State of Air Quality and Emissions Inventory

By
Sandra E. Yúdice, Ph.D.
Assistant to the County Administrator
County Administrator's Office
Revised August 2016

Contents

List of Figures

List of Tables

Office of the County Administrator

Joseph M. Kernell
County Administrator

(8640 467-7105
www.greenvillecounty.org

August 31, 2016

Dear Greenville County Residents:

Greenville County Council has established seven long term goals and governing priorities, which include: public safety, infrastructure, fiscal condition, public transit, economic development, comprehensive planning, and employment diversity. Four of these priorities are related directly to our collaborative efforts of improving air quality in the Upstate South Carolina: infrastructure, public transit, economic development, and comprehensive planning. By improving the county-maintained road network infrastructure in a state of good repair, we are reducing congestion, hence, reducing emissions and improving air quality and public health. Through our continued funding of public transit (Greenlink) and expanding and maintaining the GHS Swamp Rabbit Trail, we are supporting alternative modes of transportation, hence, reducing congestion and emissions, improving air quality and public health. By participating in collaborative efforts to continue improving air quality, we are increasing economic development, hence, improving economic opportunities and the quality of life of our residents. We are using the five priority principles for growth, which include protect air quality, that citizens identified and are included in the comprehensive plan that County Council adopted on December 1, 2009, through ordinance No. 4333. Greenville County Council is also committed to improving public health through our clean air 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 behavioral changes or habits that improve or impair the air we breathe. Our collaborative efforts with other Upstate South Carolina organizations continue and are reflected with our area attainment designation from the U.S. Environmental Protection Agency (EPA) with respect to the current ground level ozone and particulate matter 2.5 ($PM_{2.5}$) standards.

In October 2015, EPA announced that it strengthened the National Ambient Air Quality Standard (NAAQS) for ground level ozone from 75 ppb to 70 ppb. Based on current design values, it is expected that Greenville County and the Upstate SC will continue to be in attainment with respect to this criteria pollutant. It is also expected that the South Carolina Department of Health and Environmental Control (DHEC) designation recommendations to EPA (due in October 2016) will be based on the 2013-2015 design values. EPA's final decision on attainment/non-attainment designations is due October 1, 2017, and will likely be based on the 2014-2016 values. Therefore, we still need to be vigilant of our collective efforts and behaviors affecting the air we breathe.

This report provides the State of Air Quality and Emissions Inventory in Greenville County. I encourage you to read it and pledge to commit yourself to improve our air quality. If you, your school, or business is interested in participating in the Breathe Better programs please do not hesitate to contact my assistant, Sandra Yúdice, Ph.D. at syudice@greenvillecounty.org, (864) 467-7409 or DHEC's Breathe Better Coordinator Megan Johnson at johnsoM4@dhec.sc.gov, (803) 898-3752.

Sincerely,

Joseph M. Kernell
County Administrator

State of Air Quality

Greenville County, South Carolina

Background: The Early Action Compact

With the execution of the Early Action Compact (EAC) between the U.S. Environmental Protection Agency, the South Carolina Department of Health and Environmental Control, and Anderson, Greenville, and Spartanburg county councils in December 2002, the three Upstate SC counties set in motion a series of activities towards improving air quality. The goal was to meet the 1997 8-hour ground level ozone standard (0.084 parts per million (ppm)) established by the EPA, as prescribed under the Clean Air Act, earlier than required providing certain milestones were met. By signing the EAC, the counties viewed their participation in the process as a proactive means of meeting the standard by December 31, 2007, ahead of the federally-mandated compliance date. Meeting the standard using this proactive approach helped with avoiding burdensome and costly compliance with federal requirements that normally apply to non-attainment areas (County of Greenville, South Carolina, 2002). The efforts paid off when the EPA designated the Upstate SC as an attainment area in early 2008 with respect to the 1997 ozone standard. EPA revoked the 1997 ozone standard effective April 6, 2015 (U.S. Environmental Protection Agency, 2015). Figure 1 shows the areas in Region 4 that participated in the EAC

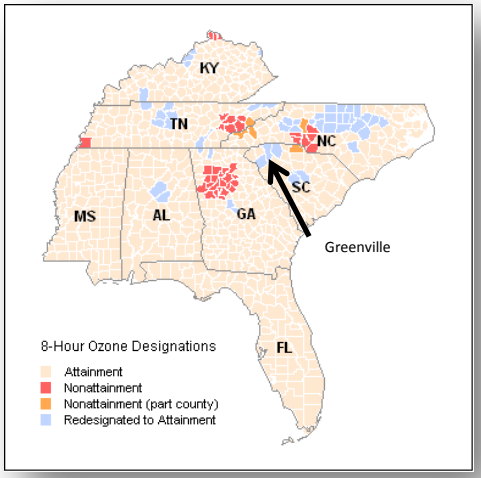

FIGURE 1. REGION 4: STATE DESIGNATIONS FOR THE 1997 8-HOUR OZONE STANDARD

Source: USEPA

Executive Summary

In December 2002, the counties Anderson, Greenville, and Spartanburg set in motion a series of activities and strategies toward improving air quality upon signing the Early Action Compact with the U.S. Environmental Protection Agency and the South Carolina Department of Health and Environmental Control. The goal was to meet the 1997 8-hour ground level ozone standard (0.084 parts per million) established by the EPA. Proactively participating in the EAC gave an opportunity to the counties to meet the standard ahead of the federally-mandated compliance date of December 31, 2007.

In early 2008, the EPA designated the Upstate SC as an attainment area with respect to the 1997 ground level ozone standard. In December 2012, EPA strengthened the annual health $PM_{2.5}$ standard to 12 $\mu g/m^3$ and retained the 24-hour fine particle standard of 35 $\mu g/m^3$. EPA has indicated that most of the country already meets the annual $PM_{2.5}$ standard of 12 $\mu g/m^3$. EPA also projects that 99% of U.S. counties with monitors would meet the annual fine particle health standard in 2020.

In 2012, EPA issued designations for the 2008 ground level ozone standard. With the exception of the Rock Hill (SC)/Charlotte (NC) area, EPA designated the remaining of South Carolina as an "unclassifiable/attainment" area. As of August 2016, the Upstate SC region enjoys an "attainment/unclassifiable" designation for both ground level Ozone and $PM_{2.5}$.

On October 1, 2015, EPA announced that it strengthened the air quality standard for ground level ozone from 75 ppb to 70 ppb. Based on current design values, it is expected that Greenville County and the Upstate SC will continue to be in attainment with respect to this criteria pollutant. It is also expected that SCDHEC recommendations to the EPA (due in October 2016) on ozone designations will be based on the 2013-2015 design values. EPA's final decision on designations is due October 1, 2017, and will likely be based on the 2014-2016 design values.

Air quality improved in Greenville County while there has been an increase in capital investment and jobs creation between 2008 and 2011. The net change in total NOx and VOC emissions represented a decrease of 1,075 tons in the county, with NOx emission accounting for 830 tons of that decrease. Since the Upstate South Carolina is a NOx-limited area and, in order, to meet future and tighter ground level ozone NAAQS, more needs to be done to decrease NOx emissions, especially in the transportation field.

process and were designated as attainment areas with respect to the 1997 ground level ozone standard.

How is Ground Level Ozone Formed?

Ground level ozone is not a pollutant that occurs naturally. 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), see Figure 2. 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.).

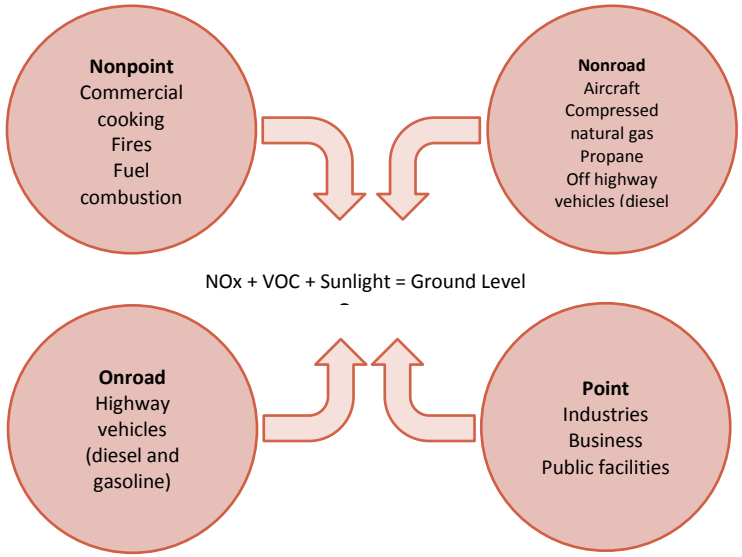

FIGURE 2. SOURCES OF NOX AND VOC EMISSIONS

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).

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, "conditions in rural areas tend to be NOx-limited" (U.S. Congress, Office of Technology Assessment, 1989, p. 98). Table 1 summarizes ozone, NOx, and VOC

relationships.

TABLE 1. 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 DHEC, South Carolina is a NOx-limited area (South Carolina Department of Health and Environmental Control, 2014). Therefore, changes in VOC emissions would cause little change or no effect on ground level ozone formation and changes (increase/decrease) in NOx emissions would cause changes (increase/decrease) in the formation of ozone at ground level. Thus, reducing NOx emissions "is a much more effective strategy for lowering monitored ozone levels in South Carolina than reducing VOCs since most of the VOCs in our state are from biogenic sources" (South Carolina Department of Health and Environmental Control, 2014, p. 5), see Figure 3.

As noted in the *Greenville County Emissions Inventory* section of this report, NOx emissions decreased with a net change in NOx emissions of 830 tons between 2008 and 2011. The net change includes the combined increase and decrease in emissions by source category or county. The federal government has proposed and/or issued rules that will help reduce ozone pollution. Such rules include requirements to reduce interstate transport of ozone, Tier 3 emission control requirements for vehicles and motor fuels, emission standards for combustion engines, retrofit technologies, and boilers, and clean power (U. S. Environmental Protection Agency, 2014). In addition to local efforts, such as the Spare the Air public awareness campaign and the anti-idling program, it is expected that implementing such rules will also help Greenville County to further reduce NOx emissions from mobile sources.

Implementation of air quality strategies to meet future and tighter standards requires the collaboration of federal, state, and local governments. At the local level, it also requires the collaboration of the community, businesses, industries, and individuals to develop and implement local strategies to improve air quality to meet future and tougher standards, improve health outcomes, and increase economic development opportunities.

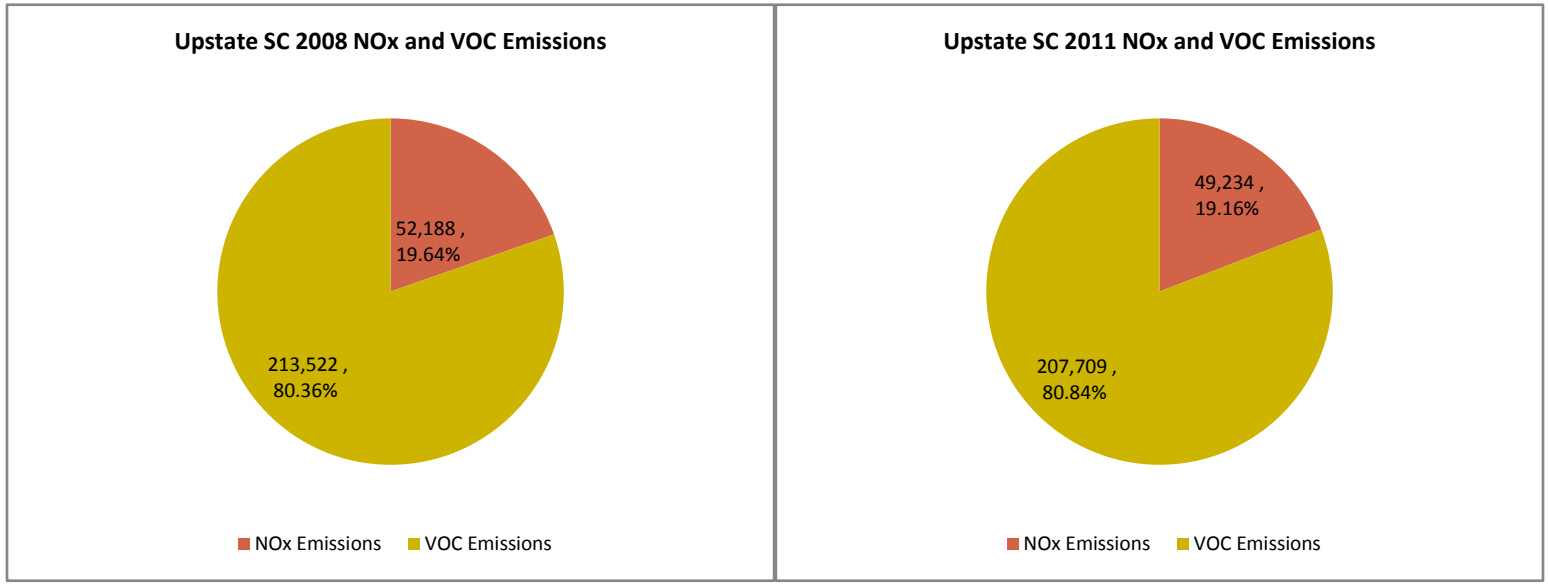

FIGURE 3. UPSTATE SOUTH CAROLINA: 2008 AND 2011 TOTAL NOX AND VOC EMISSIONS (TONS)

Source: EPA, National Emissions Inventory

Designations: Ground Level Ozone and Fine Particle (PM2.5)

According to EPA, an "attainment" designation means that an area is meeting air quality standards. The "attainment/unclassifiable" designation means "meeting the standard or expected to be meeting the standard despite a lack of monitoring data" (U. S. Environmental Protection Agency, 2012a; U. S. Environmental Protection Agency, 2012b). A "nonattainment" designation means that the area is not meeting air quality standards.

Ground Level Ozone

On January 31, 2008, EPA announced plans to designate 13 areas (the Appalachian Compact Area of Greenville-Spartanburg-Anderson included) in attainment with 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" (U. S. Environmental Protection Agency, 2008) through the EAC process. The 8-hour ozone design value for the Appalachian compact area was 0.083 ppm. The 1997 ground level ozone standard was 0.08 ppm.[1] Upon meeting the standard, the effective date for the attainment designation was April 15, 2008.

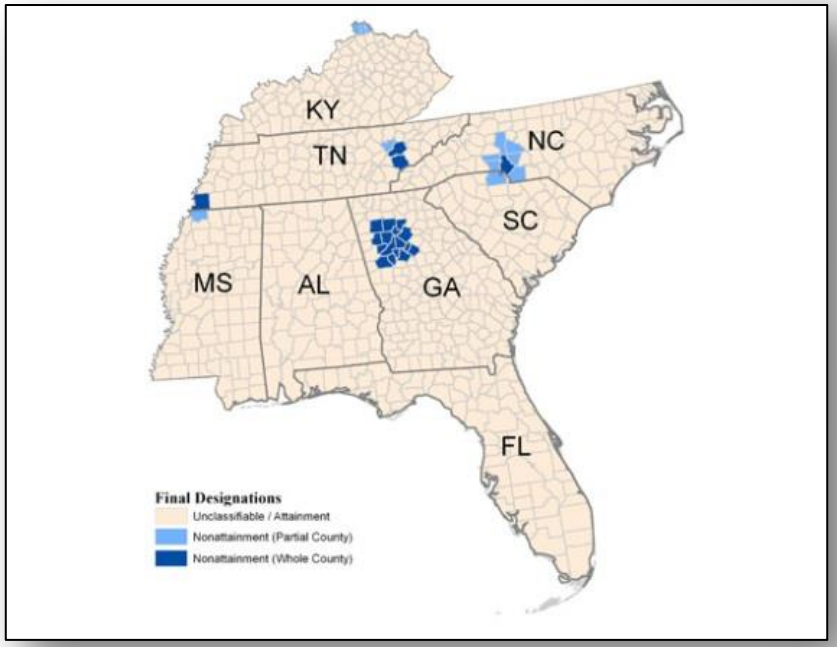

FIGURE 4. 2008 GROUND-LEVEL OZONE — REGION 4 FINAL DESIGNATIONS, APRIL 2012

Source: USEPA, https://archive.epa.gov/ozonedesignations/web/html/region4f.html

(Note: EPA will finalize official designations with respect to the 2015 ozone standard on October 1, 2017)

In 2012, EPA issued designations for the 2008 ground level ozone standard (see Figure 4). With the exception of the Rock Hill (portion of York County), SC/Charlotte, NC, area, EPA designated the remaining of South Carolina as an "unclassifiable/attainment" area (U. S. Environmental Protection Agency, 2012c). In April 2015, SCDHEC requested EPA to re-designate the Rock Hill (York County portion) area as an attainment area. EPA approved the request in October 2015. To view the interactive Ozone Designations Mapping Tool click here.[2]

On October 1, 2015, EPA announced that it had strengthened the ground level ozone standard from 75 ppb (or 0.075 ppm) to 70 ppb (or 0.070 ppm). If design values hold or improve, it is expected that Greenville County and the Upstate SC would be in attainment with respect to the 2015 ozone standard. It is expected that EPA will finalize designations for the 2015 ozone standard in October 2017 and will likely use the 2014-2016 design values.

[1] Note: "Until 2008, the standard was expressed in parts per million with two decimal places (e.g., 0.08 ppm from 1997 to 2008). Without a third decimal place, concentrations as high as 0.084 ppm (or 84 ppb) could be rounded to 0.08 and considered to be in attainment of the standard" (McCarthy & Lattanzio, 2016, p. 1)

[2] Source: https://epa.maps.arcgis.com/apps/webappviewer/index.html?id=6a89e7170dd147b1852ec11ccb3880e8

Fine Particle or Particle Matter 2.5

In October 2009, EPA issued final designations for the 2006 24-hour fine particle ($PM_{2.5}$) standard. The entire State of South Carolina was classified as "unclassifiable/ attainment" (U. S. Environmental Protection Agency, 2012d). To view the areas designated under the 2006 $PM_{2.5}$ standard click here.[3]

In December 2012, EPA strengthened the annual health $PM_{2.5}$ standard to 12 µg/m^3 and retained the 24-hour fine particle standard of 35 µg/m^3. EPA has indicated that most of the country already meets the annual $PM_{2.5}$ standard of 12 µg/m^3. EPA also projects that 99% of U.S. counties with monitors would meet the annual fine particle health standard in 2020.

Figure 5 shows EPA's designations for the 2012 $PM_{2.5}$ standard. The map shows that South Carolina is not in violation of the 2012 particle matter standard.

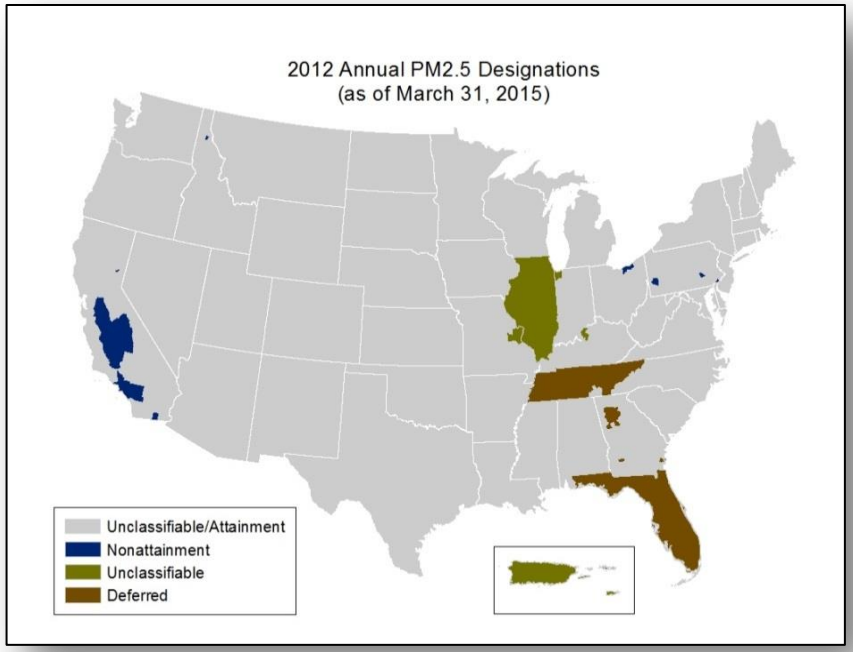

FIGURE 5. 2012 $PM_{2.5}$ DESIGNATIONS

Source: http://www.epa.gov/pmdesignations/2006standards/final/region4.htm and http://www.epa.gov/airquality/greenbook/mapnpoll.html

Air Quality Monitoring Network

An ambient air quality monitoring network is a system of monitoring stations that measure and determine how much outdoor air pollution is found at ground level where people breathe (Woods & Potoski, 2010). In South Carolina, DHEC, through its Bureau of Air Quality, is the state agency in charge of implementing, managing, and operating the ambient air quality monitoring network.

During 2007-2008, Greenville and Spartanburg counties, businesses, and industries stakeholders collaborated with DHEC, Bureau of Air Quality, representatives to identify sites within Greenville County to relocate the Downtown Greenville particle matter monitor from the Greenville County Health Department site on University Ridge and to establish two new ground level ozone monitoring stations.

[3] Source: www.epa.gov/pmdesignations/2006standards/state.htm

DHEC relocated the $PM_{2.5}$ monitor from the Greenville County Health Department to the Employment Security Commission (ESC) site on Pendleton Street on April 11, 2008. DHEC also established two new ozone monitors, one at Famoda Farms in the northern part of the county on August 7, 2008, and a second one at Hillcrest Middle School in southern Greenville County on February 17, 2009. DHEC also established a new monitor in Spartanburg (T.K. Gregg) on December 29, 2008. Each monitor needed three years' worth of data in order for DHEC to use and report the monitoring air quality information.

Table 2 includes the 2017 proposed ground level ozone and $PM_{2.5}$ monitoring network in Upstate SC. Monitors are located in Oconee County, the Greenville-Anderson-Mauldin MSA, and the Spartanburg MSA (South Carolina Department of Health and Environmental Control, 2016).

TABLE 2. PROPOSED MONITORS LOCATED IN UPSTATE SC IN 2017

Site ID	Location	County	Date Established	Ozone	$PM_{2.5}$
45-007-0005	Big Creek	Anderson	June 6, 2008	Yes	--
45-045-0015	Greenville ESC	Greenville	April 11, 2008	--	Yes
45-045-0016	Hillcrest Middle School	Greenville	February 17, 2009	Yes	Yes
45-073-0001	Long Creek	Oconee	August 1, 1983	Yes	Yes
45-077-0003	Wolf Creek	Pickens	August 10, 2010	Yes	--
45-083-0009	North Spartanburg Fire Station #2	Spartanburg	April 4, 1990	Yes	--
45-083-0011	T.K. Gregg	Spartanburg	December 29, 2008	--	Yes

Source: DHEC, http://www.scdhec.gov/HomeAndEnvironment/Docs/Final_2017%20Monitoring%20Plan%2020160728.pdf

On February 8, 2016, DHEC requested EPA authorization to terminate the Famoda Farm monitoring site in northern Greenville County with the justification that "loss of data due to the Famoda Farm Site will not compromise characterization of ozone in the Upstate of South Carolina. There will remain adequate coverage with the remaining network. Since data collection was reestablished in 2008 as part of the Greenville MSA Ozone Study, the Famoda Farm site has had the lowest design value in the area and has not had a design value above the current level of the ozone standard" (South Carolina Department of Health and Environmental Control, 2016, p. 14). To see DHEC's GIS-based application of the South Carolina Air Monitoring Network click here.[4]

[4] Source: gisweb01.dhec.sc.gov/monitoring/monitoring.html

Revisions to the National Ambient Air Quality Standards

Ground Level Ozone

As required by the Clean Air Act, EPA will "review and, if necessary, revise air quality standards every five years to ensure that they protect public health with an adequate margin of safety" (U. S. Environmetal Protection Agency, 2012f). EPA has revised the 1997 and the 2008 ozone standards. Table 3 provides a summary of the 8-hour ozone standard revisions.

TABLE 3. HISTORICAL GROUND LEVEL 8-HOUR OZONE NAAQS REVISIONS

Final Rule/Decision	Primary/Secondary Standard	Standard	Form
1997: 62 FR 38856 (July 18, 1997)	Primary and Secondary	0.08 ppm	Annual fourth-highest daily maximum 8-hr concentration, average over 3 years
2008: 73 FR 16483 (March 27, 2008)	Primary and Secondary	0.075 ppm (75 ppb)	Annual fourth-highest daily maximum 8-hr concentration, average over 3 years
2015: 80 FR 65292 (October 26, 2015)	Primary and Secondary	0.070 ppm (70 ppb)	Annual fourth-highest daily maximum 8-hr concentration, average over 3 years

Source: EPA: https://www.epa.gov/ozone-pollution/table-historical-ozone-national-ambient-air-quality-standards-naaqs

On March 12, 2008, the EPA administrator announced that the agency had strengthened the 1997 8-hour ozone standard from 0.08 ppm to 0.075 ppm for both the primary and secondary standards. Under these new standards, states were required to make attainment, nonattainment, or unclassifiable area recommendations to EPA by March 2009. In turn, EPA would have made final designations in March 2010. On January 6, 2010, EPA announced a proposal, *Reconsideration of the National Ambient Air Quality Standard for Ozone*, to further strengthen the 8-hour ozone standard below the 0.075 ppm level previously established in 2008. EPA continued preparing the reconsideration process until President Barak Obama, citing the slow recovery of the economy, announced on September 2, 2011, that “after careful consideration, I have requested that Administrator Jackson withdraw the draft Ozone National Ambient Air Quality Standards at this time” (The White House, 2011).

On May 21, 2012, the EPA published the final rules for the Implementation of the 2008 National Ambient Air Quality Standards for ozone (click here[5] to read the final implementation rule). EPA also published the Air Quality Designations for the 2008 Ozone National

[5] Source: Federal Register, www.gpo.gov/fdsys/pkg/FR-2012-05-21/pdf/2012-11605.pdf

Ambient Air Quality Standards (click here[6] to read the final designations rule). This designation became effective July 20, 2012.

On October 1, 2015, EPA announced that it had strengthened the NAAQS for ground level ozone from 75 ppb to 70 ppb. Based on 2015 design values, it is expected that Greenville County and the Upstate SC will continue to be in attainment with respect to the 70 ppb ozone standard. Figure 6 shows that all counties in South Carolina are not at risk of exceeding the 2015 ozone standard. According to DHEC,

> Whether a geographical area is in "attainment," that is, meets the NAAQS, depends on its Design Value (DV) at the time of designation. Each day during the ozone season, the maximum daily 8-hour average ozone reading (MDA8) is computed. The 4th highest MDA8 averaged over the previous three years comprises the DV. The South Carolina Department of Health and Environmental Control (DHEC) expects that South Carolina's recommendations to the EPA on attainment will be based on the 2013-2015 DV. The EPA's final decision on the designation is due one year later (Oct. 1, 2017), and will likely be based on the 2014-2016 DV. (T. Flynn, personal communication, October 2, 2015)

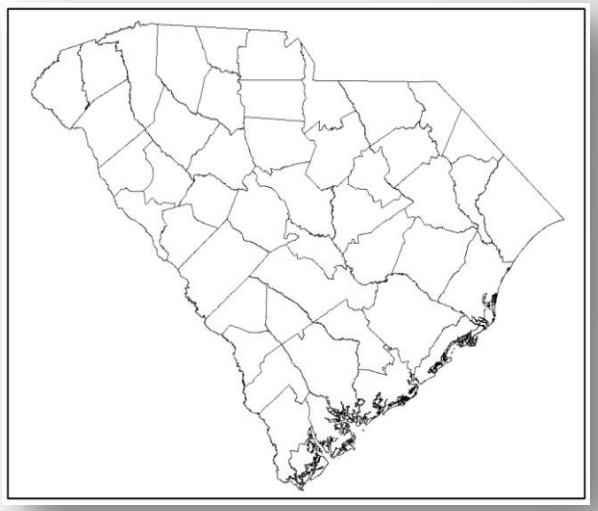

FIGURE 6. COUNTIES AT RISK OF GROUND LEVEL OZONE EXCEEDANCES (BASED ON 2015 DESIGN VALUES).

Note: No color = County is not at risk of exceeding ground level ozone.

Source: DHEC, Bureau of Air Quality

EPA 2025 Ground Level Ozone Projections

In its Regulatory Impact Analysis of the Proposed Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone[7] report, EPA modeled counties projected to exceed the proposed alternatives for the revised ozone standard (i.e., 70, 65, and 60 ppb). For a 2025 baseline scenario, EPA anticipated that "9 counties are projected to exceed 70 ppb standard, 59 additional counties are projected to be below 70 but exceed 65 ppb, and 173 additional counties are projected to be below 65 but exceed 60 ppb." (U.S. Environmental Protection Agency, 2014, pp. ES-7). Based on this model, none of South Carolina's counties were projected to exceed the alternative standards that EPA proposed with the emissions reductions applied to the model (see Figure 7).

[6] Source: Federal Register, National Archives and Records Administration: https://www.gpo.gov/fdsys/pkg/FR-2012-05-21/pdf/2012-11618.pdf

[7] Source: EPA: https://www3.epa.gov/ttn/ecas/regdata/RIAs/20141125ria.pdf

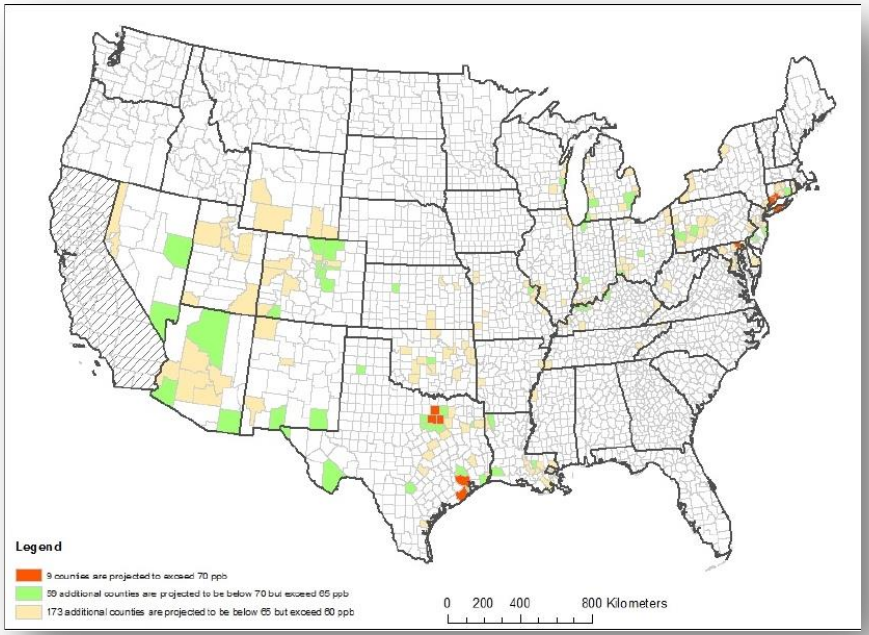

FIGURE 7. PROJECTED OZONE DESIGN VALUES IN THE 2025 BASELINE SCENARIO.

Source: USEPA, https://www3.epa.gov/ttn/ecas/regdata/RIAs/20141125ria.pdf

For demonstration purposes only and assuming that nothing changes, however, using the uncertified 2015 design values in Table 4, it could be established that none of the Upstate monitors would violate an ozone standard set above 0.065 ppm and five monitors would violate a 0.060 ppm ozone standard. Even if just one monitor's design value violates a standard, the potential exists that the Upstate region may be designated as a nonattainment area. ***Based on the EPA model and the 2015 design values, the Upstate South Carolina needs to continue reducing its NOx emissions, to meet a standard of 60 ppb that EPA might promulgate in the future since South Carolina is a NOx-limited state***. Careful consideration and implementation of additional strategies to improve air quality must take place to continue enjoying an 'attainment' designation in future years as EPA strengthens the ground level ozone standard.

TABLE 4. UPSTATE SC MONITORS POTENTIALLY VIOLATING THE 2015 PROPOSED GROUND LEVEL OZONE STANDARD RANGE

County	Monitoring Site	2015 Uncertified Design Values (ppm)*	Violates a 0.060 ppm standard	Violates a 0.065 ppm standard	Violates a 0.070 ppm standard
Abbeville	Due West	0.056	No	No	No
Anderson	Big Creek	0.060	No	No	No
Cherokee	Cowpens	0.063	Yes	No	No
Greenville	Famoda Farm	0.062	Yes	No	No
Greenville	Hillcrest	0.064	Yes	No	No
Pickens	Clemson	0.062	Yes	No	No
Pickens	Wolf Creek	0.059	No	No	No
Spartanburg	N. Spartanburg FD	0.065	Yes	No	No

Source: DHEC, Bureau of Air Quality

Based on the recommendations from states air quality agencies, EPA designates areas as attainment or nonattainment. Achieving attainment depends on the severity of ozone levels and designation classification (U. S. Environmental Protection Agency, 2014). Table 5 provides information on EPA's tentative timeline for designations and implementation for the 2015 ozone standard.

TABLE 5. ANTICIPATED CONDENSED SCHEDULES FOR THE 2015 OZONE NAAQS

Designation Schedule	Schedule	Tentative Date
State and Tribe Recommendations	Within 1 year after NAAQS promulgation	October 2016
Final Designation	Within 2 years after NAAQS promulgation (Administrator has discretion to extend the deadline by one year to collect sufficient information.)	October 2017. Effective date may vary. (Air quality data years: 2014 –2016)
Implementation Schedule	**Schedule**	**Tentative Date**
Infrastructure SIP	Within 3 years after NAAQS promulgation	October 2018
Attainment Plans Due	Within 36 - 48 months after designations depending on classification	October 2020-2021

Source: EPA, https://www.epa.gov/ozone-pollution/2015-ozone-naaqs-timelines

Table 6 provides the attainment schedule by classification for the 2015 ozone standard.

TABLE 6. ATTAINMENT SCHEDULE BY CLASSIFICATION

Classification	Schedule*
Marginal	3 years to attain
Moderate	6 years to attain
Serious	9 years to attain
Severe	15 to 17 years to attain
Extreme	20 years to attain
*Areas must attain as expeditiously as practical, but not later than the schedule in the table. Two one-year extensions are available in certain circumstances based on air quality.	

Source: EPA, https://www.epa.gov/ozone-pollution/2015-ozone-naaqs-timelines

Fine Particle or Particle Matter 2.5

On June 29, 2012, EPA proposed strengthening the annual $PM_{2.5}$ NAAQS for health from 15 $\mu g/m^3$ to a standard between 12 and 13 $\mu g/m^3$. The EPA set the 2012 standard at 12.0 $\mu g/m^3$. EPA also proposed to maintain the 24-hour $PM_{2.5}$ standard set in 2006 at 35 $\mu g/m^3$ (U. S. General Printing Office, 2012). EPA's map in Figure 8 shows the nonattainment areas with respect to the 2012 $PM_{2.5}$ standard (United States Environmental Protection Agency, 2016). Note that South Carolina is not included as a non-attainment area.

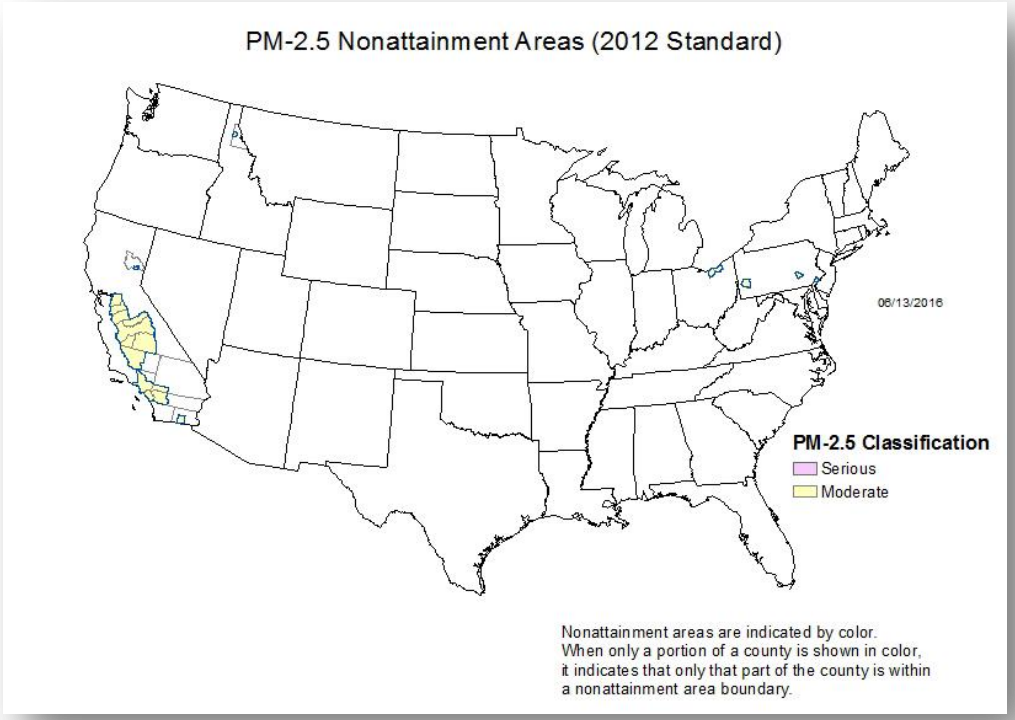

FIGURE 8. $PM_{2.5}$ NONATTAINMENT AREAS (2012 STANDARD = 12 µG/M^3)

Source: EPA, https://www3.epa.gov/airquality/greenbook/mappm25_2012.html

Air Quality Trends

EPA published Our Nation's Air: Status and Trends through 2015 report [8] and indicated that, since 1990, ozone concentrations have dropped 22% nationally (U. S. Environmetal Protection Agency, 2016). Similarly, South Carolina has registered a downward trend in ozone concentrations. This is reflected in the number of days with maximum 8-hour average ozone concentration over the ozone NAAQS. Figure 9 shows the number of ozone exceedances for South Carolina and Greenville County. Since 2005, there has been a 99% reduction in the number of exceedances statewide according to DHEC.

As mentioned previously, EPA established two standards for $PM_{2.5}$: the annual standard at 12 µg/m^3 and the 24-hour standard at 35µg/m^3. Between 1990 and 2015, both $PM_{2.5}$ concentrations (annual and 24-hour) declined nationwide by 37% each (U. S. Environmetal Protection Agency, 2016). According to SCDHEC the annual percentage of days above the $PM_{2.5}$ standard has a downward trend also for the state and Greenville County. Figure 10 shows these trends.

[8] Source: Our Nation's Air: Status and Trends through 2015 (https://gispub.epa.gov/air/trendsreport/2016/)

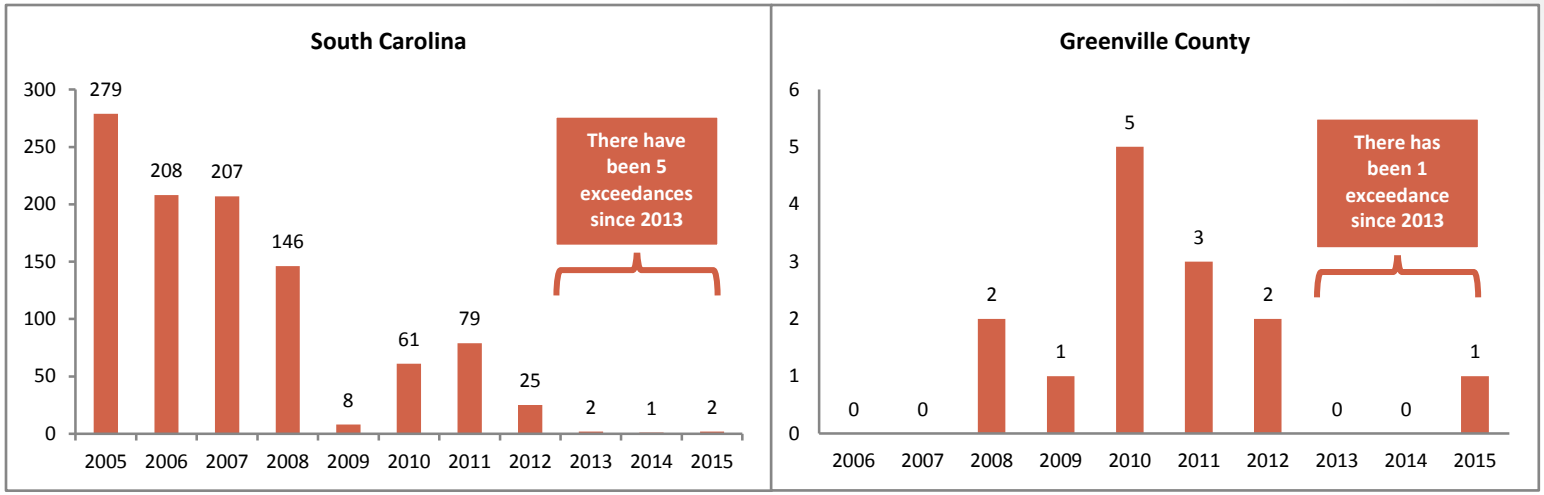

FIGURE 9. OZONE EXCEEDANCES FOR SOUTH CAROLINA (2005-2015) AND GREENVILLE COUNTY (2006-2015) BASED ON A NAAQS STANDARD OF 70 PPB

Source: DHEC, Bureau of Air Quality

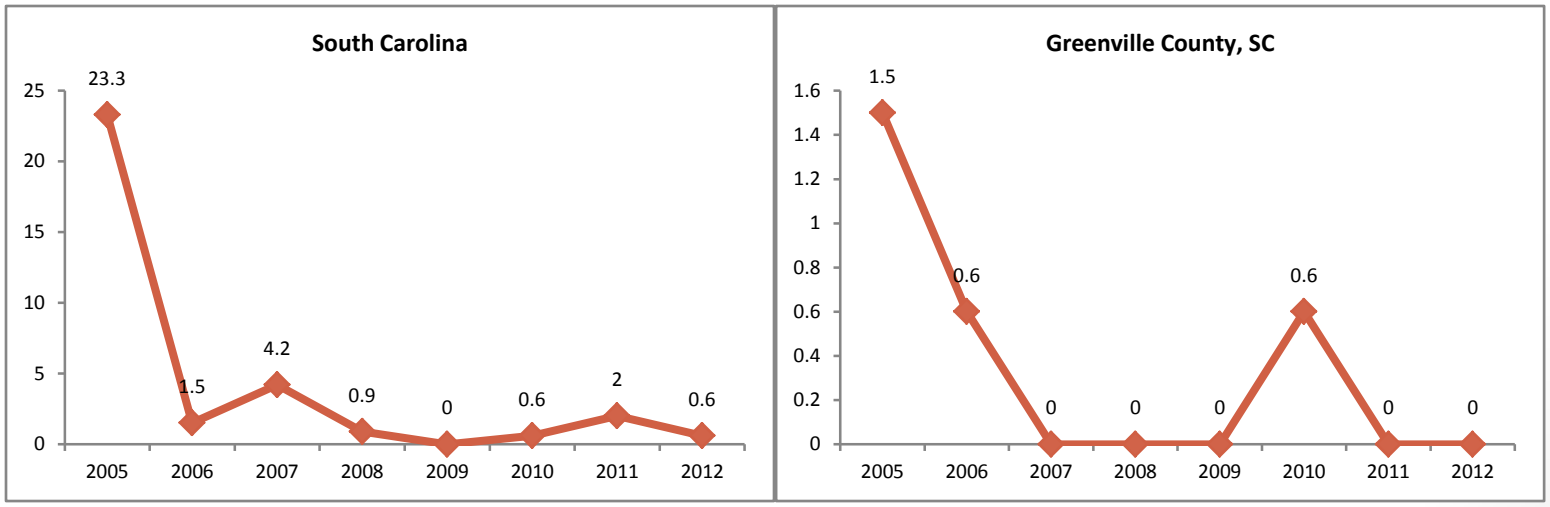

FIGURE 10. ANNUAL PERCENTAGE OF DAYS ABOVE THE LEVEL OF THE PM2.5 STANDARD: SOUTH CAROLINA AND GREENVILLE COUNTY, 2005-2012.

Source: DHEC, Bureau of Air Quality (http://infoweb02.dhec.sc.gov/epht/)

Upstate South Carolina 2008 and 2011 Emissions Inventory

According to EPA, the National Emissions Inventory (NEI)[9] is a complete and thorough estimate of emissions from different emissions sources collected from state, local and tribal air agencies. The NEI is released every three years and supplemented with data from the EPA (US Environmental Protection Agency, 2016). An analysis of the NEI for the ten counties in Upstate SC (see Appendix A, Appendix B, and Appendix C for detailed emissions information) revealed that, between 2008 and 2011, the net decrease in NOx and VOC emissions was 2,953 tons and 5,813 tons, respectively, for a total decrease of 8,766 tons of combined NOx and VOC emissions (US Environmental Protection Agency, 2016a; US Environmental Protection Agency, 2016b). It is worth noting that, in 2011, NOx emissions from mobile sources decreased by 2,940 tons. Figure 11 shows the 2008 and 2011 NOx and VOC emissions for the Upstate SC region. Further research could assist in determining which factors have contributed to the overall decrease of NOx and VOC emissions in the region.

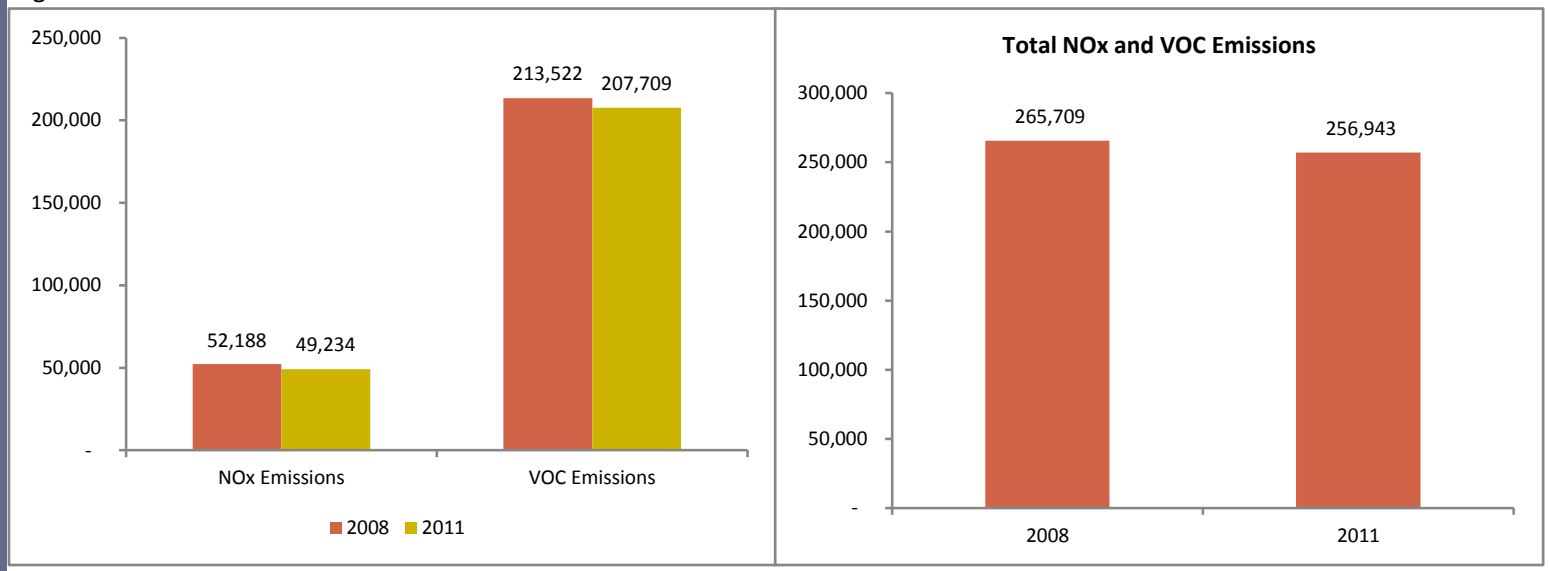

FIGURE 11. UPSTATE SC 2008 & 2011 NOX AND VOC EMISSIONS AND TOTAL EMISSIONS (TONS)

Source: EPA, National Emissions Inventory: https://www.epa.gov/air-emissions-inventories/national-emissions-inventory

In 2008 and 2011, Greenville County was the highest emitter of NOx (13,690 and 12,860 tons, respectively) followed by Spartanburg

[9] Source: National Emissions Inventory: https://www.epa.gov/air-emissions-inventories/national-emissions-inventory

County (12,712 and 11,865 tons, respectively) and Anderson County (8,541 and 7,581 tons, respectively). Figure 12 shows the total NOx emissions by county for 2008 and 2011.

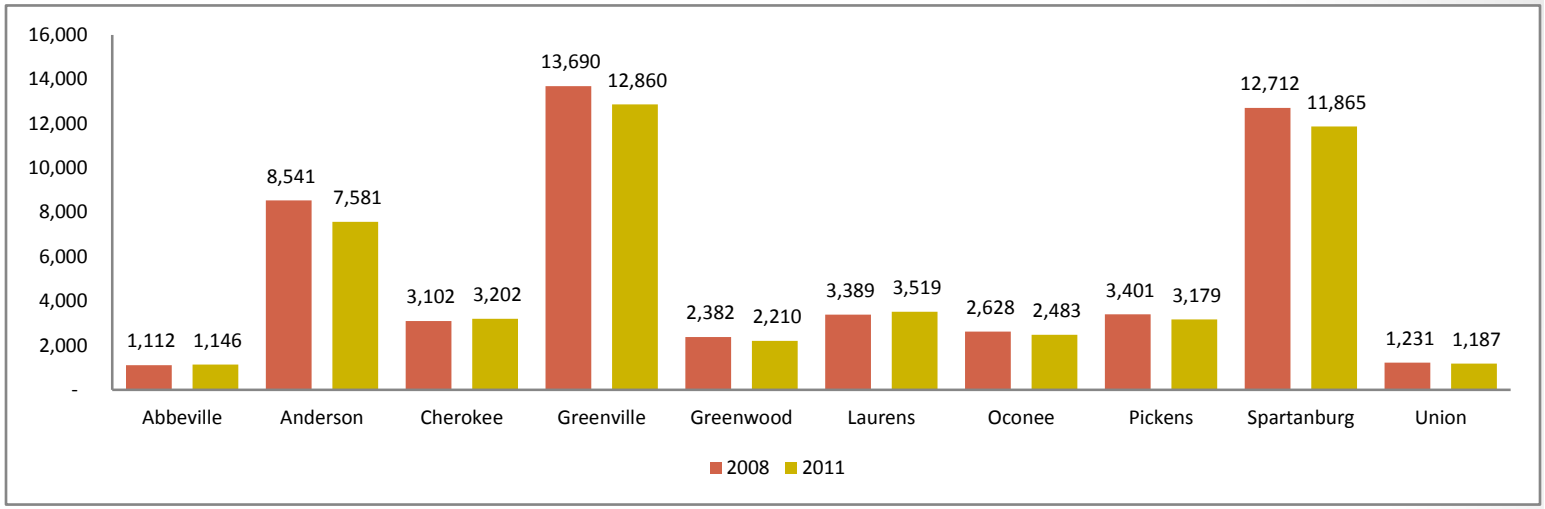

FIGURE 12. UPSTATE SOUTH CAROLINA: 2008 AND 2011 NOX EMISSIONS BY COUNTY (TONS)

Source: EPA, National Emissions Inventory

An analysis of total emissions in Upstate SC by source category also revealed that the largest increase in total (combined) NOx and VOC emissions was in the biogenics (5,645 tons) category followed by gas stations (484 tons) and industrial processes (277 tons). The largest decrease was in the solvent (5,538 tons) category followed by mobile sources (5,253 tons) and fires (3,486 tons). Figure 13 shows the 2008-2011 increase or decrease of total NOx and VOC emissions by source.

An analysis of the change in NOx emissions between 2008 and 2011 showed that Anderson County had the largest decrease (960 tons) followed by Spartanburg County (847 tons) and Greenville County (830 tons). The net change in NOx emissions showed a decrease of approximately 2,953 tons for the Upstate region. Figure 14 shows the Upstate SC NOx emissions net change between 2008 and 2011 by county.

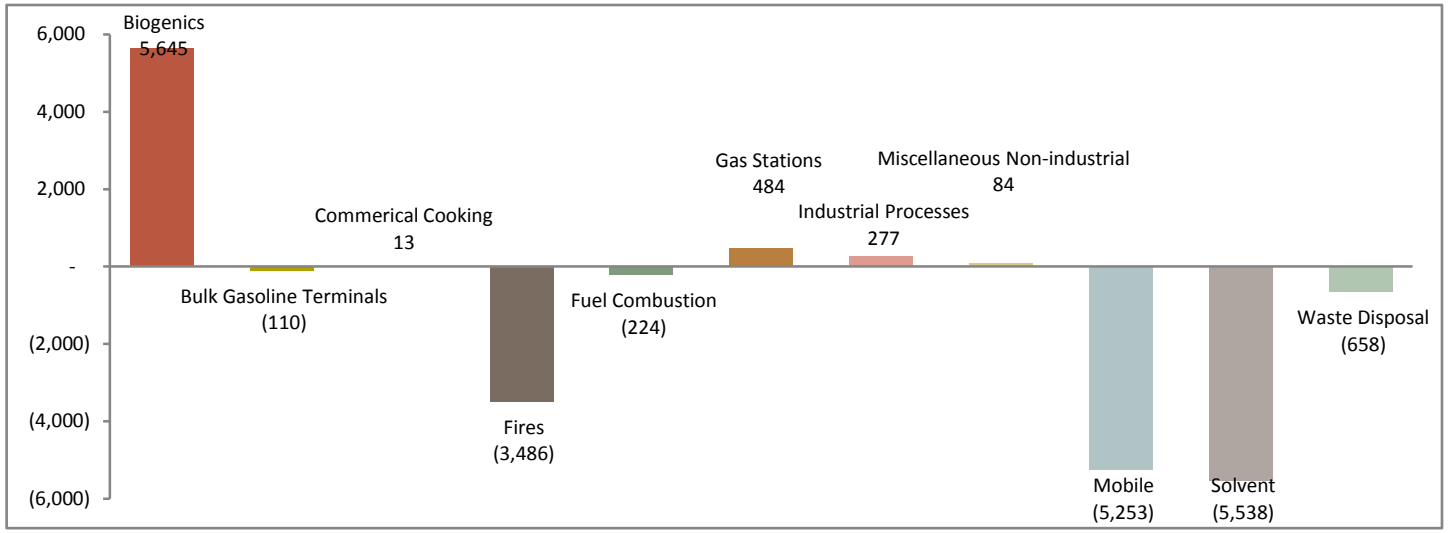

FIGURE 13. UPSTATE SOUTH CAROLINA 2008 – 2011 NET CHANGE OF TOTAL NOX AND VOC EMISSIONS BY SOURCE (TONS)

Source: EPA, National Emissions Inventory

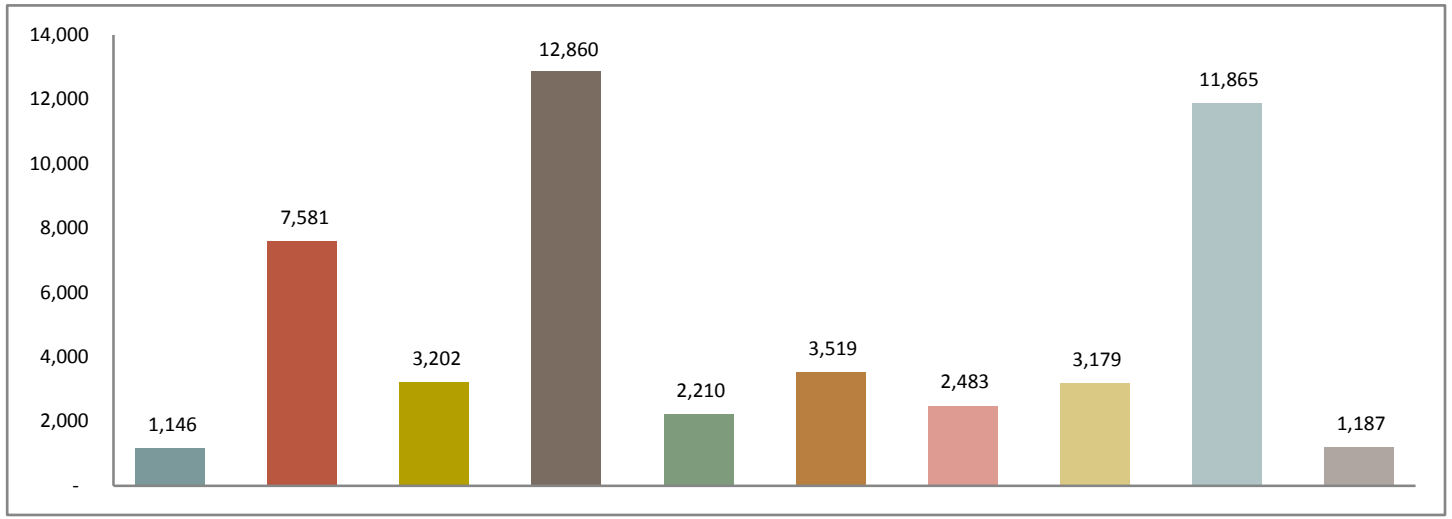

FIGURE 14. UPSTATE SOUTH CAROLINA: 2008-2011 NET CHANGE IN NOX EMISSIONS BY COUNTY (TONS)

Source: EPA, National Emissions Inventory

In 2008 and 2011, Greenville County was the highest emitter of VOC (32,680 and 32,435 tons, respectively) followed by Spartanburg County (30,061 and 28,616 tons, respectively) and Anderson County (25,248 and 23,502 tons, respectively). Figure 15 shows the total VOC emissions by county for 2008 and 2011.

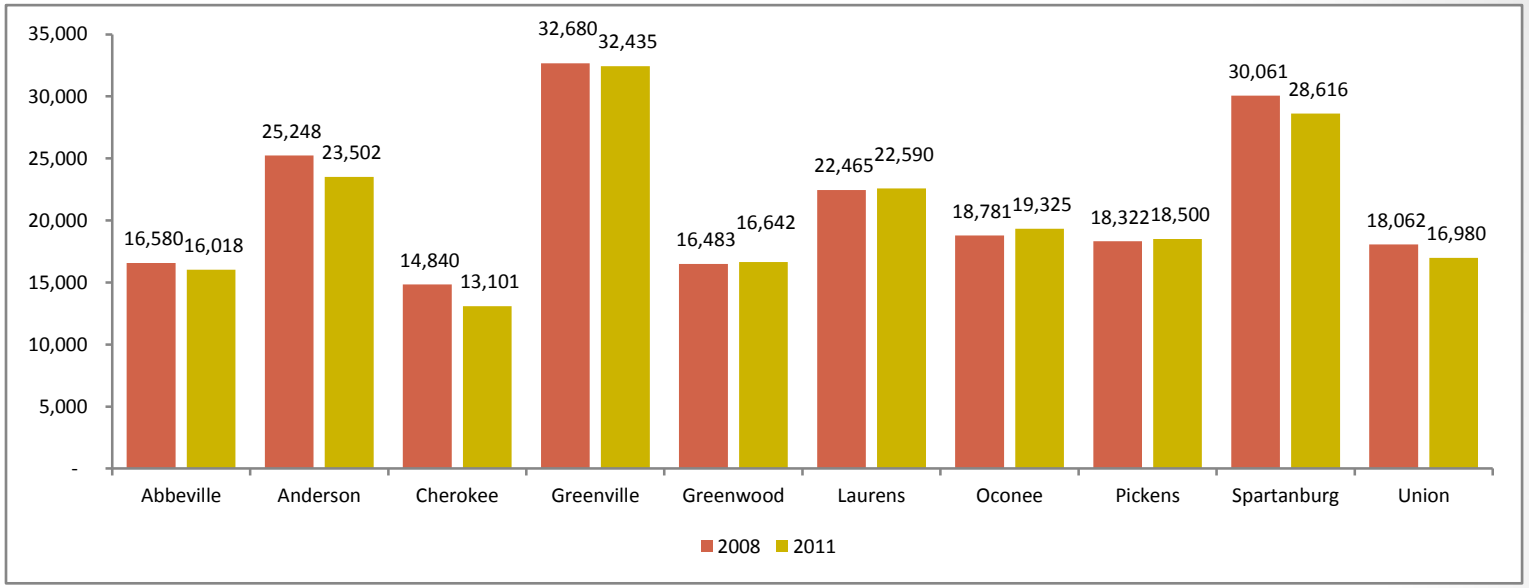

FIGURE 15. UPSTATE SOUTH CAROLINA: 2008 AND 2011 VOC EMISSIONS BY COUNTY (TONS)

Source: EPA, National Emissions Inventory

An analysis of the change in VOC emissions by county between 2008 and 2011 showed that Anderson County had the largest decrease (1,747 tons) of VOC emissions followed by Cherokee County (1,739 tons) and Spartanburg County (1,445 tons). The analysis also revealed that Oconee County had the largest increase (545 tons) of VOC emissions followed by Pickens (179 tons) and Greenwood (159 tons) counties. The net change in VOC emissions showed a decrease of approximately 5,813 tons for Upstate SC. Figure 16 shows the VOC emissions change between 2008 and 2011 by county.

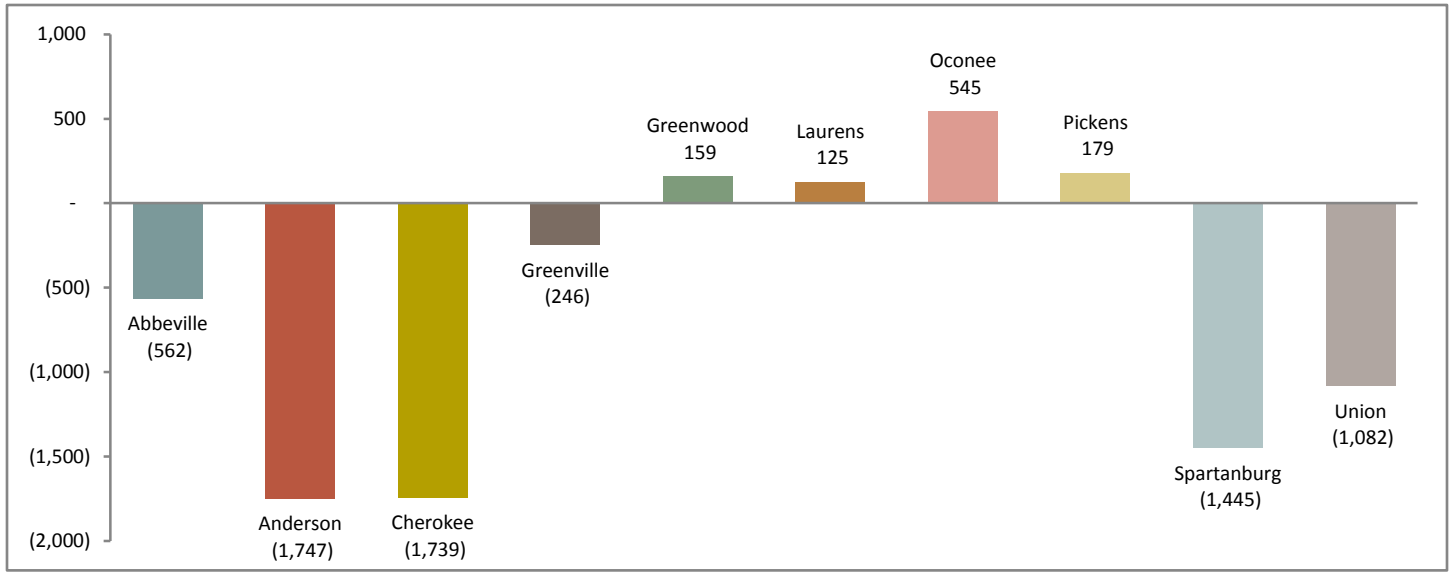

FIGURE 16. UPSTATE SOUTH CAROLINA: 2008-2011 CHANGE IN VOC EMISSIONS BY COUNTY (TONS)

Source: EPA, National Emissions Inventory

County of Greenville Emissions Inventory

In 2008, mobile sources (i.e., aircraft, locomotives, non-road equipment, and on-road vehicles) produced the largest amount of combined NOx and VOC emissions (18,719 tons, 40.37%) followed by biogenics (16,174 tons, 34.88%) and solvents (5,814 tons, 12.54%) in Greenville County. In 2011, biogenics produced the largest amount of combined NOx and VOC emissions (18,500 tons, 40.84%) followed by mobile (17,202 tons, 37.98%) and solvent (3,751 tons, 8.28%). Note in Figure 17, Figure 18, and Figure 19 that total mobile sources (NOX and VOC combined) decreased by 1,516 tons in 2011 while NOX and VOC emissions from biogenic sources increased by 2,326 tons in that year. Appendices D and E include the emissions inventory for Greenville County.

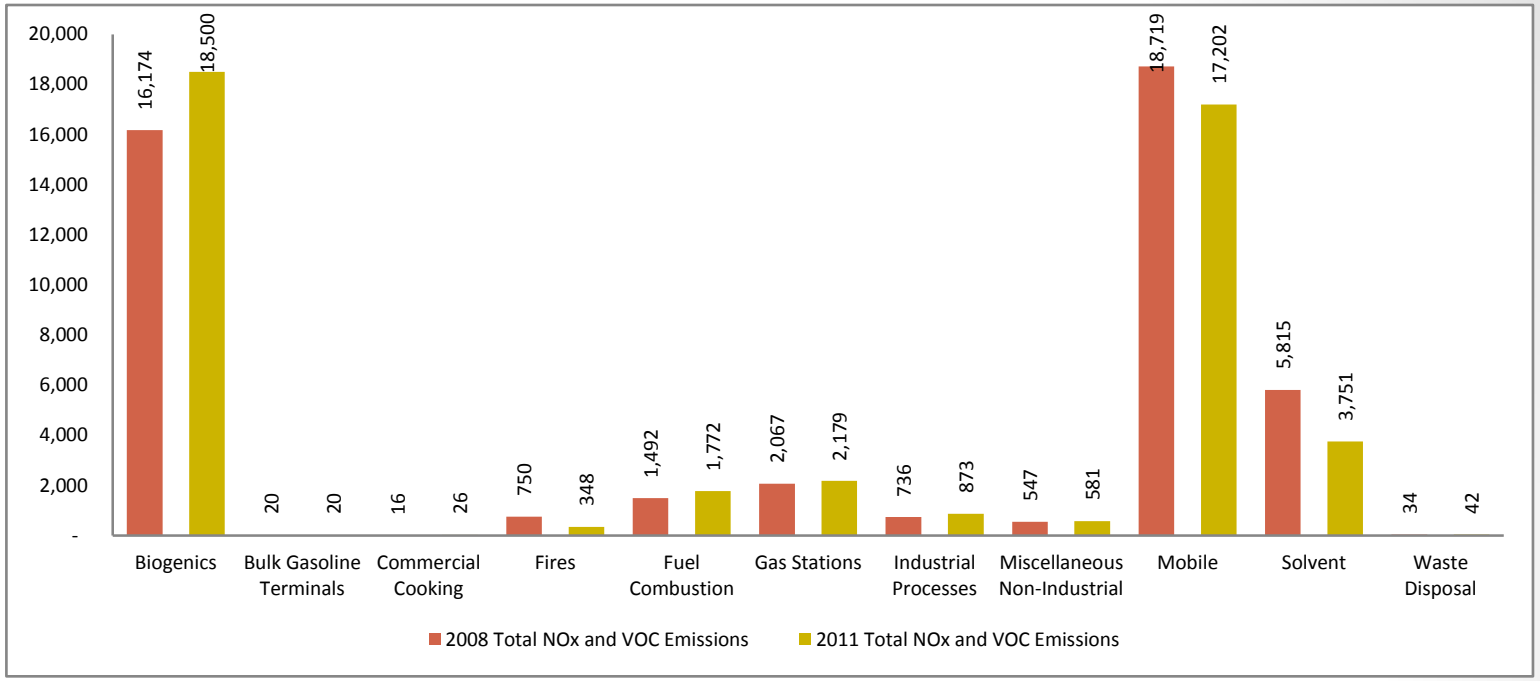

FIGURE 17. GREENVILLE COUNTY, SC: 2008 AND 2011 TOTAL NOX AND VOC EMISSIONS BY CATEGORY (TONS)

Source: EPA, National Emissions Inventory

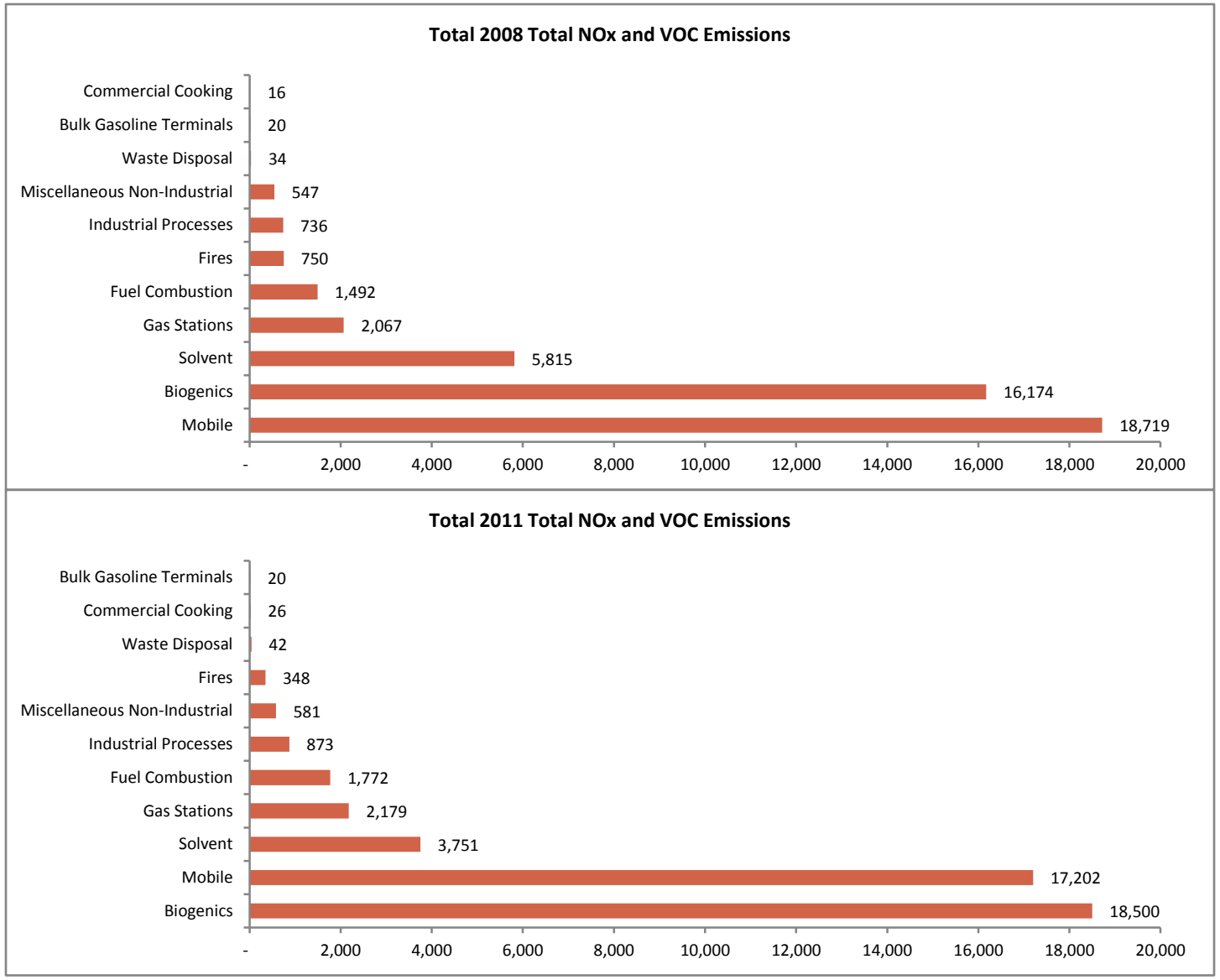

FIGURE 18. GREENVILLE COUNTY, SC: TOTAL 2008 AND 2011 NOX AND VOC EMISSIONS BY SOURCE (TONS)

Source: EPA, National Emissions Inventory

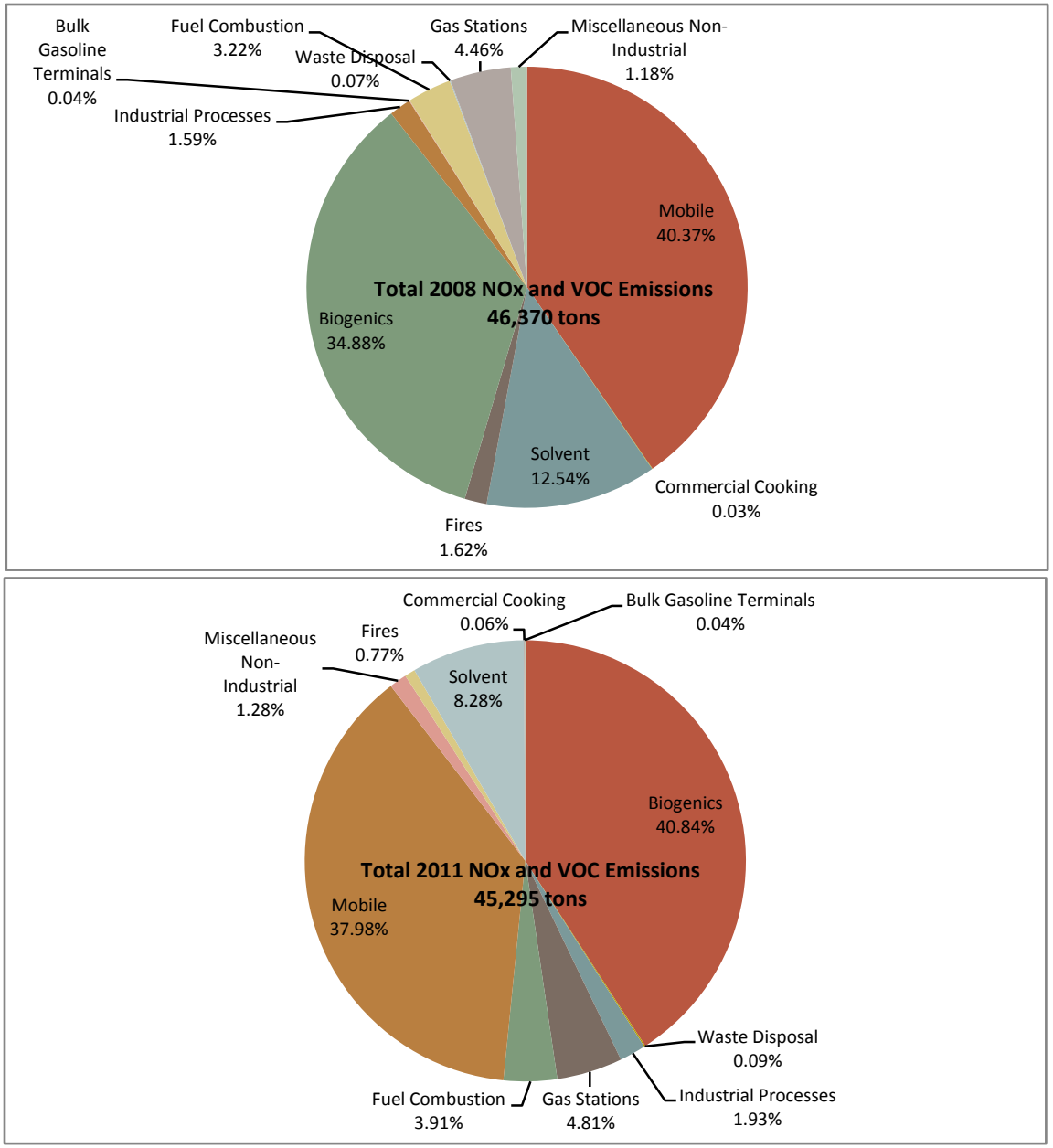

FIGURE 19. GREENVILLE COUNTY, SC: PERCENTAGE OF TOTAL EMISSIONS BY SOURCE

Source: EPA National Emissions Inventory

According to EPA's State and County Emissions Summary,[10] in Greenville County, mobile sources were the highest producer of NOx with 12,042 tons in 2008 and 11,059 tons in 2011 (US Environmental Protection Agency, 2016). Biogenic sources were the largest producer of VOC emissions with 16,029 tons in 2008 and 18,247 tons in 2011. Figure 20 and Figure 21 provide a summary of the 2008 and 2011 NOx and VOC emission by source in Greenville County. [11]

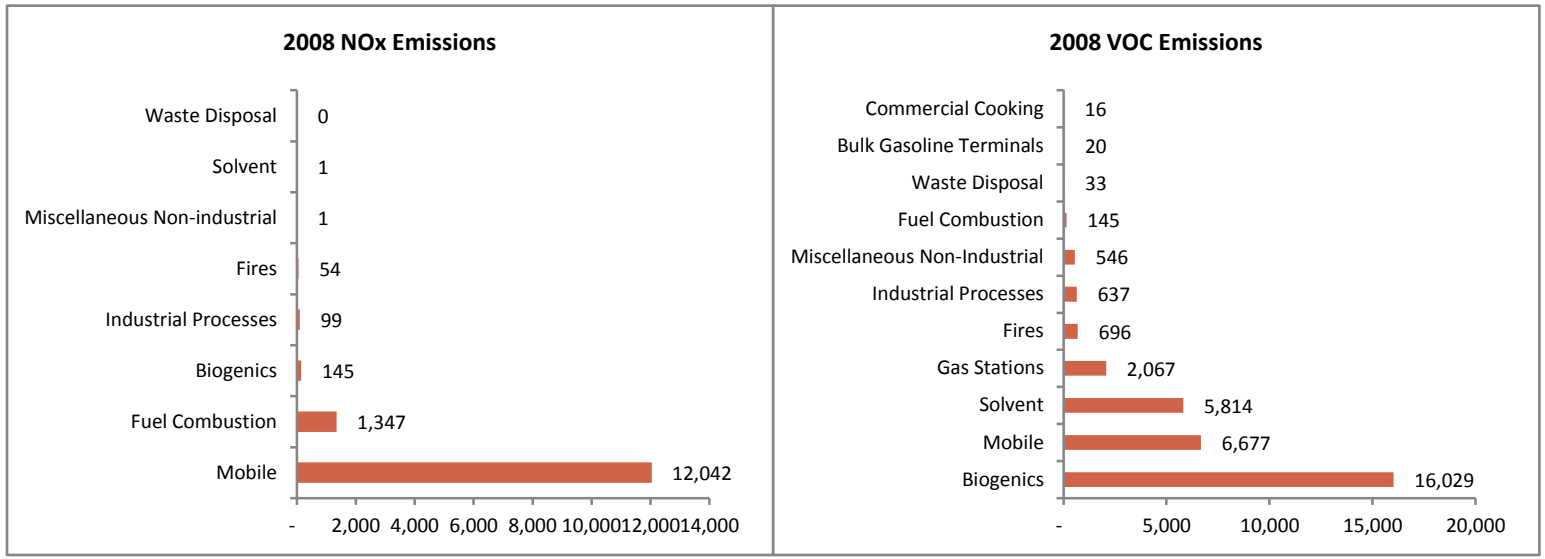

FIGURE 20. GREENVILLE COUNTY, SC, 2008 NOX AND VOC EMISSIONS BY SOURCE (TONS)

Source: EPA National Emissions Inventory

The good news is that NOx emissions from mobile sources decreased in 2011 by 983 tons, as shown in Figure 22. It is expected that EPA will further strengthen future ground level ozone NAAQS to levels that are less than the 70 ppb standard of 2015. As mentioned before, South Carolina is a NOx-limited state. Therefore, **reducing NOx emissions from mobile sources would have better results in preventing the formation of ground level ozone**.

[10] Source: U.S. EPA, National Emissions Inventory: https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-data
[11] Ibid.

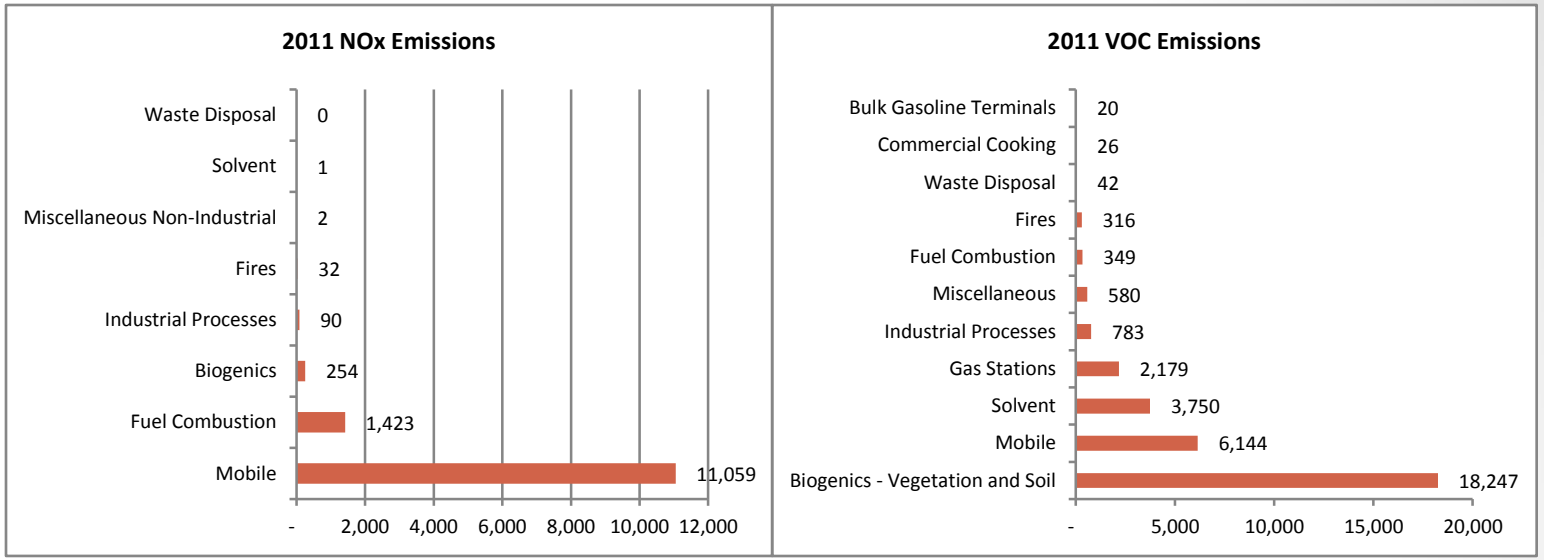

FIGURE 21. GREENVILLE COUNTY, SC, 2011 NOX AND VOC EMISSIONS BY SOURCE (TONS)

Source: EPA National Emissions Inventory

The largest 2008-2011 NOx emissions net increase in the county was in the biogenics (109 tons) category followed by fuel combustion (76 tons). The largest decrease in NOx emissions was in the mobile (983 tons) sources category followed by fires (22 tons) and industrial processes (9 tons). Overall, Greenville County's NOx emissions net decrease was approximately 830 tons between 2008 and 2011. Figure 22 shows Greenville County's 2008-2011 NOx emissions change by source category.

The largest 2008-2011 VOC emissions increase in the county was in the biogenics (2,217 tons) category followed by fuel combustion (204 tons) and industrial processes (145 tons). The largest decrease in VOC emissions was in the solvent (2,065 tons) category followed by mobile sources (533 tons) and fires (380 tons). Overall, Greenville County's VOC net emissions decrease was approximately 246 tons between 2008 and 2011. Figure 23 shows Greenville County's 2008-2011 net VOC emissions increase and decrease by source.

In sum and it cannot be emphasized enough, the Upstate SC is a NOx-limited area. Recall that in a NOx-limited scenario (i.e., high VOC/NOx ratios), ground level 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.

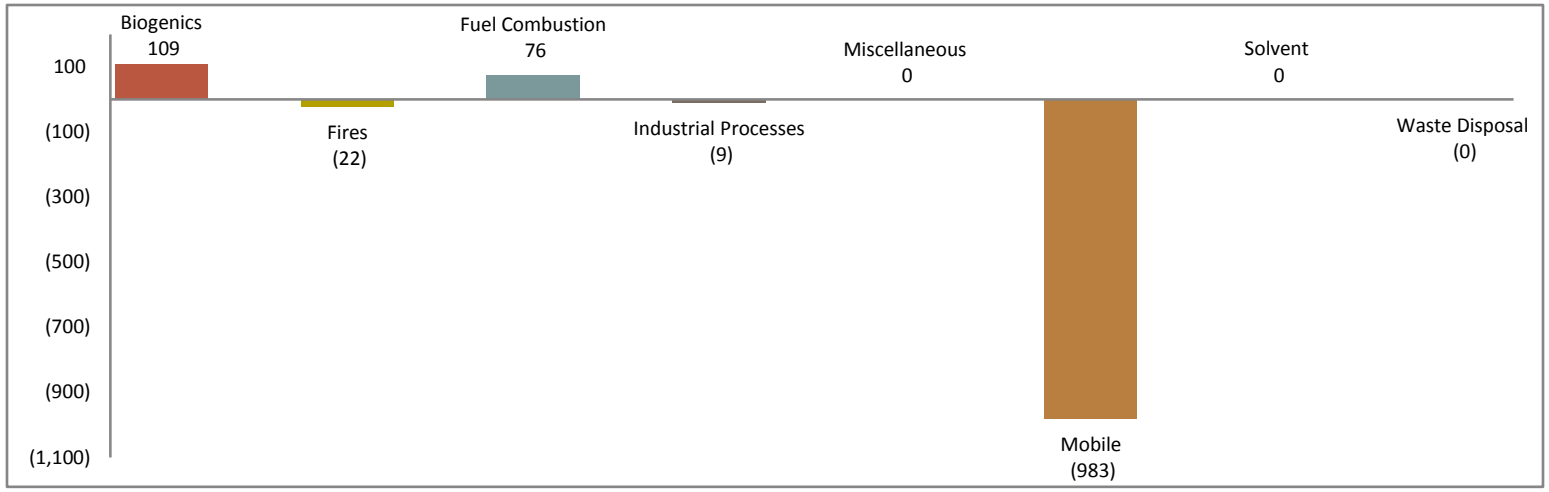

FIGURE 22. GREENVILLE COUNTY, SC, 2008 – 2011 NET CHANGE IN NOX EMISSIONS BY SOURCE (TONS)

Source: EPA National Emissions Inventory

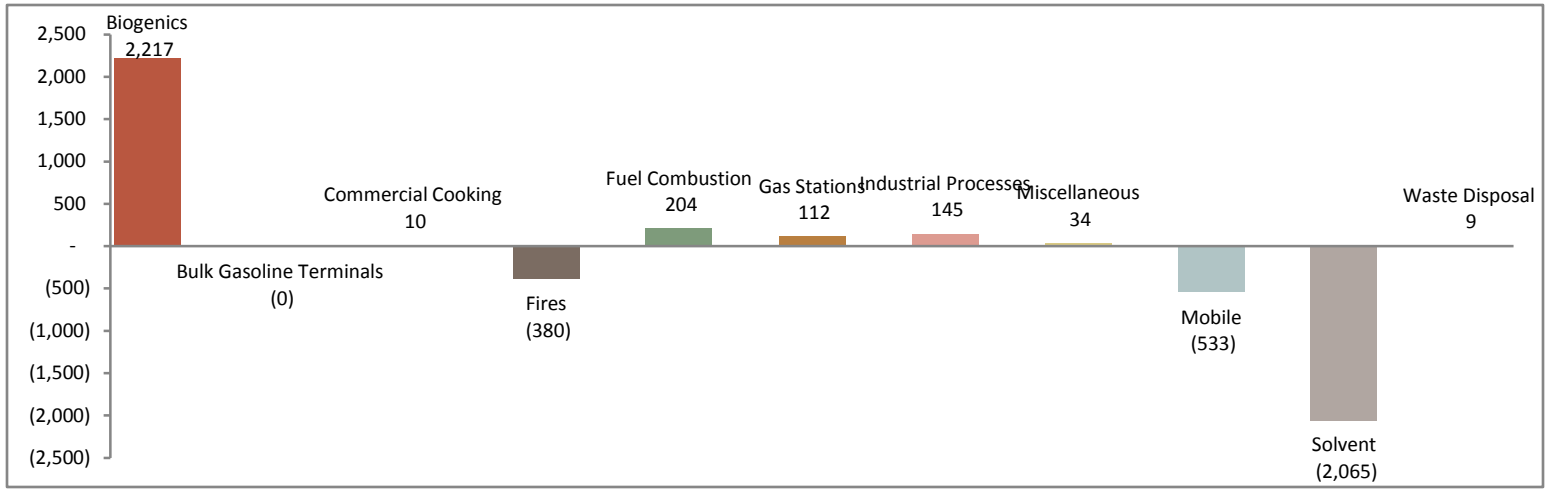

FIGURE 23. GREENVILLE COUNTY, SC, 2008 – 2011 NET CHANGE IN VOC EMISSIONS BY SOURCE (TONS)

Source: EPA National Emissions Inventory

Recall that, in Greenville County, the net change in NOx emissions was a decrease of 830 tons between 2008 and 2011. Mobile sources alone decrease 983 tons between 2008 and 2011; however, this decrease was offset by increases in NOx emissions from other sources such as biogenics and fuel combustion. The federal government has proposed and/or issued rules that will help reduce ozone pollution. Such rules include requirements to reduce interstate transport of ozone, Tier 3 emission control requirements for vehicles and motor fuels, emission standards for combustion engines, retrofit technologies, and boilers, and clean power (U. S. Environmental Protection Agency, 2014). In addition to local efforts, such as the Spare the Air public awareness campaign and the anti-idling program, it is expected that implementing such rules will also help Greenville County to reduce emissions from mobile sources.

Implementation of air quality strategies to meet future and tighter standards requires the collaboration of federal, state, and local governments. At the local level, it also requires the collaboration of the community, businesses, industries, non-profit organizations, and individuals to develop and implement local strategies to improve air quality, **especially strategies in the transportation field**, to meet future and tighter air quality standards, improve health outcomes, and increase economic development opportunities.

Economic Development and Air Quality in Greenville County

As discussed later, studies on the impact of environmental regulations on economic development have mixed results. An in-depth analysis of the impact of air quality regulations on Greenville County's economic development is beyond of the scope of this report. However, it is important to present economic development data between 2008 and 2011 to compare such activity with EPA's emissions inventory during that period.

As noted in Figure 24 and to compare to the National Emissions Inventory period, for the 2008-2011 period, the total number of jobs announced was 7,640 and the total investment was $909.43 million. According to the Greenville County Area Development Corporation (GADC), for the 2008-2015 period, the total number of jobs announced was 13,523 and the total investment was $2.268 billion.

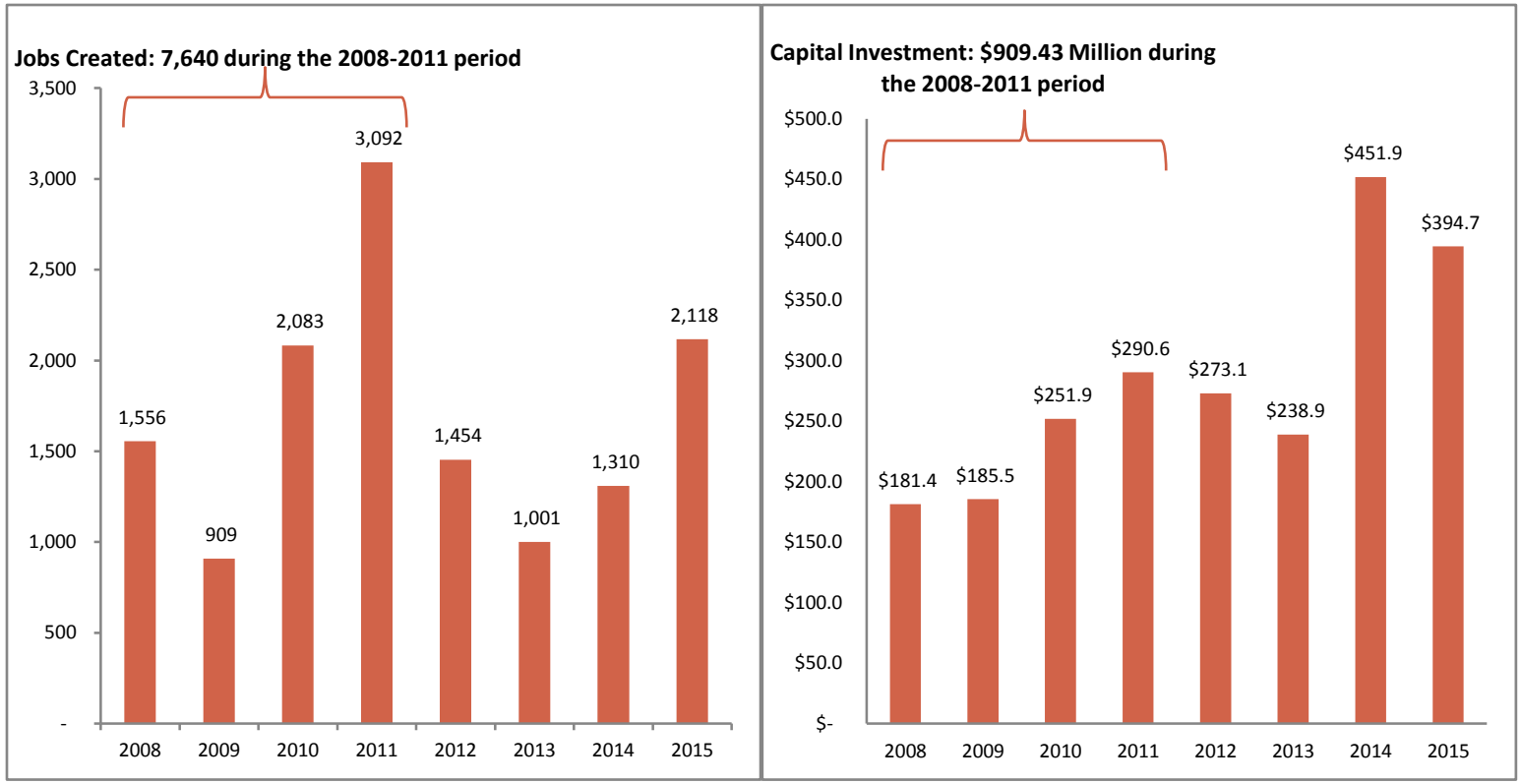

FIGURE 24. 2008 – 2015 ANNOUNCED JOBS CREATED AND CAPITAL INVESTMENT IN GREENVILLE COUNTY, SC ($ IN MILLIONS)

Source: Greenville Area Development Corporation

Recall from the previous section, the net change in the total NOx and VOC emissions was a decreased of 1,075 tons between 2008 and 2011. During that period, the net change in NOx emissions was a decrease of 830 tons and in VOC emissions, a decrease of 246 tons. In sum, economic development (i.e., capital investment and job creation) increased in Greenville County while total NOx and VOC emissions decrease for the 2008-2011 period. Figure 25 provides a summary of total capital investment and jobs created by sector during the 2008-2011 period. Notice that, with the exception of 2010, capital investment in the manufacturing sector grew in Greenville County while total NOx and VOC emissions decreased by a total of 1,075 tons.

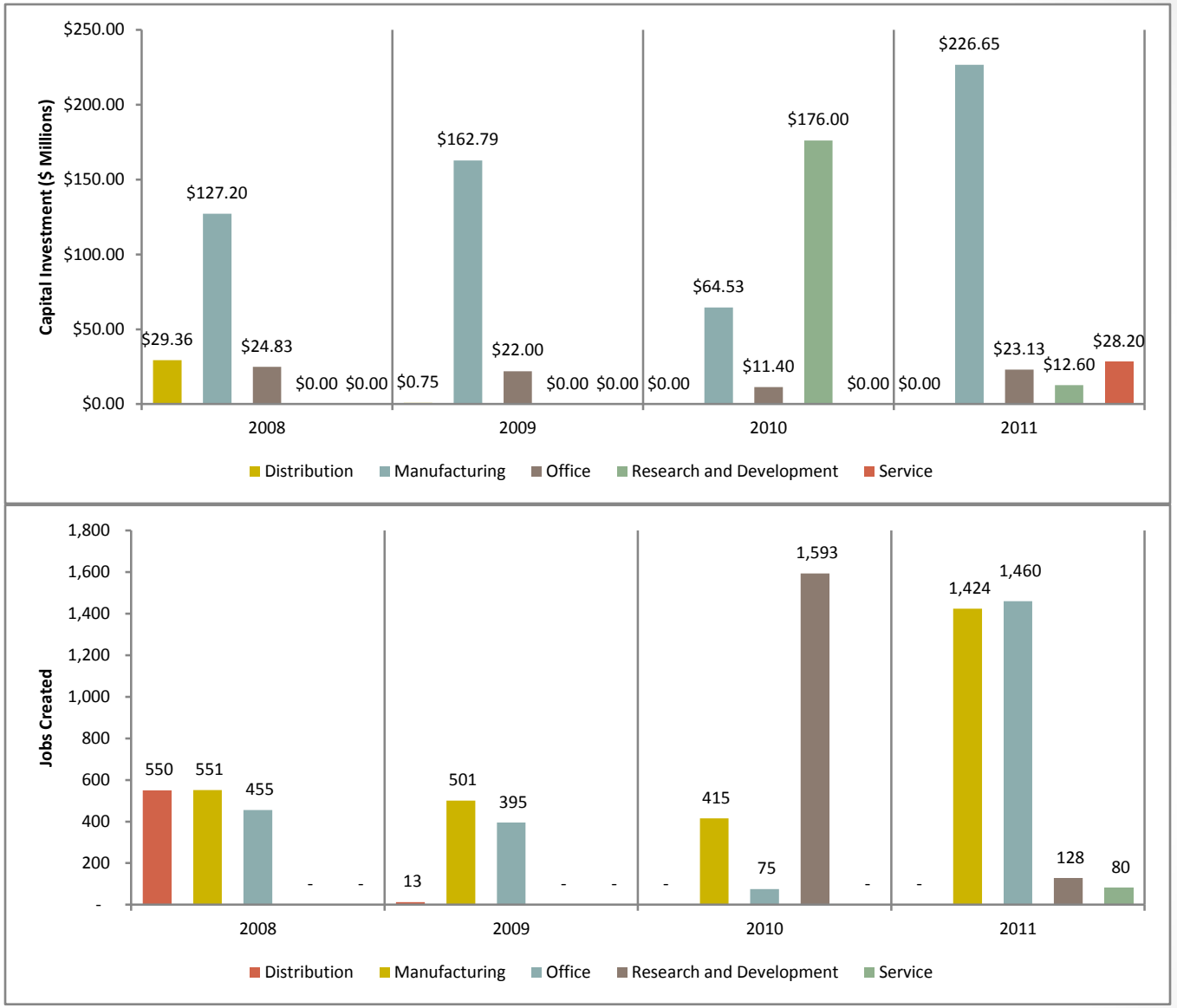

FIGURE 25. GREENVILLE COUNTY, SC, ECONOMIC DEVELOPMENT: CAPITAL INVESTMENT ($ MILLIONS) AND JOBS CREATED BY SECTOR (2008-2011)

Source: Greenville Area Development Corporation

Local and Regional Efforts to Improve Air Quality

Since 2006, with its Spare the Air Public Awareness Campaign and other initiatives, Greenville County and its municipalities have taken a proactive approach to improve air quality. Some of the initiatives that have been implemented in non-attainment areas to show conformity include smart growth, in-fill development, transit-friendly transportation projects, commuter programs, use of alternative fuel vehicles and buses, diesel retrofit, and anti-idling programs. Many of those initiatives are already in place in Greenville County. They include use of alternative fuel vehicles in the County's fleet; retrofitting Sheriff's Office patrol vehicles with propane gas (the vehicles run with propane gas and gasoline); diesel retrofit on the county's heavy equipment and trucks; expanding the Breathe Better at School (B^2)—anti-idling—program to the entire Upstate SC region; transit friendly projects (i.e., Swamp Rabbit Trail and other greenway initiatives of the municipalities in the county); partnering with local organizations to implement the Electric Vehicle (EV) Ecosystem Pilot Program; and the school bus retrofit program that DHEC and the SC Department of Education implemented (many of those buses operate in Greenville County). Greenville County is planning on acquiring gasoline engine cab and chassis for ambulance remounts in lieu of the diesel powered engines and converting them to propane fuel. The county is also purchasing two litter control trucks with gasoline engines which will be converted to propane fuel as well. The conversion of these vehicles to propane gas will reduce carbon monoxide, hydrocarbons, carbon dioxide, and NOx emissions.

The City of Greenville has also implemented air quality strategies including the deployment of standard and fast charging stations for electric vehicles and the bicycle sharing program; the use of Global Electric Motorcars by various city departments; and the use of alternative fuels such as biodiesel for GreenLink buses, turf equipment, and tractors, and compressed natural gas for dump trucks (City of Greenville, South Carolina, 2012). Other transportation control measures in the Upstate SC region include the truck stop electrification in Anderson County. In February 2005, Idle Aire Technology was installed in 51 spaces at truck stops (South Carolina Department of Health and Environmental Control, 2006). Pickens County, SC, is also producing biodiesel in-house by recycling local used vegetable oil for use in county vehicles (Upstate South Carolina's Information Hub, 2012).

In early 2012, Greenville County met with the executive director of Ten at the Top (TATT) to discuss collaborative efforts at the regional level in light of the 2013 revision of the NAAQS for ground level ozone by EPA. This revision could make the standard more stringent. TATT is a nonprofit organization whose primary objectives include:

- Grow trust and partnerships among elected officials, business & community leaders and residents by initiating, convening and facilitating discussions around key regional issues, challenges and opportunities.
- Identify and promote collaborative efforts that enhance the Upstate's physical and social infrastructure by encouraging quality growth and supporting economic vitality, natural and cultural resources and quality of life in the region.
- Measure, analyze and report information on the needs and progress of the region on key cross-jurisdictional issues. (Ten at the Top, 2016)

Since then, several private, public, and nonprofit organizations from the region have met to identify, assess, select, develop, seek funding, and implement regional strategies to reduce emissions and improve air quality. TATT has demonstrated commitment to facilitate and coordinate the region's clean air efforts with public and private sector organizations from the Upstate SC. As a result of those efforts and commitment, the Upstate Air Quality Advisory Committee was formed. The Committee includes representatives from businesses, local governments, and community organizations across the Upstate SC. The group has worked together since 2011 to develop regional air quality actions and strategies for organizations to adopt and implement. TATT was also instrumental in developing the Clean Air Upstate program and maintains its website at www.cleanairupstate.org with information on clean air efforts in the region.

Another initiative of the Clean Air Upstate group developed no-idling signs to be posted on private business parking lots as a reminder for visitors to turn off engines when in a parked position. TATT worked with a Greenville area developer to install the first signs in visible parking lots throughout the City of Greenville. The program expanded to the local General Electric location as well as other locations nationwide and communities across the region. This is another opportunity to remind Upstate residents that we all can make a difference with improving the air we breathe.

Following a pilot program developed by the SC Department of Health and Environmental Control called Breathe Better[12] (B^2 or B square), Greenville County implemented the program locally in 2006. The core purpose of the B^2 program is to educate parents, staff, bus drivers, teachers, and visitors about the importance of not idling vehicles and school buses to have clean air around schools. Through grants received from a local and a regional foundation, the Clean Air Upstate initiative has offered non-restricted grants to up to 40 public and private schools in the 10 Upstate SC counties to start or continue participation in the Breathe Better Clean Air Program. TATT was also instrumental in obtaining grants to expand the B^2 program at the regional level increasing the number of schools in the Upstate SC that have implemented it.

On April 15, 2012, EPA announced the availability of the Ozone Advance Program[13] (OAP). In May 2012, DHEC requested and EPA approved South Carolina's participation in the OAP. The program is a collaborative effort at all levels of governments to reduce emissions in ozone attainment areas meeting the 2008 ground level ozone NAAQS. OAP has three goals (U. S. Environmental Protection Agency, 2012k):

[12] Breathe Better website: http://www.scdhec.gov/HomeAndEnvironment/K12SchoolsStudentsTeachers/B2BreatheBetterProgram/. Contact: Megan Johnson at SCDHEC at johnsoM4@dhec.sc.gov, (803) 898-3752, to learn more about the B2 program.
[13] Ozone Advance Program website: https://www.epa.gov/advance

- Help attainment areas take action in order to keep ozone levels below the level of the ozone NAAQS to ensure continued health protection for their citizens,
- Better position areas to remain in attainment, and
- Efficiently direct available resources toward actions to address ozone problems quickly. (p. 1)

Several have been the awards that Greenville County has received for its air quality improvement efforts. Those awards include the Clean Excellence from EPA (2008 and 2012), the Spare the Air awards from DHEC (2008, 2011), and the National Association of Counties Achievement award (2009) (County of Greenville, South Carolina, 2012). These recognitions demonstrate the commitment of Greenville County to improve air quality. The county is also committed to work with public, private, and nonprofit organizations for the Upstate's "physical and economic vitality" through the collaborative efforts facilitated by TATT.

FIGURE 26. AIR QUALITY RECOGNITIONS AWARDED TO GREENVILLE COUNTY, SC

Requirements for Non-Attainment Designated Areas

Transportation Conformity

EPA began offering training to state and local governments on the transportation conformity process in September 2010. Transportation conformity ensures "that federal funds go to transportation activities that are consistent with their air quality goals" (U. S. Environmental Protection Agency, 2012i). The Clean Air Act requires state and local governments in nonattainment areas to comply with this process. Both, EPA and the U. S. Department of Transportation (USDOT) administer this requirement as it applies to

"transportation plans, transportation improvement programs, and highway and transit projects funded or approved by the Federal Highway Administration (FHWA) and the Federal Transit Authority (FTA)" (U. S. Environmental Protection Agency, 2012i).

Metropolitan Planning Organizations (MPOs) make initial conformity determinations but the FHWA and FTA make final determinations. Conformity determination estimates emissions resulting from a region's transportation system and shows that those emissions conform as outlined in the State Implementation Plan (SIP) that each state submits. Transportation conformity also requires inter-agency consultation and that transportation control measures included and approved in the SIP are implemented in a timely fashion. Conformity determinations must be made each time transportation plans are amended or updated or when FHWA or FTA approve or provide funding to non-exempt transportation projects, (U. S. Environmental Protection Agency, 2012i).

As of August 2016, the Upstate South Carolina has been designated as an attainment area with the 2008 ground level ozone and $PM_{2.5}$ standards. The October 1, 2015, announcement from EPA on the revised ozone standard to 70 ppb will allow Greenville County to continue under its current attainment designation provided air quality remains at its current level or continues to improve. As such, the region will not be held to the regulations described above.

The Greenville-Pickens Area Transportation Study (GPATS), the MPO in the Upstate that includes Greenville and Pickens counties urbanized areas, is aware that it could be possible that the region could fall into nonattainment with respect to future ground level ozone standard revisions and has made all reasonable contingencies to comply with federal regulations if nonattainment designation is reached in the future. GPATS entered into a Memorandum of Agreement with the DHEC, SCDOT, EPA, FHWA, FTA, and eight other MPO agencies in South Carolina to cooperatively support and implement the interagency consultation procedures included in the SIP. This collaboration will ensure that the plans, programs, and projects adopted by the parties to the agreement conform to the purpose of the SIP to meet national ambient air quality standards for any applicable criteria pollutant.

New Source Review

In addition to transportation conformity, another significant requirement that nonattainment areas face is the New Source Review (NSR) permitting program. NSR permits are legally binding documents and the owners/operators of facilities must comply with them in non-attainment areas. The only known NSR process in South Carolina was implemented in York County in March 2006. The NSR program has two purposes:

- First, it ensures that air quality is not significantly degraded from the addition of new and modified factories, industrial boilers and power plants. In areas with unhealthy air, NSR assures that new emissions do not slow progress toward cleaner air. In areas with clean air, especially pristine areas like national parks, NSR assures that new emissions do not significantly worsen air quality.

- Second, the NSR program assures people that any large new or modified industrial source in their neighborhoods will be as clean as possible, and that advances in pollution control occur concurrently with industrial expansion. (U. S. Environmental Protection

Agency, 2012j).

The Clean Air Act requires new source review under two programs. These programs regulate major sources of emissions (new or modified) under the nonattainment NSR program and the prevention of significant deterioration (PSD) program in attainment areas. The nonattainment NSR program applies lowest achievable emission rate (LAER) requirements to new or altered existing facilities in nonattainment designated areas and in ozone transport regions. LAER is the most strict emissions limitations requirement. Depending on the nonattainment area classification, i.e., marginal, moderate, serious, severe, or extreme, regulated sources must offset their increased emissions according to the classification's offset ratios (The Air Pollution Consultant, 1999). The PSD program applies to major regulated sources in attainment and unclassifiable areas using best available control technology (BACT). Sources include those emitting or having the potential to emit 250+ tons per year (tpy) of CAA regulated pollutants or 100 tpy if it is a "major emitting facility" listed in Section 169 of the CAA (U. S. Environmetal Protection Agency, 1990).

Economic Impact of Air Quality Regulation: Review of the Literature

Public perception on the effects of environmental regulations is that it costs jobs (Berman & Bui, 1997). Economic theory might reinforce that perception since it vaguely arguments that "the job loss due to reduced sales could be smaller than the job gain due to abatement activity in the plants [due to environmental regulations]" (p. 23). Studies have been conducted, mostly in the late 1980s and 1990s, on the effects of air quality regulations on decisions made by industries on location selection and the results are mixed. On one hand, a study on the effects of environmental regulations (e.g., the Clean Air Act and the Federal Water Pollution Control Act) on plants location concluded that the "study does not find any statistically significant effect of state environmental regulations on the location of new branch plants" (Bartik, 1988, p. 37). Bartik noted that industries consider many variables when it comes to making location or re-location decisions, including profit maximization, regions, industrial sites characteristics, cost of complying with pollution regulations, wages, property taxes, labor force skills, etc. Bartik noted,

> *If business location decisions are based solely or primarily on profitability* [emphasis added], then the effect of a variable on business location should also depend on what proportion of costs is accounted for by that variable. Environmental regulation's share of costs is quite small compared to other inputs… (p. 37)

The caveat with this statement is that it does not consider any future environmental impact to the surroundings, the environment, the community, and/or any future clean ups that a company would have to pay based on the decision to locate or re-locate.

Henderson (1996) concluded that regulations on air quality affect the location of industries noting that "a switch to maintaining attainment status increases the number of polluting plants by 7—9 percent" (p. 810). Tannenwald (1997) noted that dirty air hindered counties' economic growth in two ways: by making labor cost higher because workers are not attracted to live in those counties due to

decreased quality of life or by discouraging business to relocate to or expand in those areas due to more rigorous regulations, which increase compliance costs. Tannenwald researched 10 econometric studies on the impact of environmental regulations on economic development at the state and local levels. A noticeable generalization from Tannenwald's research indicates that "most of the 10 studies find negative, statistically significant relationships between some measures of regulatory stringency and their measure of economic activity. However, these estimated effects tend to be small" (p. 87). The largest effect of environmental regulatory stringency on economic development, Tannenwald noted, was found in two 1996 studies of Matthew Kahn on particulate pollution and Vernon Henderson on the effects of air quality regulation on certain industries. Kahn's study concluded that manufacturing job growth in nonattainment counties with respect to PM was "9 percent slower than in 'attainment' counties" (Tannenwald, 1997, p. 88). Henderson's study on specific industries found that more regulated counties have fewer start-ups (7% to 10% less) than counties with less severe regulations (Tannenwald, 1997). Counties with less severe regulations will attract businesses if these feel confident that the "regulatory environment will remain favorable" (Tannenwald, 1997, p. 88). Industries would not consider counties going in and out of attainment frequently more attractive than counties having always nonattainment designations (Tannenwald, 1997). Another finding was that plants located in nonattainment areas were less likely to close; however, to stay in business, their growth was slower than plants in attainment areas (Tannenwald, 1997).

Berman and Bui (1997) conducted an analysis of the impact of air quality regultions on manufacturing plants in the Los Angeles area during the 1979-1991 period. Analizing manufacturing and employment data from the Census Bureau, the authors councluded that "the most severe episode of increased air quality regulation of manufacturing industries did not have a large effect on manufacturing employment" (p. 2).

Becker and Henderson (1997) examined the unintended consequences of air quality regulations as they related to decisions made by polluting industries during the early 1960s to early 1990s. Some of the unintended consequences include (a) the relocation of those industries from polluted areas to less polluted ones, which goes against the intentions of the Clean Air Act; (b) the increase of scaled-down plants due to lesser costs (small plants are not regulated as big plants); and (c) changes in investment decisions as to when to open or close plants. Becker and Henderson found that (a) polluting industries reduced the creation of firms between 40-50% in nonattainment areas; (b) more small and unregulated firms were established; (c) turnover of older plants due to pre-regulation grandfathering slowed air quality improvements; and (d) regulation affects investment, e.g., investment is more guarded in nonattainment areas than it is in attainment areas. Findings show that businesses make decisions of establishing new or relocating plants to less inhabited areas with attainment status, "hence fewer pollution victims to damage" (Becker & Henderson, 1997, p. 1). Becker and Henderson (1997) also found that such decisions led to improved air quality in nonattainment areas and a decline of air quality in attainment areas. Becker and Henderson (1999) also explored the impact of costs associated with ground level ozone regulations on the industrial organic chemicals and miscellaneous plastic product industries. These industries are major producers of volatile organic compounds (VOCs) and nitrogen oxides (NOx), the two ground level ozone precursors. The authors noted that previous research showed that the size and age of plants are significant factors of who, when, and how exhaustively plants are

regulated. Becker and Henderson (1999) found that regulation (a) increased production costs, especially for newer plants; (b) led plants to limit their size; and (c) changed investment patterns, with more investment at the beginning and less in the future. The authors also provided a summary of required technologies for plants in nonattainment and attainment areas. Table 7 provides the summary.

TABLE 7. ENVIRONMENTAL REGULATIONS: REQUIRED TECHNOLOGY

Plant Category	Area Designation	Required Technology	Notes
New	Nonattainment	Lowest Achievable Emission Rates (LAER)	Installation of cleanest available equipment. Cost is not considered.
Existing: expanding and/or renewal	Nonattainment	Lowest Achievable Emission Rates (LAER)	Installation of cleanest available equipment. Cost is not considered.
Existing: grandfathered	Nonattainment	Reasonably Available Control Technology (RACT)	Simple retrofit. Cost is taken into account. Grandfathered until equipment upgrades.
New (emitting over 100 tons/year)	Attainment	Best Available Control Technology (BACT)	Regulated on capital equipment. Sensitive to cost impact on firm. Negotiated on case-by-case.
New small	Attainment	No requirements	
Existing	Attainment	No requirements	

Expanding on this information, before starting construction, all stationary sources must obtain permits. Table 8 shows DHEC's summary of required new source review permits in SC (South Carolina Department of Health and Environmental Control, 2011).

TABLE 8. NONATTAINMENT AREAS PERMITTING: NEW SOURCE REVIEW PERMITS

Types of Permit	Required Technology	Notes
Prevention of Significant Deterioration (PSD)	BACT	New major sources or existing major sources making major modifications.
Nonattainment New Source Review (NNSR)	LAER	New or expanding major sources. Customized for the area. Must provide emissions offsets and opportunity for public involvement.
Minor New Source Review (Minor NSR)		Stationary sources that are not required PSD or NNSR permits. Purpose: prevent construction interfering with attainment or maintenance of NAAQS or violate pollution control strategies in nonattainment areas.

Source: SC Department of Health and Environmental Control

Condliffe and Morgan (2009) examined the effects of ground level ozone regulations on location decisions of pollution intensive plants. The results showed that the construction of new plants decreased in nonattainment counties. Another finding revealed that population also impacted the location of plants, i.e., industries located in more densely populated areas to take advantage of the labor

market. Areas with higher property taxes also prevented industries from establishing in those areas. Condliffe and Morgan provided evidence that a nonattainment designation "significantly deters new high-polluting plant births in the affected counties" (p. 92). Thus, installing the mandatory cleanest technology to reduce emissions requires a significant cost to industries, which, in turn, impact location decisions (Condliffe & Morgan, 2009).

Most of the reviewed literature supports what has been generally accepted in the economic development field that (a) industries would not consider nonattainment designated areas when relocating their businesses; (b) existing industries may not be able to expand if located in nonattainment areas until they show that the expansion would not make air quality worse; and (c) industries would have to go through the cumbersome, lengthy, and costly NSR permitting process. In non-attainment areas with higher non-attainment classifications (i.e., serious, severe, and extreme), even small sources become major sources of pollution for permitting and other requirements purposes. Consider the example of industries in the south-central part of New Hampshire,

> Senator Molly Kelly, who lives in Keene, [NH], gathered local officials at a meeting at Cheshire Medical Center to discuss the public health dimensions of air pollution, and also the economic development consequences of it. On this latter point, if air quality gets too bad here, federal Clean Air Act sanctions for businesses could automatically kick in; unintendedly, those sanctions would do nothing to reduce the emissions of particulate matter from wood stoves and other heating devices that are the perceived main sources of the air quality problem.
>
> The sanctions would apply to factories — either ones that plan to move here or ones that are already doing business in the area — and would require them to meet extra high standards for their smokestacks and boilers. The sanctions would be similar to ozone related requirements in the south-central part of the state that have forced employers to reduce emissions that lead to smog. In some cases, employers have found it makes more business sense to avoid triggering such costly mandates by simply cutting back their production. (SentinelSource.com, 2012)

Conclusion

Signing the 2002 Early Action Compact triggered a series of initiatives to reduce emissions and improve air quality in Upstate SC. EPA designated the Upstate region as an attainment area in 2008 for ground level ozone. In 2009, EPA designated South Carolina as an "unclassifiable/attainment" area for $PM_{2.5}$. According to EPA, air quality has improved nationally since both, ground level ozone and $PM_{2.5}$ concentrations have had a downward trend through 2015. In South Carolina and Greenville County, air quality has also improved.

The CAA requires EPA to revise the NAAQS periodically. EPA revised the standard for ground level ozone in 2008 from 0.08 ppm to

0.075 ppm. In October 2015, EPA announced that the new ozone standard was set at 0.070 ppm (or 70 ppb). In June 2012, EPA proposed strengthening the annual $PM_{2.5}$ standard at 12 $\mu g/m^3$ and retaining the 24-hour $PM_{2.5}$ standard. In light of the revisions that EPA has completed on the ground level ozone NAAQS, it is anticipated that future revisions of this standard will only get tighter. It is important that Upstate stakeholders including counties, residents, businesses, and industries join forces to continue developing strategies that could be implemented at the regional level. Air knows no boundaries.

Between 2008 and 2011, in Upstate SC, the net decrease in NOx and VOC emissions was 2,953 tons and 5,813 tons, respectively, for a total net decrease of 8,766 tons of combined NOx and VOC emissions. In 2008 and 2011, Greenville County was the highest emitter of NOx and VOC emissions followed by Spartanburg County and Anderson County. From 2008 to 2011, the largest increase in total (combined) NOx and VOC emissions was in the biogenics source category followed by gas stations and industrial processes. The largest decrease was in the solvent category followed by mobile sources and fires.

The Upstate SC is a NOx-limited area. In a NOx-limited scenario (i.e., high VOC/NOx ratios), ground level 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. **Reducing NOx emissions from mobile sources would have better results in preventing the formation of ground level ozone**. Implementation of air quality strategies to meet future and tighter standards requires the collaboration of federal, state, and local governments. Federal rules include requirements to reduce interstate transport of ozone, Tier 3 emission control requirements for vehicles and motor fuels, emission standards for combustion engines, retrofit technologies, and boilers, and clean power. In addition to local and regional efforts, it is expected that implementing such rules and requirements will also help the region to reduce emissions from mobile sources but more needs to be done at the local level. At the local level and with an increasing population in Greenville County, reducing NOx emissions requires the collaboration of the community, businesses, industries, non-profit organizations, and individuals to develop and implement local strategies to improve air quality, **especially strategies in the transportation field**, to meet future and tighter air quality standards, improve health outcomes, and increase economic development opportunities.

Mobile and biogenics were the largest sources of NOX and VOC emissions in Greenville County in 2008 and 2011. Emissions from mobile sources dropped while emissions from biogenic sources increased in 2011. In 2008, emissions from mobile sources represented 40.37% (18,719 tons) of total NOx and VOC emissions while biogenic emissions represented 34.88% (16,174 tons). In 2011, emissions from biogenic sources represented 40.84% (18,500 tons) of total NOx and VOC emissions while mobile emissions represented 37.98% (17,202 tons). The net change in total NOx and VOC emissions between 2008 and 2011 was a decrease of 1,075 tons in Greenville County. Air quality has also improved in the county while there has been an increase in capital investment and jobs creation as demonstrated in this report.

The Upstate Air Quality Advisory Committee held its first meeting on November 4, 2010, and it has been actively meeting since then with Ten at the Top as the facilitator of the efforts with other public, private, and nonprofit stakeholders in the region. The committee

meets on a quarterly basis at TATT's office located at 124 Verdae Boulevard, Suite 202, Greenville, SC, 29607. This committee is composed of nonprofit, public, and private sector organizations and it will continue to be instrumental in developing regional collaborative efforts. Committed to decrease NOx emissions, through the Clean Air Upstate initiative, TATT increased the number of schools in the Upstate SC that have implemented the Breather Better program, expanded public education throughout the Upstate region, and continuous lending support to local governments to improve air quality.

Please remember…"*It All Adds Up to Cleaner Air*."

Appendix A: Upstate South Carolina - 2008 and 2011 NOx and VOC Emissions by County

County	2008			2011			2008 – 2011 Change		
	NOx emissions (Tons)	VOC emissions (Tons)	Total NOx and VOC Emissions (Tons)	NOx emissions (Tons)	VOC Emissions (Tons)	Total NOx and VOC Emissions (Tons)	NOx Emissions Change (Tons)	VOC Emissions Change (Tons)	Total NOx and VOC Emissions Change (Tons)
Abbeville	1,112	16,580	17,692	1,146	16,018	17,164	35	(562)	(528)
Anderson	8,541	25,248	33,790	7,581	23,502	31,083	(960)	(1,747)	(2,707)
Cherokee	3,102	14,840	17,942	3,202	13,101	16,303	100	(1,739)	(1,639)
Greenville	13,690	32,680	46,370	12,860	32,435	45,295	(830)	(246)	(1,075)
Greenwood	2,382	16,483	18,865	2,210	16,642	18,853	(171)	159	(12)
Laurens	3,389	22,465	25,853	3,519	22,590	26,109	131	125	256
Oconee	2,628	18,781	21,409	2,483	19,325	21,808	(145)	545	399
Pickens	3,401	18,322	21,723	3,179	18,500	21,679	(222)	179	(44)
Spartanburg	12,712	30,061	42,773	11,865	28,616	40,481	(847)	(1,445)	(2,292)
Union	1,231	18,062	19,293	1,187	16,980	18,167	(44)	(1,082)	(1,125)
Totals	52,188	213,522	265,709	49,234	207,709	256,943	(2,953)	(5,813)	(8,766)

Source: USEPA, National Emissions Inventory (https://www.epa.gov/air-emissions-inventories/national-emissions-inventory)

Appendix B: Summary of Upstate South Carolina - 2008 and 2011 NOx and VOC Emissions by Source

	2008 Emissions			2011 Emissions			2008 - 2011 Emissions Change		
Source	NOx (Tons)	VOC (Tons)	Total NOx and VOC (Tons)	NOx (Tons)	VOC (Tons)	Total NOx and VOC (Tons)	NOx (Tons)	VOC (Tons)	Total NOx and VOC (Tons)
Biogenics	1,058	151,815	152,873	2,166	156,352	158,518	1,108	4,537	5,645
Bulk Gasoline	3	796	799	4	684	688	1	(112)	(110)
Commercial Cooking	-	48	48	-	61	61	-	13	13
Fires	555	7,623	8,178	389	4,303	4,692	(166)	(3,320)	(3,486)
Fuel Combustion	8,124	777	8,901	7,532	1,146	8,678	(592)	369	(224)
Gas Stations	-	6,430	6,430	-	6,913	6,913	-	484	484
Industrial Processes	509	2,946	3,455	348	3,384	3,732	(161)	438	277
Miscellaneous Non-Industrial NEC	4	1,339	1,344	5	1,423	1,428	0	84	84
Mobile	41,415	23,172	64,586	38,474	20,859	59,334	(2,940)	(2,312)	(5,253)
Solvent	2	17,426	17,427	2	11,887	11,889	1	(5,539)	(5,538)
Waste Disposal	519	1,149	1,668	314	696	1,010	(205)	(453)	(658)
Totals	52,188	213,522	265,709	49,234	207,709	256,943	(2,953)	(5,813)	(8,766)

Source: USEPA, National Emissions Inventory (https://www.epa.gov/air-emissions-inventories/national-emissions-inventory)

Appendix C: Detailed Upstate South Carolina - 2008 and 2011 NOx and VOC Emissions by Source

Source	2008 Total NOx and VOC Emissions (Tons)	2011 Total NOx and VOC Emissions (Tons)	2008-2011 Total NOx and VOC Emissions Change (Tons)
Biogenics - Vegetation and Soil	152,873	158,518	5,645
Bulk Gasoline Terminals	799	688	(110)
Commercial Cooking	48	61	13
Fires - Agricultural Field Burning	-	14	14
Fires - Prescribed Fires	8,089	4,492	(3,597)
Fires - Wildfires	89	186	96
Fuel Comb - Commercial/Institutional - Biomass	81	22	(58)
Fuel Comb - Commercial /Institutional - Coal	79	3	(76)
Fuel Comb - Commercial /Institutional - Natural Gas	440	375	(66)
Fuel Comb - Commercial /Institutional - Oil	11	37	25
Fuel Comb - Commercial /Institutional - Other	99	52	(47)
Fuel Comb - Electric Generation - Biomass	-	9	9
Fuel Comb - Electric Generation - Coal	1,656	945	(711)
Fuel Comb - Electric Generation - Natural Gas	272	550	278
Fuel Comb - Electric Generation - Oil	38	73	35
Fuel Comb - Electric Generation - Other	9	53	44
Fuel Comb - Industrial Boilers, ICEs - Biomass	1,790	1,597	(193)
Fuel Comb - Industrial Boilers, ICEs - Coal	464	590	126
Fuel Comb - Industrial Boilers, ICEs - Natural Gas	2,664	2,242	(423)
Fuel Comb - Industrial Boilers, ICEs - Oil	75	637	562
Fuel Comb - Industrial Boilers, ICEs - Other	14	38	24
Fuel Comb - Residential - Natural Gas	544	547	3
Fuel Comb - Residential - Oil	100	48	(52)
Fuel Comb - Residential - Other	147	122	(25)
Fuel Comb - Residential - Wood	416	737	321
Gas Stations	6,430	6,913	484

Source	2008 Total NOx and VOC Emissions (Tons)	2011 Total NOx and VOC Emissions (Tons)	2008-2011 Total NOx and VOC Emissions Change (Tons)
Industrial Processes - Chemical Manufacturing	609	694	85
Industrial Processes - Ferrous Metals	68	-	(68)
Industrial Processes - NEC	2,014	2,045	31
Industrial Processes - Non-ferrous Metals	4	2	(2)
Industrial Processes - Pulp & Paper	196	291	95
Industrial Processes - Storage and Transfer	564	700	136
Miscellaneous Non-Industrial NEC	1,344	1,428	84
Mobile - Aircraft	154	204	50
Mobile - Locomotives	2,432	2,361	(71
Mobile - Non-Road Equipment - Diesel	5,400	4,766	(634)
Mobile - Non-Road Equipment - Gasoline	8,357	7,598	(759)
Mobile - Non-Road Equipment - Other	1,786	1,040	(746)
Mobile - On-Road Diesel Heavy Duty Vehicles	13,299	14,558	1,259
Mobile - On-Road Diesel Light Duty Vehicles	456	669	213
Mobile - On-Road non-Diesel Heavy Duty Vehicles	1,929	753	(1,176)
Mobile - On-Road non-Diesel Light Duty Vehicles	30,774	27,385	(3,389)
Solvent - Consumer & Commercial Solvent Use	5,829	5,940	112
Solvent - Degreasing	1,223	314	(909)
Solvent - Dry Cleaning	410	4	(406)
Solvent - Graphic Arts	3,534	853	(2,681)
Solvent - Industrial Surface Coating & Solvent Use	4,414	3,184	(1,230)
Solvent - Non-Industrial Surface Coating	2,017	1,594	(423)
Waste Disposal	1,668	1,010	(658)
Totals	265,709	256,943	(8,766)

Source: USEPA, National Emissions Inventory (https://www.epa.gov/air-emissions-inventories/national-emissions-inventory)

Appendix D: Greenville County, SC - Summary of 2008 and 2011 NOx and VOC Emissions by Source

Greenville County Emissions by Source	2008				2011				2008 – 2011 Change		
	NOx emissions (Tons)	VOC emissions (Tons)	Total NOx and VOC Emissions (Tons)	Percent	NOx emissions (Tons)	VOC emissions (Tons)	Total NOx and VOC Emissions (Tons)	Percent	NOx (Tons)	VOC (Tons)	Combined NOx and VOC (Tons)
Biogenics	145	16,029	16,174	34.88%	254	18,247	18,500	40.84%	109	2,217	2,326
Bulk Gasoline Terminals	-	20	20	0.04%	-	20	20	0.04%	-	(0)	(0)
Commercial Cooking	-	16	16	0.03%	-	26	26	0.06%	-	10	10
Fires	54	696	750	1.62%	32	316	348	0.77%	(22)	(380)	(402)
Fuel Combustion	1,347	145	1,492	3.22%	1,423	349	1,772	3.91%	76	204	280
Gas Stations	-	2,067	2,067	4.46%	-	2,179	2,179	4.81%	-	112	112
Industrial Processes	99	637	736	1.59%	90	783	873	1.93%	(9)	145	136
Miscellaneous Non-Industrial NEC	1	546	547	1.18%	2	580	581	1.28%	0.13	34	34
Mobile	12,042	6,677	18,719	40.37%	11,059	6,144	17,202	37.98%	(983)	(533)	(1,516)
Solvent	1	5,814	5,815	12.54%	1	3,750	3,751	8.28%	0.32	(2,065)	(2,064)
Waste Disposal	0	33	34	0.07%	0	42	42	0.09%	(0.07)	9	9
Totals	13,690	32,680	46,370	100%	12,860	32,435	45,295	100%	(830)	(246)	(1,075)

Source: USEPA, National Emissions Inventory (https://www.epa.gov/air-emissions-inventories/national-emissions-inventory)

Appendix E: Greenville County, SC - Detailed 2008 and 2011 NOx and VOC Emissions by Source

Source	2008 Total NOx and VOC Emissions (Tons)	2011 Total NOx and VOC Emissions (Tons)	2008-2011 Total NOx and VOC Emissions Change (Tons)	2008-2011 NOx Emissions Change (Tons)	2008-2011 VOC Emissions Change (Tons)
Biogenics - Vegetation and Soil	16,174	18,500	2,326	109	2,217
Bulk Gasoline Terminals	20	20	(0)	-	(0)
Commercial Cooking	16	26	10	-	10
Fires - Agricultural Field Burning	-	1	1	0	0
Fires - Prescribed Fires	750	329	(421)	(24)	(397)
Fires - Wildfires	-	18	18	2	17
Fuel Combustion - Commercial/Institutional - Biomass	38	10	(27)	(26)	(2)
Fuel Combustion - Commercial /Institutional - Coal	-	1	1	1	0
Fuel Combustion - Commercial /Institutional - Natural Gas	255	155	(100)	(94)	(5)
Fuel Combustion - Commercial /Institutional - Oil	7	23	15	15	1
Fuel Combustion - Commercial /Institutional - Other	21	38	17	1	16
Fuel Combustion - Electric Generation - Natural Gas	0	0	(0)	(0)	(0)
Fuel Combustion - Electric Generation - Oil	1	12	10	10	1
Fuel Combustion - Industrial Boilers, ICEs - Biomass	482	430	(51)	(48)	(4)
Fuel Combustion - Industrial Boilers, ICEs - Coal	24	101	77	76	0
Fuel Combustion - Industrial Boilers, ICEs - Natural Gas	301	286	(15)	(13)	(2)
Fuel Combustion - Industrial Boilers, ICEs - Oil	22	194	171	159	13
Fuel Combustion - Industrial Boilers, ICEs - Other	12	35	23	1	22
Fuel Combustion - Residential - Natural Gas	198	199	1	1	0
Fuel Combustion - Residential - Oil	33	16	(17)	(16)	(1)
Fuel Combustion - Residential - Other	32	26	(6)	(5)	(1)
Fuel Combustion - Residential - Wood	66	248	181	13	168
Gas Stations	2,067	2,179	112	-	112
Industrial Processes - Chemical Manufacturing	230	261	32	4	27

Source	2008 Total NOx and VOC Emissions (Tons)	2011 Total NOx and VOC Emissions (Tons)	2008-2011 Total NOx and VOC Emissions Change (Tons)	2008-2011 NOx Emissions Change (Tons)	2008-2011 VOC Emissions Change (Tons)
Industrial Processes - NEC	467	554	87	(14)	101
Industrial Processes - Pulp & Paper	0	0	0	-	0
Industrial Processes - Storage and Transfer	40	57	17	-	17
Miscellaneous Non-Industrial NEC	547	581	34	0	34
Mobile - Aircraft	20	17	(4)	(1)	(2)
Mobile - Locomotives	165	156	(9)	(9)	(0)
Mobile - Non-Road Equipment - Diesel	1,985	1,756	(229)	(203)	(26)
Mobile - Non-Road Equipment - Gasoline	2,221	2,008	(212)	37	(249)
Mobile - Non-Road Equipment - Other	567	333	(234)	(184)	(50)
Mobile - On-Road Diesel Heavy Duty Vehicles	4,011	4,333	322	224	98
Mobile - On-Road Diesel Light Duty Vehicles	143	208	65	24	42
Mobile - On-Road non-Diesel Heavy Duty Vehicles	560	232	(328)	(200)	(129)
Mobile - On-Road non-Diesel Light Duty Vehicles	9,046	8,159	(887)	(671)	(216)
Solvent - Consumer & Commercial Solvent Use	1,873	1,928	55	-	55
Solvent - Degreasing	425	22	(403)	-	(403)
Solvent - Dry Cleaning	170	1	(169)	-	(169)
Solvent - Graphic Arts	1,255	289	(966)	0	(966)
Solvent - Industrial Surface Coating & Solvent Use	1,431	983	(447)	0	(448)
Solvent - Non-Industrial Surface Coating	662	528	(134)	-	(134)
Waste Disposal	34	42	9	(0)	9
Totals	46,370	45,295	(1,075)	(830)	(246)

Source: USEPA, National Emissions Inventory (https://www.epa.gov/air-emissions-inventories/national-emissions-inventory)

Bibliography

AirNow. (2014, February 5). *County Comparisons*. Retrieved July 16, 2015, from AirCompare - County Comparisons: http://www.epa.gov/aircompare/compare.htm

Bartik, T. J. (1988). The effects of environmental regulation on business location in the United States. *Growth and Change, 19*(3), 22-44.

Becker, R. A., & Henderson, J. V. (1999, August). *Costs of air quality regulation.* Retrieved from Naional Bureau of Economic Research: http://www.nber.org/papers/w7308

Becker, R., & Henderson, V. (1997). *Effects of airquality regulation on decisions of firms in polluting industries.* Retrieved from National Bureau of Economic Research: NBER Working Papers: http://www.nber/org/papers/w6160

Berman, E., & Bui, L. T. (1997). *Clearing the air: The impact of air quality regulations on jobs.* Washington, SC: Economic Policy Institute.

City of Greenville, South Carolina. (2012). *City of Greenville sustainability and mobility*. Retrieved from Sustainability: https://www.greenvillesc.gov/Sustainability/mobility.aspx

Condliffe, S., & Morgan, O. A. (2009). The effects of air quality regulations on the location decisions of pollution-intensive manufacturing plants. *Journal of Regulatory Economics, 36*(1), 83-93.

County of Greenville, South Carolina. (2002, December 18). *South Carolina's 8-hour ozone early action compact*.

County of Greenville, South Carolina. (2012). *Clean air awards*. Retrieved from Clean Air: http://www.greenvillecounty.org/air_quality/

Environmental Protection Agency. (2014, November 25). *Regulatory actions: National Ambient Air Quality Standards for Ozone.* Retrieved from Ground level ozone: http://www.epa.gov/groundlevelozone/actions.html#nov2014

Henderson, J. V. (1996). Effects of air quality regulation. *The American Economic Review, 86*(4), 789-813.

McCarthy, J. E., & Lattanzio, R. K. (2016). *Ozone Air Quality Standards: EPA's 2015 Revision.* Washington, DC: Congressional Research Service.

Osby, L. (2015, August 4). *State issues ozone alert for Upstate Wednesday*. Retrieved October 9, 2015, from Greenville News: http://www.greenvilleonline.com/story/news/local/2015/08/04/state-issues-ozone-alert-upstate-wednesday/31126657/

SentinelSource.com. (2012, January 25). *Local economic development could be hurt by air pollution*. Retrieved from Opinion Editorial:

http://www.sentinelsource.com/opinion/editorial/local-economic-development-could-be-hurt-by-air-pollution/article_948b1a7d-24fc-5730-b831-95bd267f965d.html

South Carolina Department of Health and Environmental Control. (2006). *2006 Early Action Compact Progress Report.* Retrieved from http://www.scdhec.gov/environment/baq/docs/EAP/December2006ProgressReports/Enclosure%203%20Local%20EAC%20Activities%20for%20Participating%20Areas/Appalachian%20Area%20December%202006%20Progress%20Reports/Anderson%20County%20December%202006%20Progress%20Re

South Carolina Department of Health and Environmental Control. (2011, April). *DHEC fact sheet: Nonattainment permitting.* Retrieved from http://www.scdhec.gov/administration/library/CR-010098.pdf

South Carolina Department of Health and Environmental Control. (2012, July 31). *Current ozone monitoring data*. Retrieved from Air Quality: Air Pollutants - Ozone - Forecasting and Monitoring: http://www.scdhec.gov/environment/baq/Ozone/ForecastingandMonitoring/current_ozone_data.asp

South Carolina Department of Health and Environmental Control. (2014). *South Carolina Ozone Advance and Particulate Matter (PM) Advance Programs: Path Forward Plan.* South Carolina Department of Health and Environmental Control, Bureau of Air Quality.

South Carolina Department of Health and Environmental Control. (2016, August 1). *State of South Carolina Network Description and Ambient Air Network Monitoring Plan - Calendar Year 2017.* Retrieved August 8, 2016, from Ambient Air Monitoring Network: http://www.scdhec.gov/HomeAndEnvironment/Docs/Final_2017%20Monitoring%20Plan%2020160728.pdf

Tannenwald, R. (1997). State regulatory policy and economic development. *New England Economic Review*, 84-107.

Ten at the Top. (2016). *About Ten at the Top*. Retrieved from Ten at the Top: http://tenatthetop.org/about/overview/

The Air Pollution Consultant. (1999). EPA plans to crack down on NSR violators—Injunctive relief guidance issued. *The Air Pollution Consultant, 9*(4), 3.1-3.6.

The White House. (2011, September 2). *Statement by the President on the Ozone National Ambient Air Quality Standards*. Retrieved from Office of the Press Secretary: http://www.whitehouse.gov/the-press-office/2011/09/02/statement-president-ozone-national-ambient-air-quality-standards

U. S. Environmental Protection Agency. (2008, January 31). *Communities Reduce Smog Ahead of Schedule*. Retrieved from Newsroom - 2008 News Releases: http://yosemite.epa.gov/opa/admpress.nsf/dc57b08b5acd42bc852573c90044a9c4/e414625cb91a5ede852573e100695d13!O

penDocument&Highlight=2,january,31,2008

U. S. Environmental Protection Agency. (2012a, July 13). *Area Designations for 2008 Ground-level Ozone Standards*. Retrieved from EPA HomeAir & Radiation - Six Common Pollutants - Ground-level Ozone - Ground-level Ozone Standards Designations - Area Designations for 2008 Ground-level Ozone Standards: http://www.epa.gov/ozonedesignations/2008standards/index.htm

U. S. Environmental Protection Agency. (2012b, October 23). *Fine Particle (PM2.5) Designations.* Retrieved from EPA Home - Air & Radiation - Six Common Pollutants - Particulate Matter - Fine Particle (PM2.5) Designations: http://www.epa.gov/pmdesignations/

U. S. Environmental Protection Agency. (2012c, July 13). *Area Designations for 2008 Ground-level Ozone Standards.* Retrieved from EPA Home Air & Radiation: Six Common Pollutants - Ground-level Ozone: www.epa.gov/ozonedesignations/2008standards/index.htm

U. S. Environmental Protection Agency. (2012d, July 19). *Area designations for 2006 24-Hour fine particle (PM2.5) standards*. Retrieved from EPA Home Air & Radiation: Six Common Pollutants - Particulate Matter: http://www.epa.gov/pmdesignations/2006standards/state.htm

U. S. Environmental Protection Agency. (2012e, July 27). *Counties Projected to Violate Primary 8-hr Ground-Level Ozone Standard in 2020.* Retrieved from Ozone pollution: http://www.epa.gov/air/ozonepollution/pdfs/CountyOzoneLevels2020primary.pdf

U. S. Environmental Protection Agency. (2012g, July 18). *Particulate matter (PM).* Retrieved from EPA Home Air & Radiation Six Common Pollutants - Particulate Matter: http://www.epa.gov/pm/2012/mapa.pdf, http://www.epa.gov/pm/2012/mapb.pdf, and http://www.epa.gov/pm/2012/mapc.pdf

U. S. Environmental Protection Agency. (2012i, January 23). *The bridge to cleaner air.* Retrieved from State and Local Transportation Resources: http://www.epa.gov/otaq/stateresources/transconf/420f06001.pdf

U. S. Environmental Protection Agency. (2012j, July 3). *New source review*. Retrieved from EPA Home Air and Radiation New Source Review: http://www.epa.gov/nsr/

U. S. Environmental Protection Agency. (2012k, May 3). *Ozone advance guidance*. Retrieved from EPA Home Air and Radiation - Air Quality Planning and Standards Ground Level Ozone - Ozone Advance - Basic Information: http://www.epa.gov/airquality/advance/pdfs/2012404guidance.pdf

U. S. Environmental Protection Agency. (2014, December). *Proposed Revisions to National Ambient Air Quality Standards for Ozone.* Retrieved July 16, 2015, from Ozone Pollution: http://www.epa.gov/airquality/ozonepollution/pdfs/2014decwebinar.pdf

U. S. Environmetal Protection Agency. (1990). *Clean Air Act.* Retrieved from http://www.airimpacts.org/documents/local/CleanAirAct.pdf

U. S. Environmetal Protection Agency. (2012f, May 1). *EPA takes next step to implement 2008 ozone standards / Most areas that need to take steps to reduce ozone pollution are close to meeting the standards; only three new areas have been added*. Retrieved from Newsroom: http://yosemite.epa.gov/opa/admpress.nsf/0/82A521A65A9B21F0852579F1005CE183

U. S. Environmetal Protection Agency. (2016). *Our Nation's Air: Status and Trends through 2015*. Retrieved August 8, 2016, from Air trends: https://gispub.epa.gov/air/trendsreport/2016/

U. S. General Printing Office. (2012, June 29). *Federal Register, Vol. 77, No. 176, Part II.* Retrieved from National Archives and Records Administration: http://www.gpo.gov/fdsys/pkg/FR-2012-06-29/pdf/2012-15017.pdf

U.S. Environmental Protection Agency. (2014). *Regulatory Impact Analysis of the Proposed Revisions to the National Ambient Air Quality Standards for Ground-Level Ozone.*

U.S. Environmental Protection Agency. (2015, April 6). *8-Hour Ozone Nonattainment Area Map (NAAQS Revoked)*. Retrieved August 9, 2016, from Green Book Nonattainment Areas: https://www3.epa.gov/airquality/greenbook/map8hr.html

United States Environmental Protection Agency. (2016, June 13). *PM2.5 Nonattainment Areas (2012 Standard)*. Retrieved August 8, 2016, from Green Book Nonattainment Areas: https://www3.epa.gov/airquality/greenbook/mappm25_2012.html

Upstate South Carolina's Information Hub. (2012). *Pickens County Makes the Case for Biodiesel*. Retrieved from OurUpstateSC.info: http://www.ourupstatesc.info/pickens-county-biodiesel.php

US Environmental Protection Agency. (2016, May 24). *National Emissions Inventory*. Retrieved August 25, 2016, from Air Emissions Inventories: https://www.epa.gov/air-emissions-inventories/national-emissions-inventory

US Environmental Protection Agency. (2016a, March 9). *2008 National Emissions Inventory (NEI) Data*. Retrieved August 11, 2016, from Air Emissions Inventories: https://www.epa.gov/air-emissions-inventories/2008-national-emissions-inventory-nei-data

US Environmental Protection Agency. (2016b, March 9). *2011 National Emissions Inventory (NEI) Data*. Retrieved August 11, 2016b, from Air Emissions Inventories: https://www.epa.gov/air-emissions-inventories/2011-national-emissions-inventory-nei-data

Woods, N. D., & Potoski, M. (2010). Environmental federalism revisited: Second-order devlution in air quality regulation. *Review of Policy Research, 27*(6), 712-739.

Notes

County of Greenville
Office of the County Administrator
301 University Ridge, Suite 2400
Greenville, South Carolina 29680
(864) 467-7409
cleanair@greenvillecounty.org