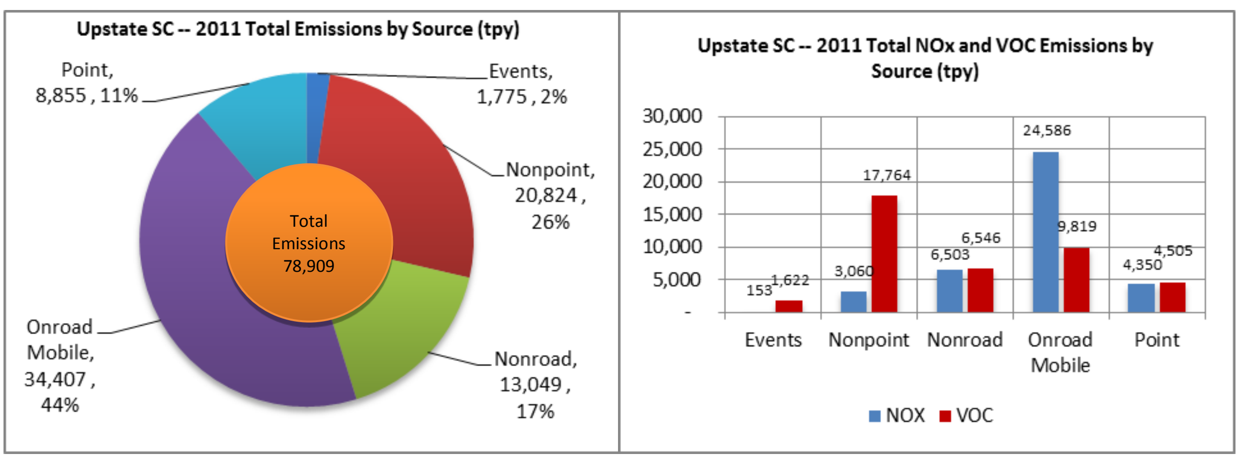


Figure 7. Upstate SC: 2011 Total Emissions by Source

Of the six counties, in 2010, Greenville was the highest producer of both NOx and VOC emissions with 10,972 tpy of NOx and 16,670 tpy of VOC, followed by Spartanburg with 10,494 tpy of NOx and 12,637 tpy of VOC, and Anderson with 5,910 tpy of NOx and 8,536 tpy of VOC. The next highest contributors of NOx emissions are Pickens, Cherokee, and Oconee; and of VOCs are Pickens, Oconee, and Cherokee. Similarly, in 2011, Greenville

County was the highest emitter of NOx and VOC emissions with 12,208 tpy of NOx and 13,522 tpy of VOC, followed by Spartanburg and Anderson counties. The next highest contributors of NOx emissions are Pickens, Cherokee, and Oconee counties; and of VOC emissions are Pickens, Oconee, and Cherokee. Figure 8 provides a summary of the total 2010 and 2011 NOx and VOC emissions by county.

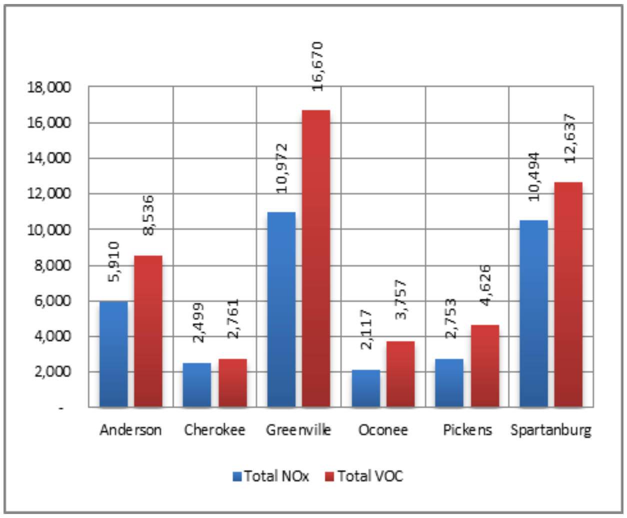
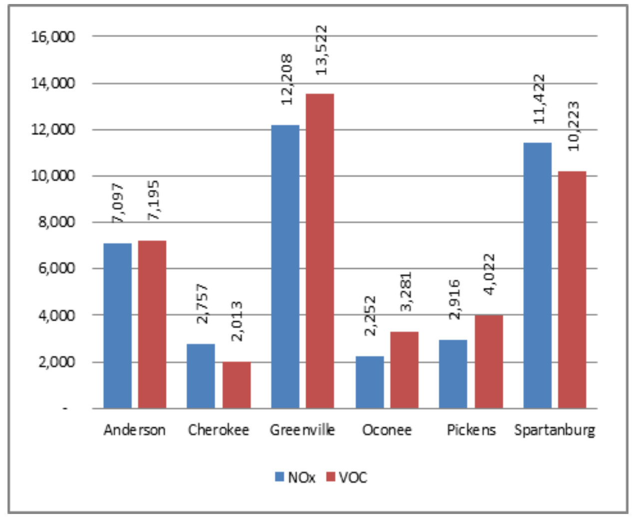


Figure 8. Upstate SC: 2010 Total NOx and VOC Emissions by County



Upstate SC: 2011 Total NOx and VOC Emissions by County

Comparing 2010 and 2011 NOx and VOC emissions, Greenville County NOx emissions increased in 2011 by 1,236 tpy and VOC emissions decreased by 3,148 tpy. Also, Spartanburg County NOx emissions increased in 2011 by 928 tpy and VOC emissions decreased by 2,414 tpy. Anderson County NOx emissions increased in 2011 by 1,187 tpy and VOC decreased by 1,341 tpy. Figure 9 summarizes the comparison of 2010 and 2011 NOx and VOC

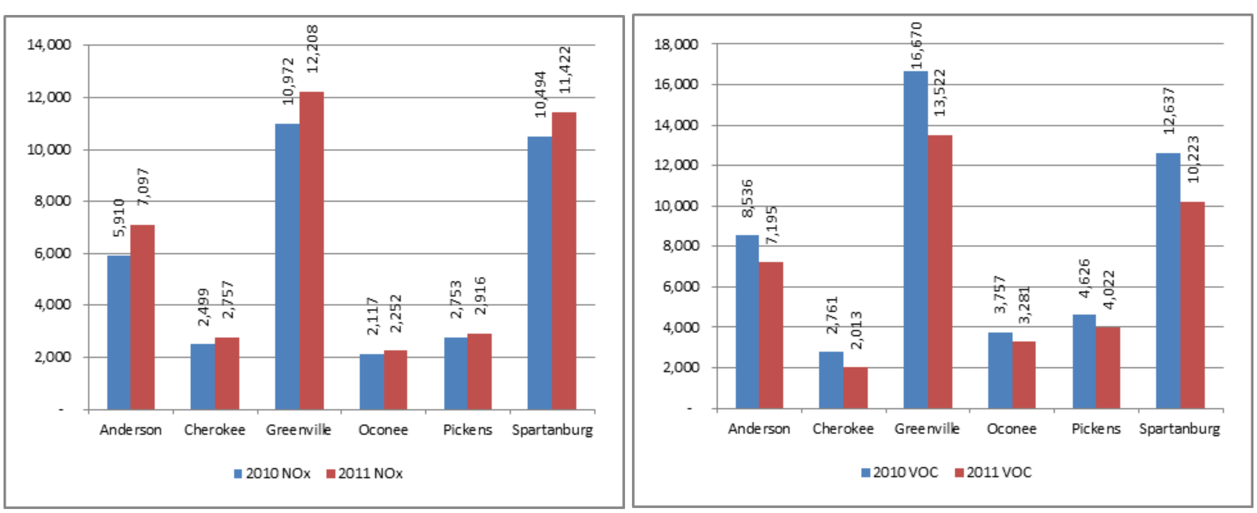


Figure 9. Upstate SC: Comparison of 2010 and 2011 NOx and VOC Emissions by County

emissions by county.

Nonpoint Emissions

Recall Table 6 which includes the different sources of emissions by category. Nonpoint sources of emissions include commercial cooking, agricultural field burning, fuel combustion (commercial, industrial, residential), open burning, storage/transport of petroleum products, use of solvents, and wastewater treatment.

In 2010, fuel combustion from industrial (1,720 tpy), residential (648 tpy), and commercial/institutions (391 tpy) with a combined total 2,741 tpy and open burning with a total of 494 tpy were the highest contributors of nonpoint NOx emissions. For nonpoint VOC emissions, the highest contributors were solvent use from miscellaneous activities with 13,635 tpy and petroleum products with 7,824 tpy. The three highest contributors of Nonpoint NOx and VOC emissions are Greenville, Spartanburg, and Anderson counties. Figure 10 provides a summary of NOx and VOC nonpoint emissions by county and source.

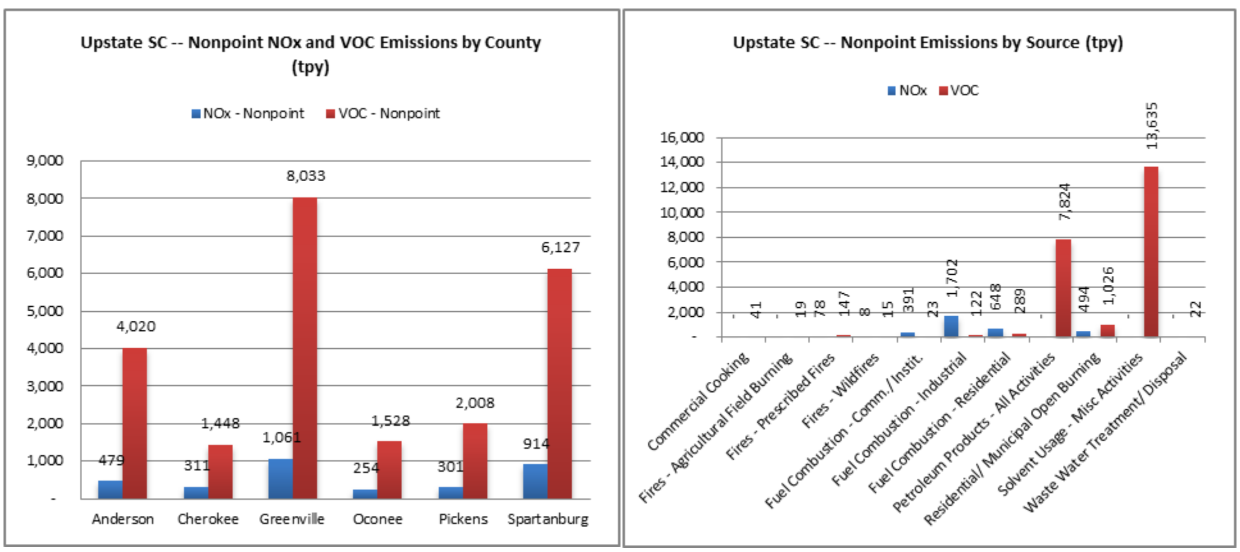


Figure 10. Upstate SC: 2010 Nonpoint NOX and VOC Emissions

In 2011, fuel combustion from industrial (1,902 tpy), residential (618 tpy), and commercial/institutions (305 tpy) with a combined total 2,825 tpy and open burning with a total of 229 tpy were the highest contributors of nonpoint NOx emissions. For nonpoint VOC emissions, the highest contributors were solvent use with 8,720 tpy and petroleum products storage/transport with 7,704 tpy. The three highest contributors of Nonpoint NOx and VOC emissions are Greenville, Spartanburg, and Anderson counties. Figure 11 provides a summary of the 2011

NOx and VOC nonpoint emissions by county and source.

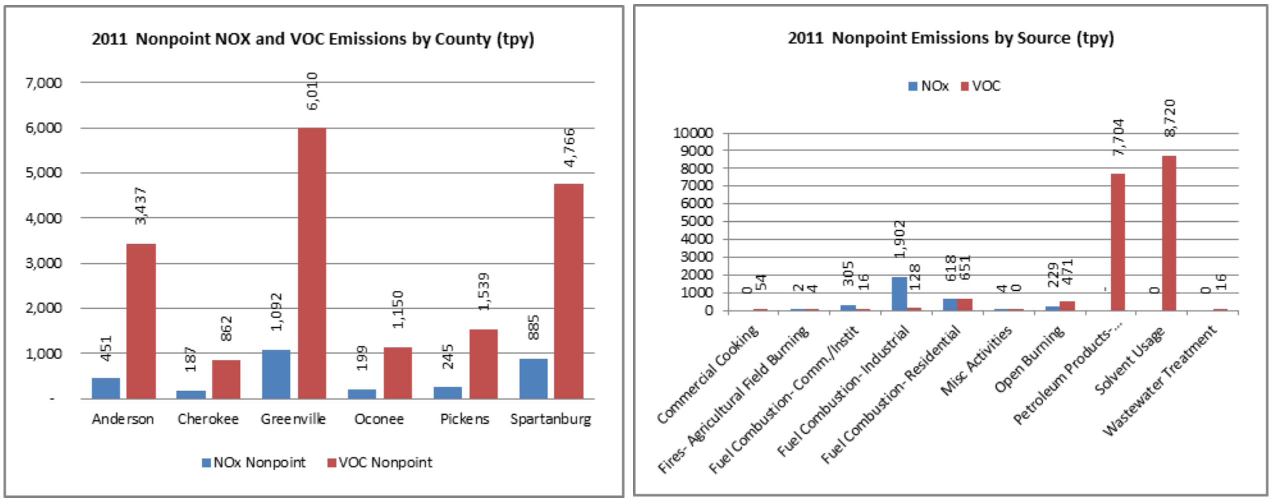


Figure 11. Upstate SC: 2011 Nonpoint NOx and VOC Emissions

Comparing 2010 and 2011 NOx Nonpoint emissions, except for Greenville County whose NOx nonpoint emissions increased by 31 tpy, these emissions decreased in the remaining counties. The overall total of NOx nonpoint emissions decreased 261 tpy from 2010 to 2011 for all six counties. VOC nonpoint emissions decreased for all six counties with an overall total of 5,400 tpy decrease from 2010 to 2011. Figure 12 shows a summary of NOx and VOC Nonpoint emissions by county.

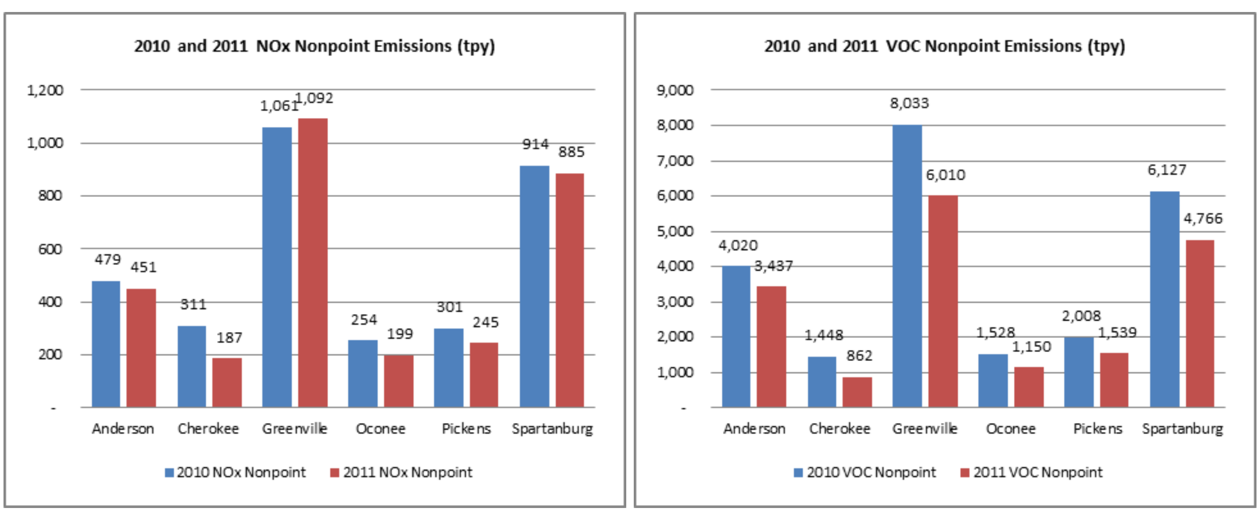


Figure 12. Upstate SC: 2010 and 2011 NOx and VOC Emissions by County

Nonroad Emissions

Nonroad emissions sources include compressed natural gas, line haul railroads, liquid propane gas, off-highway vehicle diesel, off-highway vehicle gasoline (2-stroke and 4-stroke, i.e., lawn maintenance equipment), and pleasure craft.

In 2010, the three major contributors of Nonroad NOx emissions were Greenville, Spartanburg, and Anderson counties. The three highest contributors of Nonroad VOC emissions were Greenville, Pickens, and Oconee counties. The three major sources of nonroad NOx emissions included off-highway diesel vehicles (4,242 tpy), railroad equipment (1,287 tpy), and LPG (propane) (1,108 tpy). Off-highway gasoline vehicles (4 and 2 stroke with 2,711 tpy and 2,189 tpy, respectively) and pleasure craft (1,852 tpy) were the major contributors of nonroad VOC emissions. Figure 13 summarizes nonroad emissions by county and source.

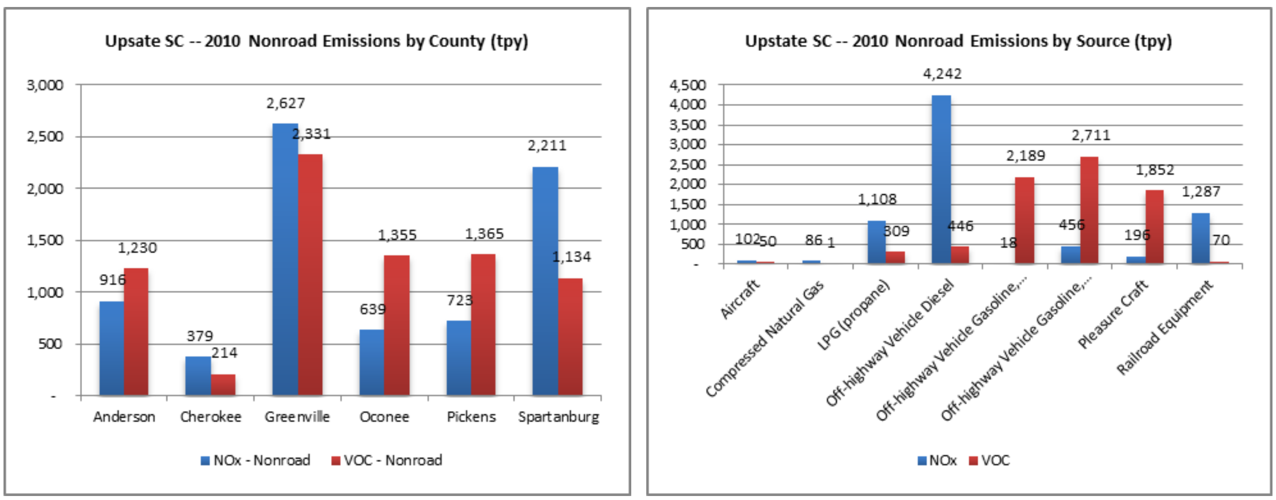


Figure 13. Upstate SC: 2010 Nonroad Emissions

In 2011, the three major contributors of Nonroad NOx emissions were also Greenville, Spartanburg, and Anderson counties. The three highest contributors of Nonroad VOC emissions were again Greenville, Pickens, and Oconee counties. The three major sources of nonroad NOx emissions included off-highway diesel vehicles (3,741 tpy), liquid propane gas (645 tpy), and off-highway vehicle gasoline 4-stroke (517 tpy). Off-highway gasoline vehicles (4 and 2 stroke with 2,285 tpy and 2,078 tpy, respectively), and pleasure craft (1,561 tpy) were the major contributors of nonroad VOC emissions. Figure 14 summarizes the 2011 nonroad emissions by county and source.

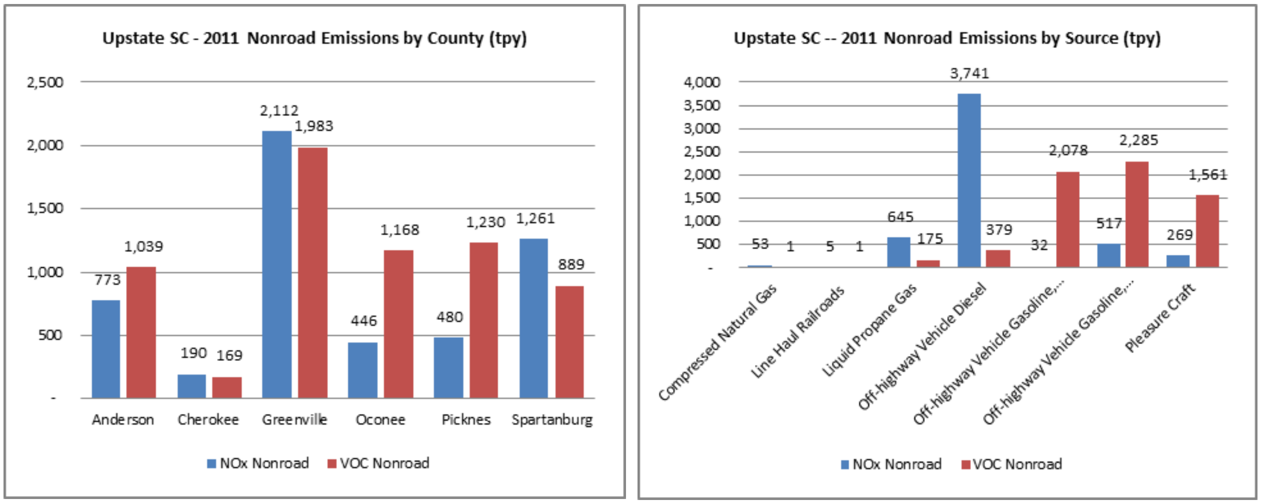


Figure 14. 2011 Nonroad Emissions by County and Source

NOx Nonroad emissions decreased in all counties from 2010 to 2011 with the highest decrease in Spartanburg County, i.e., 950 tpy. The overall total of NOx Nonroad emissions decreased 2,233 tpy from 2010 to 2011 for all six counties. VOC Nonroad emissions decreased for all six counties with an overall total of 1,151 tpy decrease from 2010 to 2011 with the highest decrease in Greenville County, i.e., 348 tpy. Figure 15 shows a summary of NOx and VOC Nonroad emissions by county for 2010 and 2011.

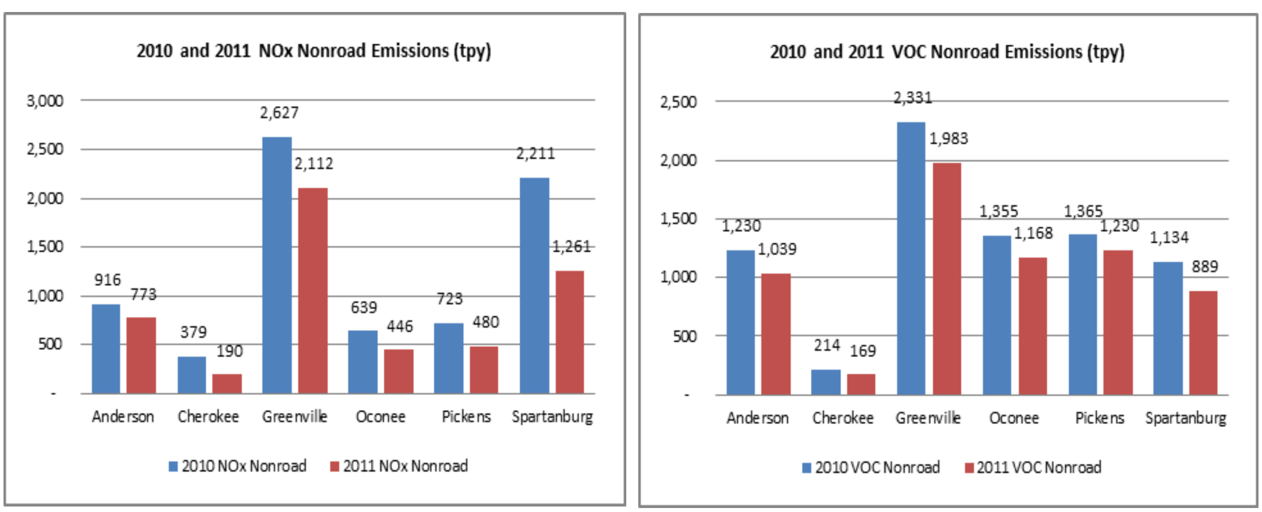


Figure 15. Upstate SC: 2010 and 2011 NOx and VOC Nonroad Emissions

Onroad Mobile Emissions

Sources of onroad mobile emissions include diesel and gasoline heavy and light duty vehicles. In 2010, the three highest contributors of onroad NOx and VOC emissions were Greenville (NOX: 6,912 tpy and VOC: 5,026 tpy), Spartanburg (NOx: 5,538 tpy and VOC: 3,924 tpy), and Anderson (NOx: 3,553 tpy and VOC 2,505 tpy) counties. The highest sources of both NOx and VOC onroad emissions were gasoline vehicles (NOx: 11,535 tpy and VOC: 13,782 tpy) followed by diesel (NOx: 8,603 tpy and VOC: 636 tpy). Figure 16 provides a summary of onroad NOx and VOC emissions by county and source.

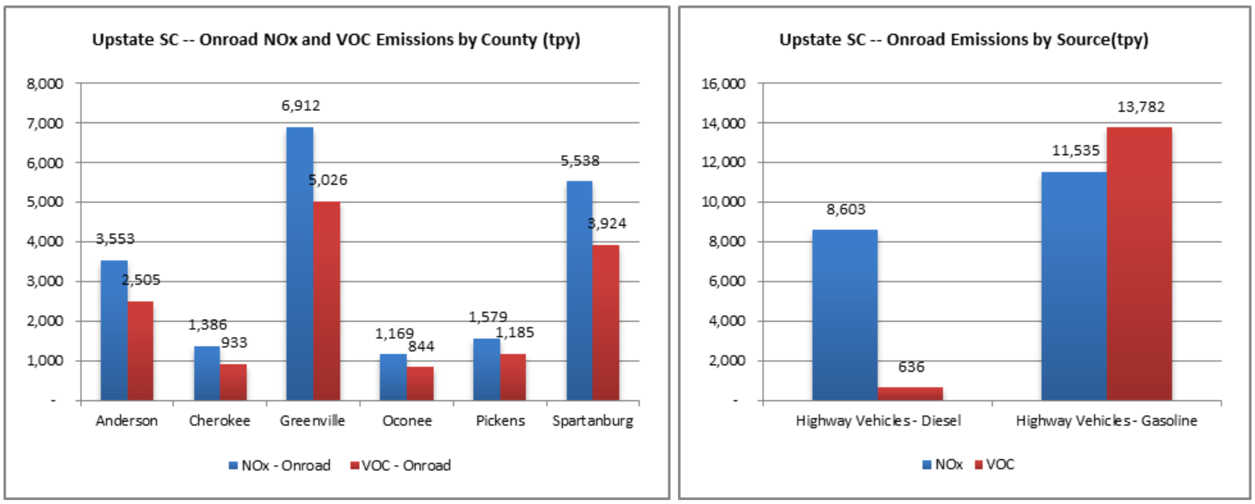


Figure 16. Upstate SC: 2010 Onroad Emissions by County and Source

As mentioned before, in 2010, 58% of total NOx emissions and 29% of total VOC emissions came from onroad sources. Gasoline vehicles accounted for 57% of onroad NOx emissions and 96% of onroad VOC emissions while diesel vehicles accounted for 43% of NOx and 4% of VOC emissions. Figure 17 shows the onroad emissions and the percentage share by type of vehicle.

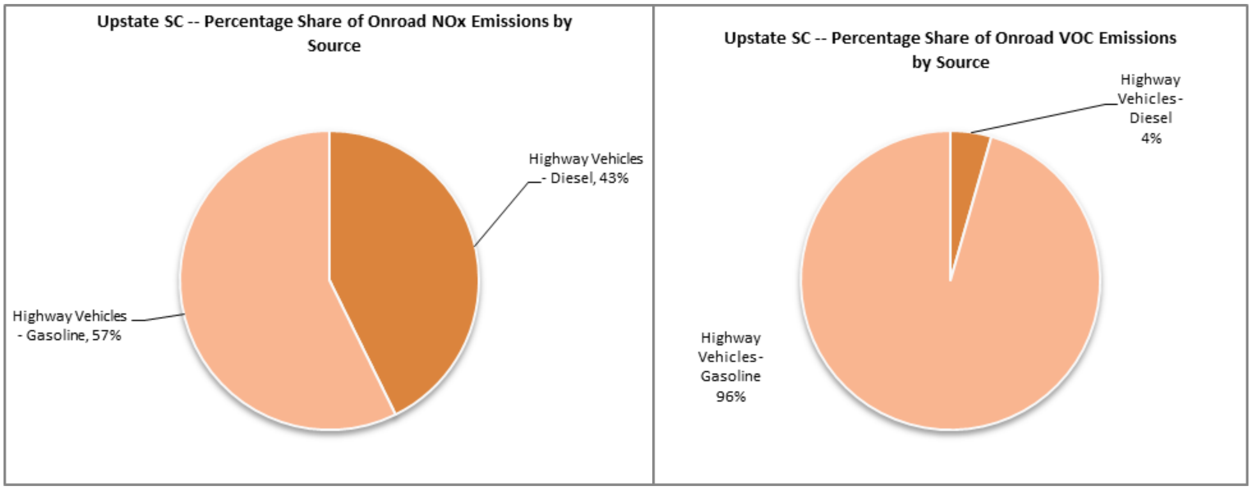


Figure 17. Upstate SC: 2010 Onroad NOx and VOC Emissions

In 2011, the three highest contributors of onroad NOx and VOC emissions were Greenville (NOX: 8,402 tpy and VOC: 3,611 tpy), Spartanburg (NOx: 6,786 tpy and VOC: 2,513 tpy), and Anderson (NOx: 4,412 tpy and VOC 1,659 tpy) counties. The highest sources of onroad NOx emissions were diesel heavy duty vehicles with 50% and gasoline light duty vehicles with 45% share of total onroad NOx emissions. The highest sources of onroad VOC emissions were gasoline light duty vehicles with 84% and diesel heavy duty vehicles with 10% share of total onroad VOC emissions. Figure 18 provides a summary of onroad NOx and VOC emissions by county and source.

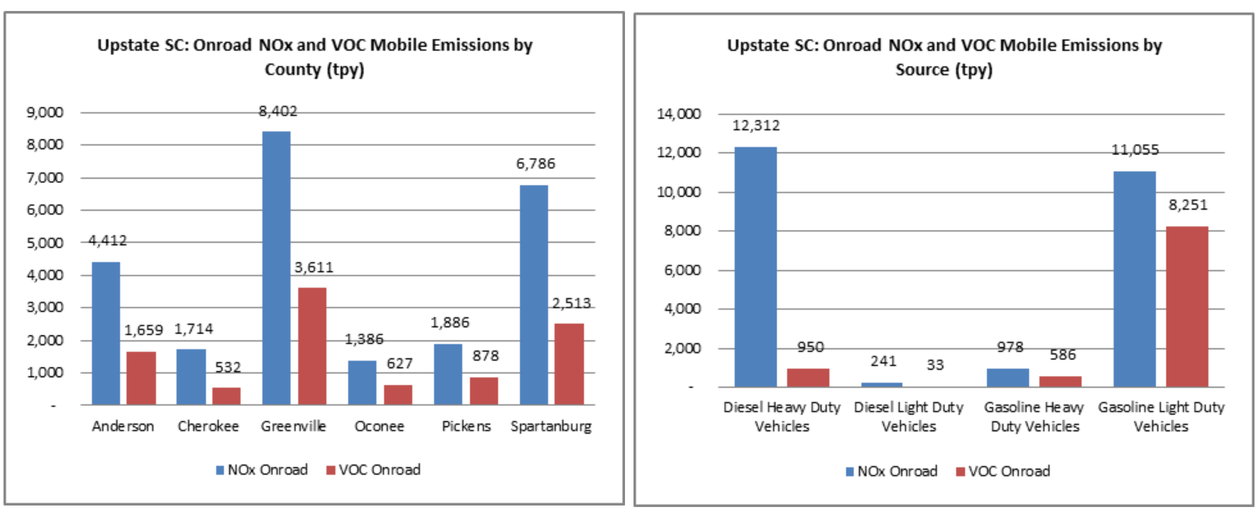
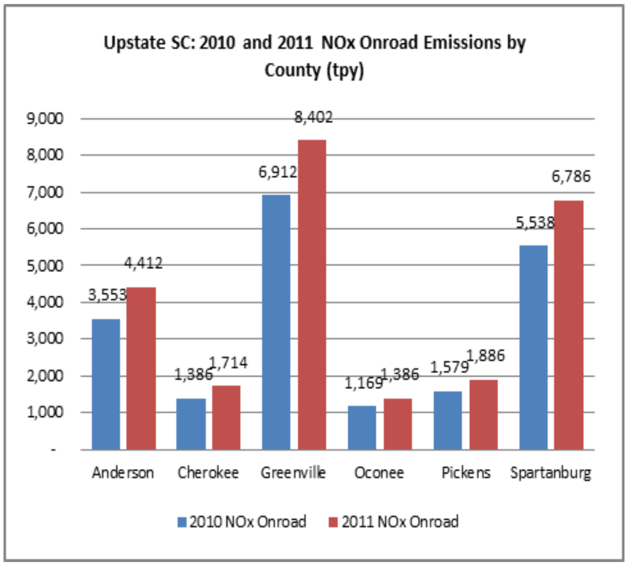


Figure 18. Upstate SC: 2011 Onroad NOx and VOC Mobile Emissions

Onroad NOx emissions increased in all six counties from 2010 to 2011. The highest increased (1,490 tons) registered in Greenville County followed by Spartanburg and Anderson counties. Onroad VOC emissions decreased in all six counties with the highest decrease in Spartanburg County (1,471 tons) followed by Greenville and Anderson counties. Figure 19 shows the NOx and VOC onroad emissions changes for 2010 and 2011 for all six counties.



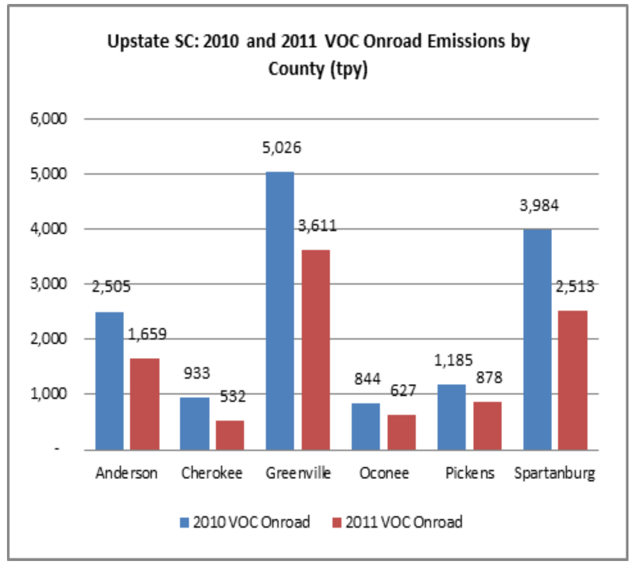


Figure 19. Upstate SC: 2010 and 2011 NOX and VOC Onroad Emissions

A break down of the onroad mobile source emissions reveals that, in 2011, diesel heavy duty vehicles accounted for 50% of NOx emissions followed by gasoline light duty vehicles with 45% and gasoline light duty vehicles accounted for 84% of VOC emissions followed by diesel heavy duty vehicles with 10%. Figure 20 shows the breakdown of NOx and VOC onroad mobile emissions by source.

Point Emissions

Sources of point emissions include industries, business, and private and public facilities. In 2010, the three highest producers of NOx point emissions included Spartanburg County with 1,831 tpy followed by Anderson with 963 tpy and Cherokee with 423 tpy. VOC point emissions from Spartanburg County (1,451 tpy) were also the highest, followed by Greenville (1,280 tpy) and Anderson (781 tpy) counties in 2010.

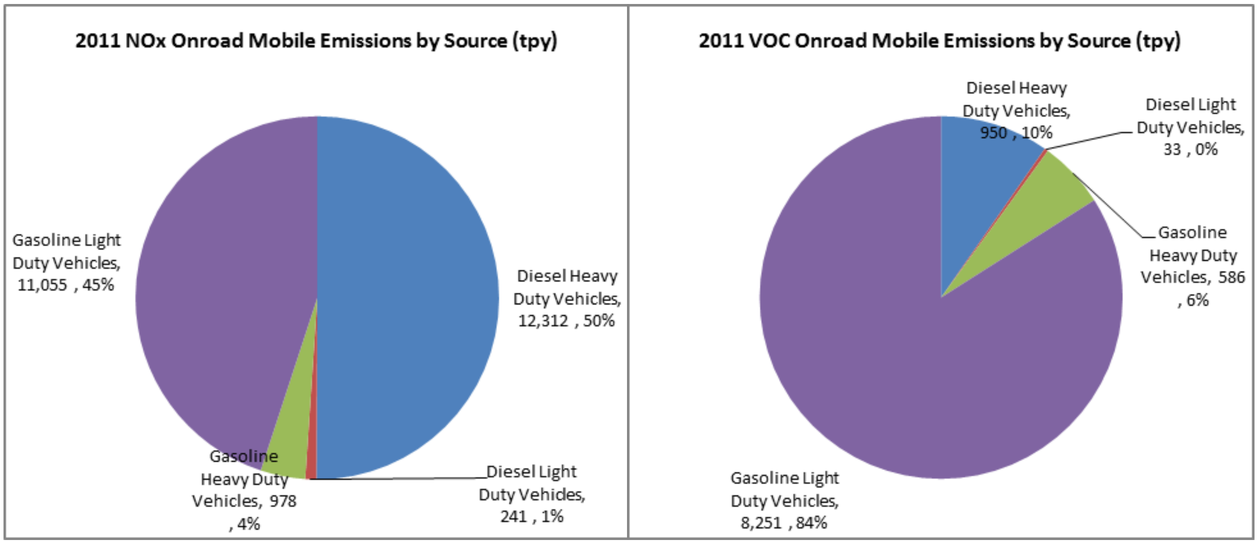


Figure 20. 2011 NOx and VOC Onroad Mobile Emissions by Source

In 2011, Spartanburg County had the highest NOx point emissions (1,879 tpy) again followed by Anderson and Cherokee counties with 1,411 tpy and 500 tpy, respectively. In 2011, Spartanburg, Greenville, and Anderson counties were the three highest emitters of VOC emissions with 1,831 tpy, 1,595 tpy, and 767 tpy, respectively. Figure 21 provides a summary of industries point NOx and VOC emissions by county for 2010 and 2011.

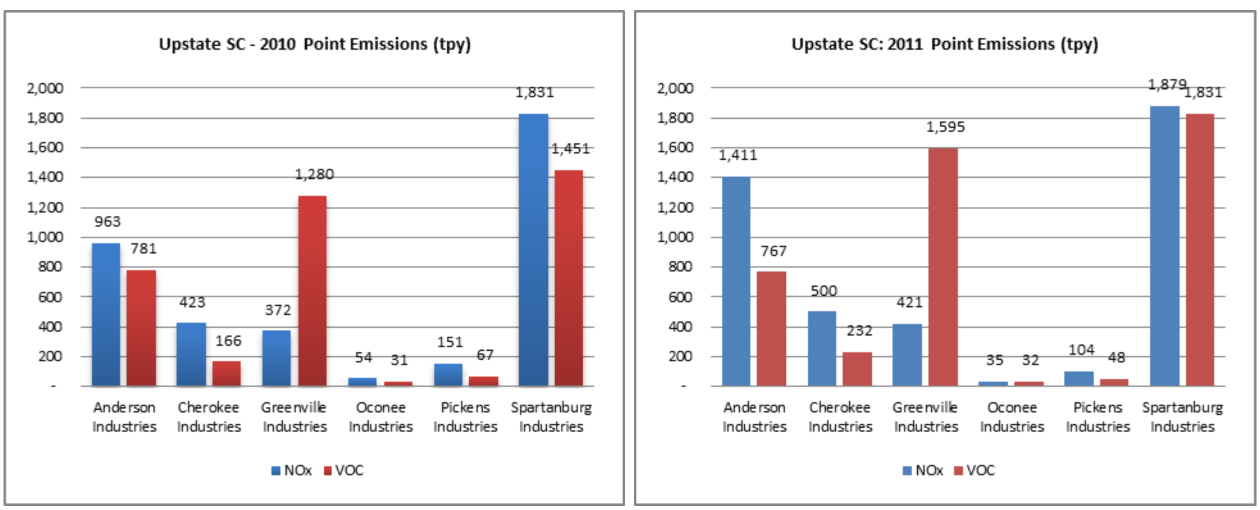


Figure 21. Upstate SC: 2010 and 2011 Point Emissions

Compared to the 2010 NOx point emissions, in 2011, Anderson County registered the highest increase with 448 tons followed by Cherokee County with 77 tons and Greenville County with 48 tons. Pickens and Oconee counties registered a decrease of NOx emissions by 47 tons and 19 tons, respectively. The net increase of point NOx emissions during 2011 for all six counties was 556 tons. In 2011, Spartanburg County registered the highest VOC point emissions increase with 380 tons followed by Greenville County with 315 tons and Cherokee County with 66 tons. Pickens and Anderson registered a decrease of VOC emissions of 19 tons and 14 tons, respectively. The net increase of VOC point emissions during 2011 for all six counties 729 tons. Figure 22 shows a summary of the 2010 and 2011 NOx and VOC point emissions by county.

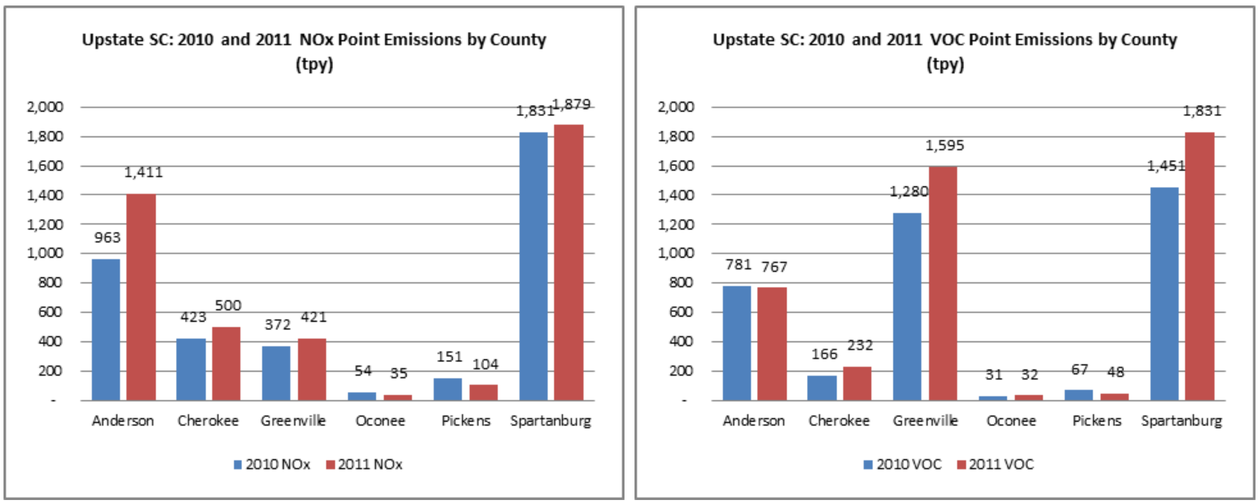


Figure 22. Upstate SC: 2010 and 2011 Point Emissions

More often than not, industries carry the stigma that they are the ones contributing the most to air pollution. This is not the case in the Upstate SC as it has been noted that, in 2010, onroad emissions were the highest contributors with 58% of the share of total NOx and nonpoint emissions were 47% of the total VOC emissions (see Figure 4). Additionally, in 2011, onroad mobile emissions totaled 64% of the share of total NOx and nonpoint share was 44% of total VOC emissions. In 2010, point emissions from industries in the Upstate accounted for only 11% of total NOx and 8% of total VOC emissions (see Figure 4). In 2011, point emissions from industries in the Upstate accounted for 11% of NOx and VOC emissions (see Figure 6). Lastly, Figure 5 and Figure 7 show that point emissions were 9% in 2010 and 11% in 2011 of total emissions.

Total NOx and VOC point emissions increased by approximately 557 tons and 743 tons, respectively, from 2010 to 2011. The highest point emissions increase was at the Duke Energy Lee Steam Station with a total increase of 425 tons (412 tons of NOx and 13 of VOC) followed by BMW Manufacturing with an increase of 316 tons (20 tons of NOx and 296 tons of VOC). Table 7 provides a list of point emissions sources in the Upstate in 2010 and 2011 and the increases (decreases) of point emissions by source. The Appendices section includes detail graphics of each county's point emissions and a summary of NOx and VOC point emissions separately.

Table 7. Upstate SC: Point Emissions (in tons)

Point Source	2010		2011		Increase (Decrease)	
	NOx	VOC	NOx	VOC	NOx	VOC
3M Film/Tape Plants	19	338	23	502	4	164
Anderson Regional			3	5	3	5
Anderson Regional Landfill	4	6	2	8	(3)	2
Auriga Polymers	201	109	226	152	25	43
BASF Corporation	54	31	33	29	(20)	(2)
BMW Manufacturing	63	217	83	514	20	296
Bob Jones University	79	17	27	5	(51)	(12)
Broad River Energy	122	7	162	9	40	2
Caraustar Mill Group Carotel Paperboard	49	1	46	1	(3)	0
Celanese Emulsions	13	137	13	93	0	(45)
CGTC Grover Compressor Station	16	0	17	0	1	0
Cherokee Co. Cogeneration	16	0	55	4	39	4
Clemson University	84	1	40	1	(43)	1
Core Molding Tech	2	5	0	6	(2)	1
Cryovac Sealed Air	15	328	29	304	14	(25)
Cytec Carbon Fibers Pictch Based/Acrylonitrile	79	40	85	89	6	49
Donaldson Center			2	4	2	4
Donnelley RR & Sons	9	154	7	172	(2)	18
Duke Energy Lee Steam	550	6	962	19	412	13
Duke Energy Mill Creek	29	1	27	2	(2)	1
Exopack	6	154	2	91	(3)	(63)
Fibertech Columns	0	14				
Flexi Wall Systems	0	6	0	5	0	(1)
Flint Group North America	-	2	0	2	0	0
GE Gas Turbines	16	12	62	15	46	3
Greenville Downtown			4	6	4	6
Greenville Gas Producers	8	6	21	17	13	11
Greenville-Spartanburg			142	34	142	34
Hanson Brick Blacksburg Plant	0	0.05	0	0.08	0	0.02
Hayne			25	2	25	2
Henkel Corp.	1	2	4	2	3	0
Hydro Aluminum NA	3	19	3	11	0	(8)
Johns Manville	1	10	1	9	0	(1)
Kapstone Kraft Papel Corporation			13	17	13	17
Kohler (all plants)	22	95	20	37	(3)	(59)
Lockheed Martin Aeronautics Company	6	14	11	16	5	2
Magellan Terminals I and II	3	46	4	53	1	7
Medline Industries	1	19	1	48	0	30
Michelin (all plants)	76	1,090	84	1,351	8	261
Milliken (all plants)	306	144	319	205	(15)	(14)
Mitsubishi Polyester Film	28	76	29	49	1	(26)
Nutra Manufacturing	5	20	7	49	1	29
Oconee County Regional			1	3	1	3
One World Technologies	1	17				
Owens Corning	187	71	46	112	(141)	41
OWT Industries			1	2	1	2
Palmetto Landfill & Recycling	13	28	5	19	(8)	(9)
Pickens County			1	2	1	2
Pickens County Solid Waste	10	15	11	13	1	(1)
Plastic Omnium Auto Exterior	5	193	3	42	(2)	(151)

Point Source	2010		2011		Increase (Decrease)	
	NOx	VOC	NOx	VOC	NOx	VOC
Reynolds Chemical	2	38	2	30	0	(8)
Sage Automotive Interiors	29	5	8	9	(21)	3
Santee Cooper (Rainey)	120	26	299	31	187	21
Santee Cooper Anderson County Landfill			5	9	(4)	(6)
Shaw Industries Group	56	29	51	24	(5)	(5)
Spartanburg Downtown			3	6	3	6
Tegrant Alloyd Brands	0	10	0	8	0	(2)
Transcontinental Gas Pipeline	1,469	89	1,313	100	(156)	11
Trelleborg Coated Systems	5	23	1	13	(3)	(10)
Twin Chimneys Landfill	2	9	1	33	(1)	25
US Corrugated	7	83				
Wellford Landfill	1	14	3	11	2	(2)
Wilson Composites LLC			0.06	1.17	0.06	1.17
Totals	3,793	3,762	4,350	4,505	557	743

CONCLUSION

In 2010, the numbers indicated that total VOC emissions were higher than NOx emissions making the Upstate SC a NOx limited area (Figure 3). Onroad emissions from highway gasoline vehicles were the highest contributor of total emissions, followed by nonpoint (solvent use), nonroad (off-highway diesel vehicles), and point (Figure 5). The two highest contributors to NOx emissions included onroad (highway gasoline vehicles) and nonroad (off-highway diesel vehicles). Point and nonpoint emissions followed with the Transcontinental Pipeline and fuel combustion from industries as the top NOx emissions producers, respectively. The two highest contributors of VOC emissions included nonpoint (solvent use) and onroad (highway gasoline vehicles) followed by nonroad (off-highway gasoline vehicles) and point emissions (Michelin-all plants).

In 2011, the share of total emissions for NOx was 49% and for VOC, 51% (see Figure 3). Onroad mobile (64%) sources had the largest share of NOx emissions followed by nonroad (17%), point (11%), nonpoint (8%), and events (0.4%). Nonpoint (44%) was the highest source of VOC emissions followed by onroad mobile (25%), nonroad (16%), point (11%), and events (4%).

Total NOx emissions for the six counties increased 3,907 tons from 2010 to 2011. Greenville County had the highest NOx emissions increase followed by Anderson and Spartanburg counties. Total VOC emissions decreased 8,731 tons. Greenville County had the highest decrease with 3,148 tons followed by Spartanburg and Anderson counties. It is safe to assume and conclude that this increase in NOx and decrease in VOC emissions caused the total NOx and VOC emissions to be 49% and 51% in 2011 as shown in Figure 3.

Without disregarding what industries can do to reduce point emissions, as collectively everything helps to improve air quality, the Upstate SC has the big task of keeping the region in attainment with respect to ground level ozone, especially now in light that EPA announced that the new standard will fall within the 0.065 and 0.070 ppm range and the potential that climate change would have on ozone concentration during summer times if offsetting emissions reductions are note made. It is obvious that NOx emissions from onroad mobile sources are on the raise since in the Upstate SC, in 2011, these emissions increased to a share of 64% of NOx up from a 58% in 2010. Therefore, the need still exists to lower NOx emissions from onroad mobile sources.

Collaborative efforts such as the Upstate SC Air Quality Improvement Committee's discussions and a comprehensive and extensive multimedia public education campaign have increased awareness of air quality issues and improvement efforts. In the Upstate South Carolina, these efforts concentrated on ways to reduce emissions from mobile sources through a no idling campaign. Such campaign should continue educating Upstate SC residents with a consistent message on how their individual behavior affects—positively or negatively—the air we breathe. Other means to reduce onroad mobile sources emissions may be implemented such as synchronizing or adapting traffic lights with traffic flow; allowing right turns on red lights; using public transportation; avoiding running errands during rush hours; trip chaining errands; carpooling to school, work, and entertainment; maintaining vehicles in good conditions; and avoiding driving with underinflated tires. Car dealers may be asked to provide no-idling information to educate individuals purchasing vehicles. Lastly, schools are encouraged to participate in the Breathe Better program may contact Ms. Debra Briggs-Monroe via email at briggsmd@dhec.sc.gov or at (803) 898-3752.

APPENDICES

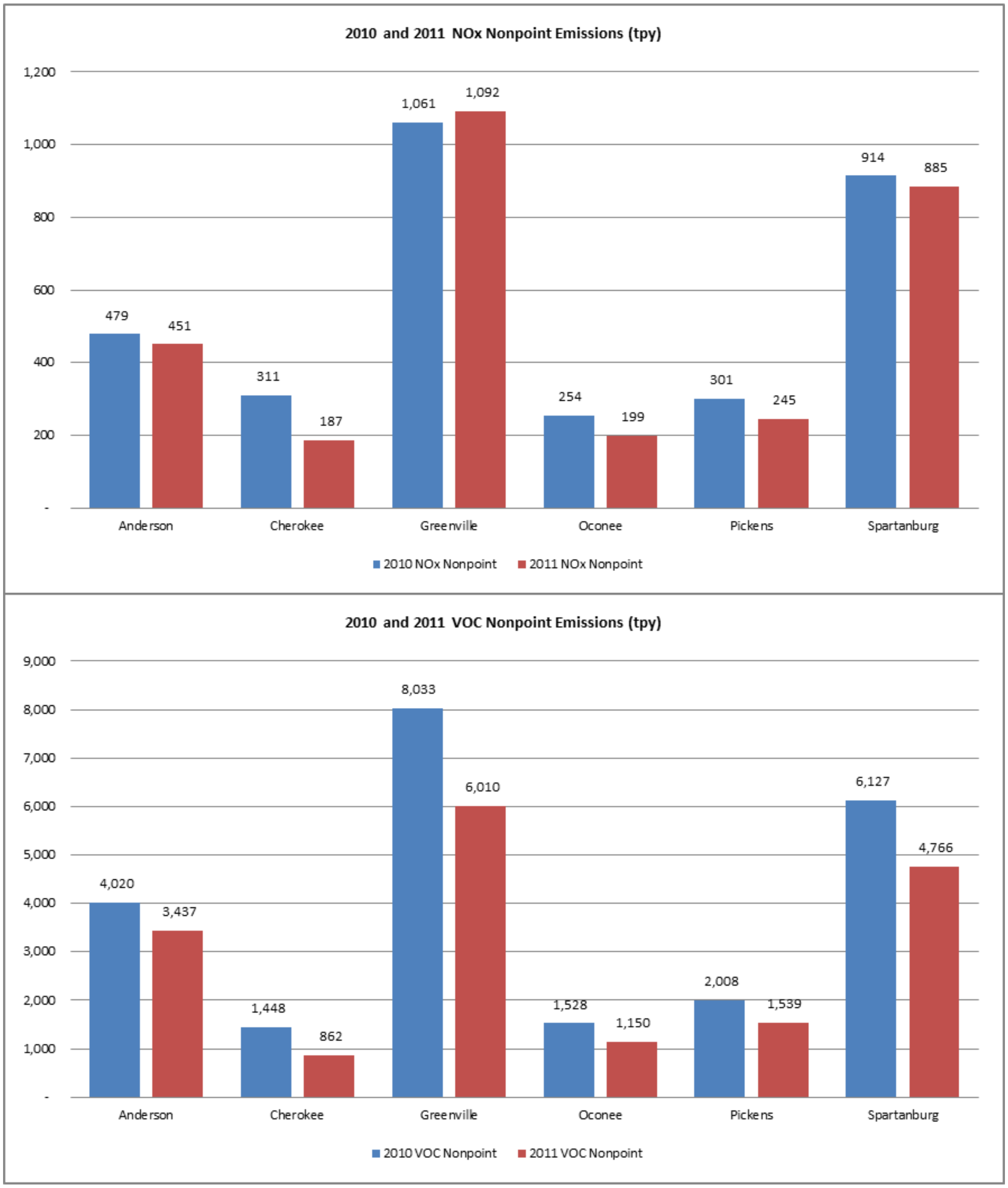


Figure 23. 2010 and 2011 NOx and VOC Nonpoint Emissions by County (tpy)

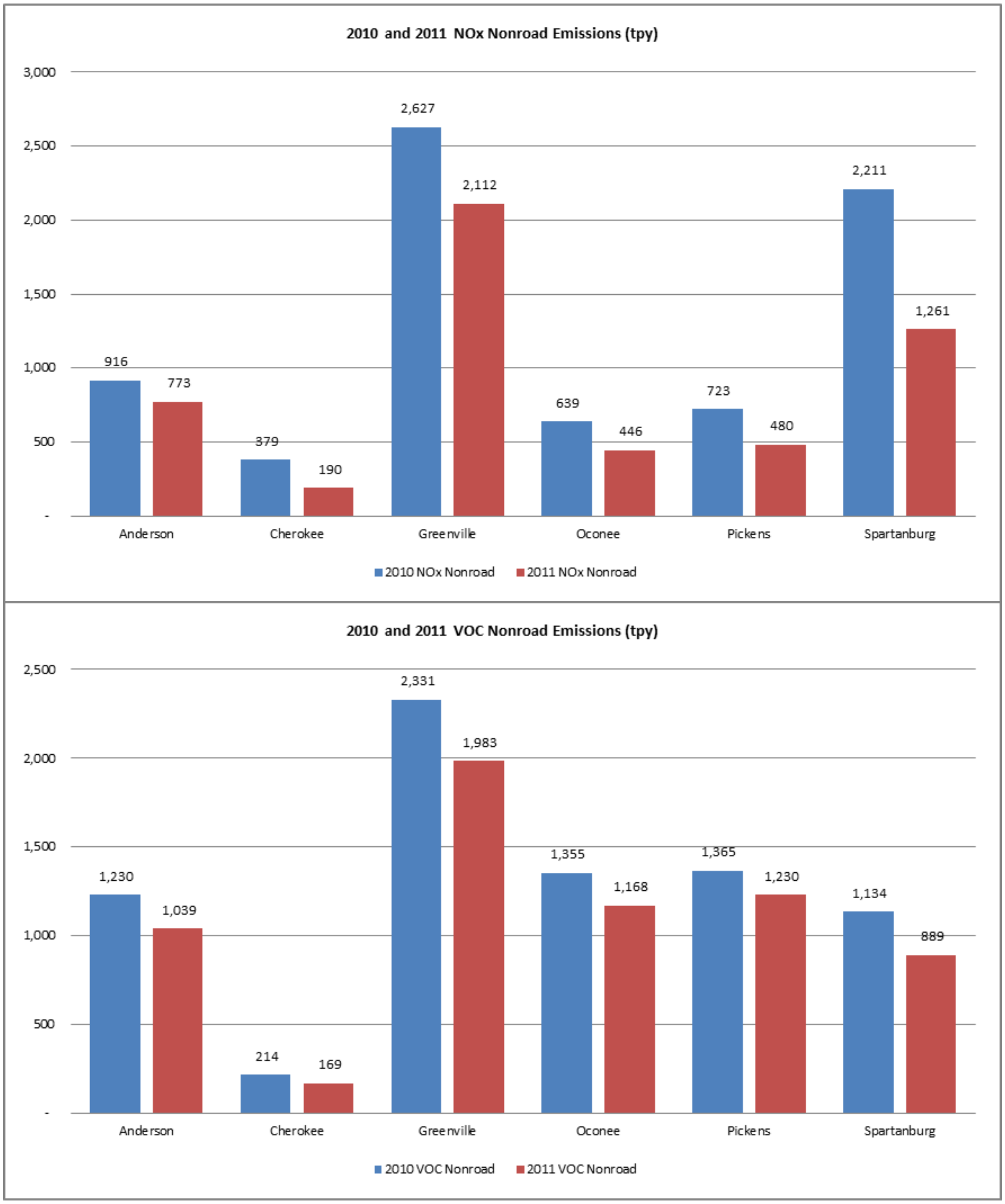


Figure 24. 2010 and 2011 NOx and VOC Nonroad Emissions (tpy)

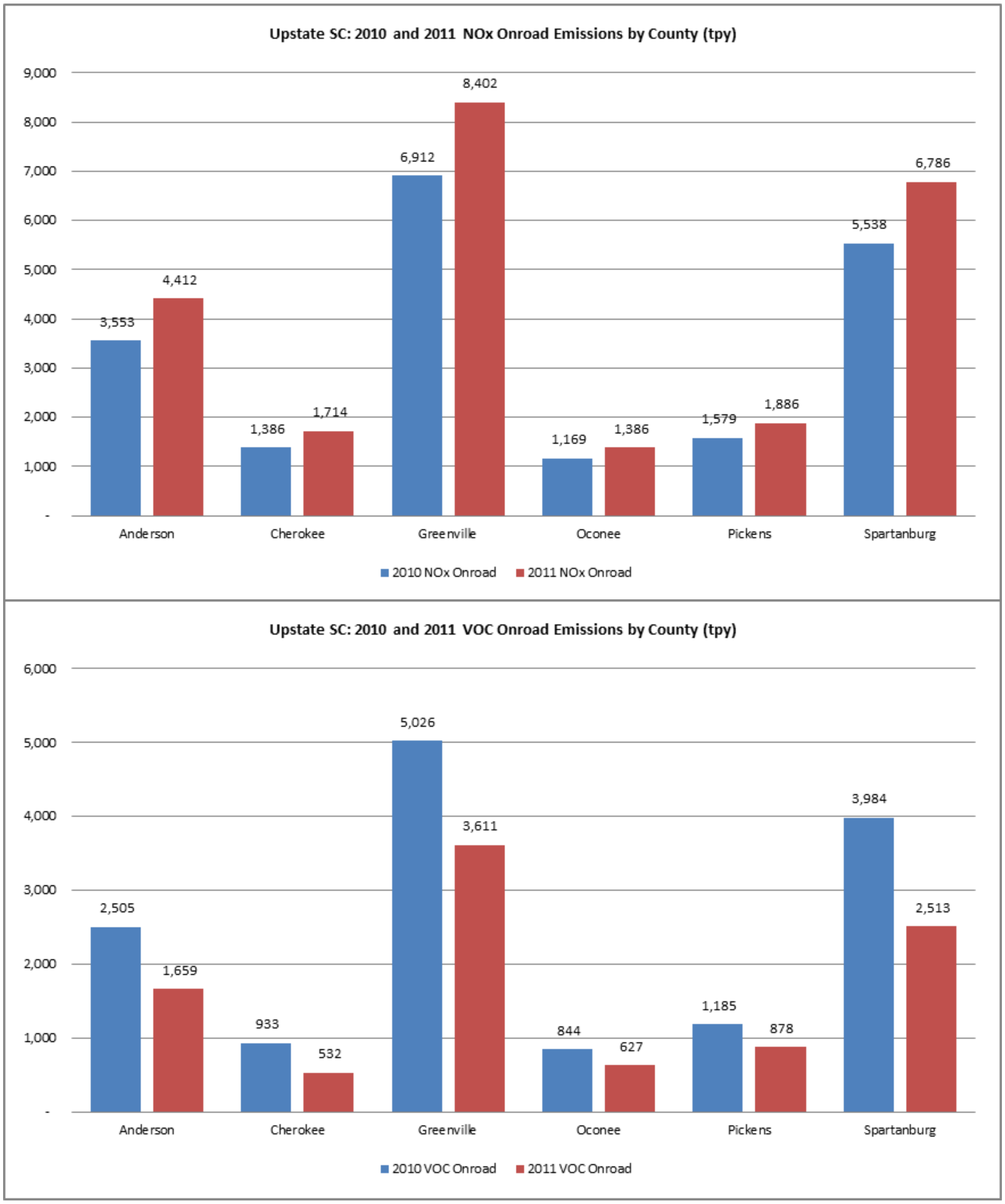
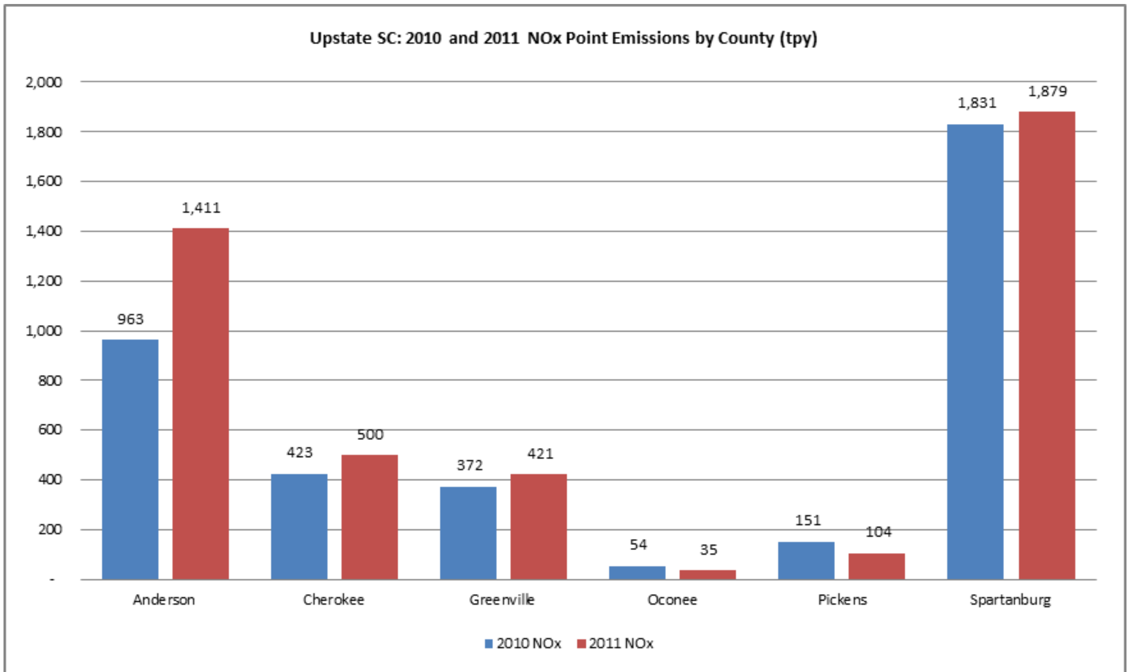


Figure 25. 2010 and 2011 NOx and VOC Onroad Emissions (tpy)



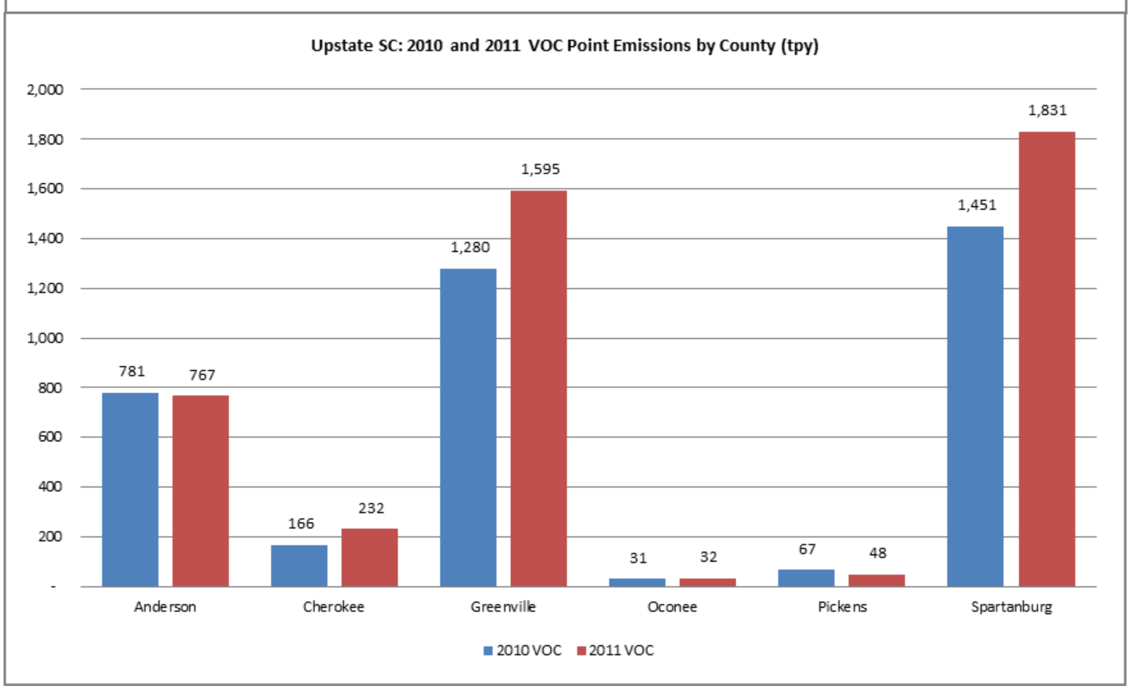


Figure 26. 2010 and 2011 NOx and VOC Point Emissions (tpy)

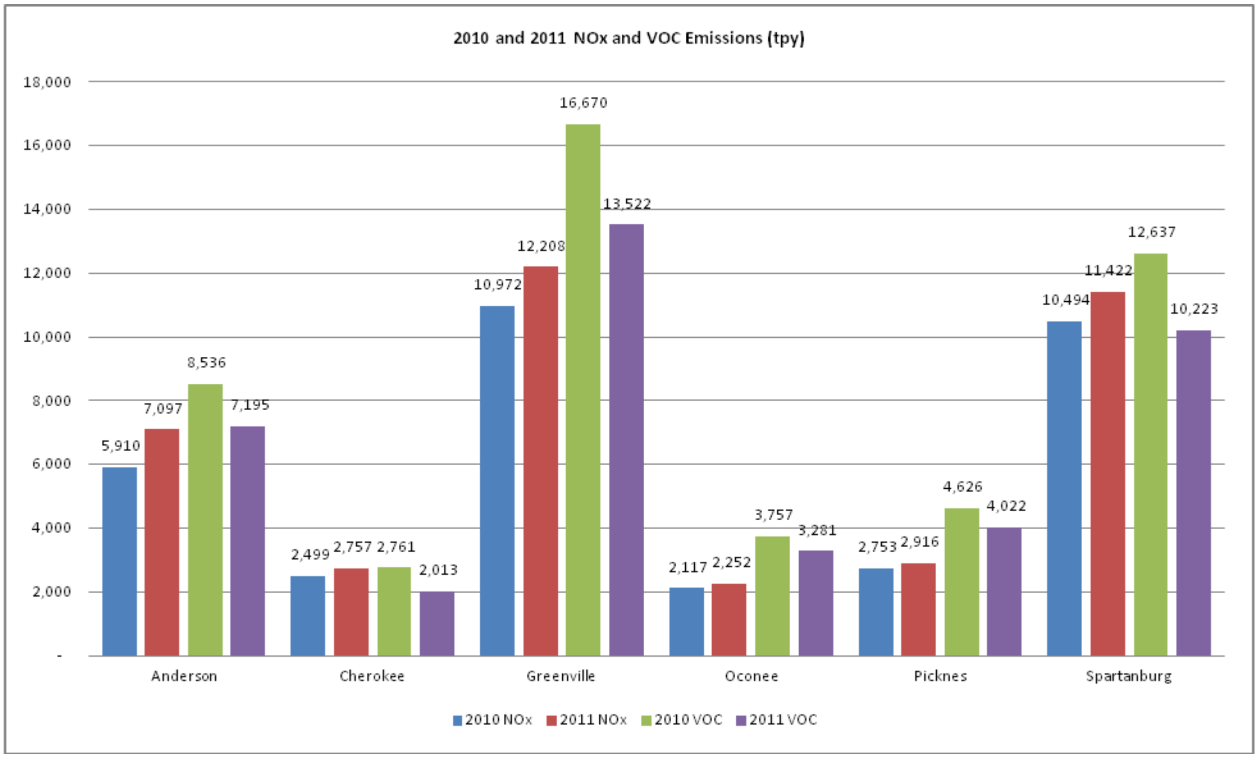


Figure 27. 2010 and 2011 NOx and VOC Emissions (tpy)

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COUNTY ADMINISTRATOR OFFICE
COUNTY OF GREENVILLE, SOUTH CAROLINA

DECEMBER 2014