NORTH CAROLINA'S GREEN ECONOMY

A Report by Capstone Students at the University of North Carolina - Chapel Hill for the North Carolina Conservation Network

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Contributors: Adelle Schubarg, Blake Newton, Christian Rasnake, Claire Kubitschek, Delia Wegner, Garrett Basnight, John Thompson, Michael Meeks, Taylor Cooleen, Theo Pryzwansky and Virginia Sparks

Supervisor: David Salvesen

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Abstract

This study aims to quantify the impact of the green industry on North Carolina's economy through a sector analysis consisting of a comprehensive list of businesses within each sector that meet the definition of a "green" business as defined in this report. The metrics used to represent the green industry's impact include number of jobs, number of firms and sales volume. Our goal was to develop an initial estimate of the contribution of the green industry as well as a methodology by which the North Carolina Conservation Network can measure annually the impact of green industries in North Carolina and to track progress over years to come. This report also seeks to use data gathered to garner support for the green industry in quantifying its influence on the North Carolina economy at large.

Acknowledgements

<u>Executive Summary</u>

As the impacts of climate change become more apparent, private firms, nonprofit organizations, and government agencies are incorporating sustainability into their business models, marketing strategies, and missions. Customer demands, government subsidies, and technological innovations have all led the "green economy" to become an important factor in both climate change mitigation and the overall economy. Our capstone group was tasked with creating a set of metrics to represent the share of the North Carolina economy that can be described as "green". Our goal was to identify metrics that would be based on a convincing definition for the word green, use data that would be readily available, and be easily replicable on an annual or biennial basis. This report summarizes the results of our semester-long capstone project to estimate the impact of green jobs and firms in North Carolina. It was produced with the intention of being replicated by the North Carolina Conservation Network for use in its State of the Environment Report.

Findings at a Glance

We identified eight major sectors of the economy (as seen in Table A below) that are likely to contain green businesses. We used different methodologies to generate estimates for total firms, jobs, and economic contribution of the green portion of each sector. In some cases, e.g., for the renewable energy sector, we relied on estimates compiled annually by other entities, such as the North Carolina Sustainable Energy Association. For other sectors, we developed a methodology based on the best available data. Overall, we found that the green economy accounts for a small, but significant portion of the North Carolina economy. About 22,366 firms, approximately 1.1% of all firms in North Carolina, can be considered green and have in turn created approximately 557,138 green jobs in the state. These jobs account for approximately 11.3% of jobs in North Carolina. We estimate that these green organizations have contributed $218 trillion in total sales to the North Carolina economy in 2019.

Table 1: Green Economy Findings by Sector

Sector	Firms		Jobs		Economic Contribution[1]	
	# of Green	% of Sector Considered Green	# of Green	% of Sector Considered Green	Sales Volume of Green Firms **in millions**	% of Sector Considered Green
Renewable Energy	1,717	100%	43,238	100%	$14,200.0	100%
Recycling & Waste Management	339	39%	3,218	34%	$852.8	54%
Remediation	26	37%	350	66%	$53.1	63%
Conservation	193	97%	1,621	94%	$290.2	93%
Research & Development	1,859	27%	26,950	21%	$4,600[2]	14%[3]
Manufacturing	17,426	40%	467,899	26%	$155,269.2	17%
Agriculture	624	1.3%	13,166	3.9%	$1,117.5	8%
Transportation	182	100%	696	100%	$17.4	100%
Total Green Economy:	**22,366 Green Firms**	**1.1% of All Firms in NC are Green**	**557,138 Green Jobs**	**11.3% of All Jobs in NC are Green**	**$218 trillion in sales volume contributed to the NC economy**	
Total NC Economy:	**1,882,632 Total Firms**		**4,945,600 Total Jobs**			

1. Economic Contribution = average total sales volume
2. Economic contribution to Gross Regional Product
3. Percent of Gross Regional Product contributed

The numbers in Table 1 represent a snapshot of North Carolina's green economy in 2019. As this report is compiled in future years, it will be important to analyze the trends in growth or decline of green firms, jobs and their economic contribution over time. It will also be important to see how government legislation and the state of the economy affect the trends in growth or decline of the green economy.

Recommendations at a Glance

Based on our findings, we offer a few recommendations to improve our methodology and our process as a whole. The sample size for our surveys were quite small, sometimes as small as 10 respondents. Thus, we suggest that supplemental surveys should be distributed to a larger

sample of organizations in order to compare with our results. The information collected during this process should be kept and recorded in a database on an annual basis to analyze trends and data over time. To simplify the data collection process, we suggest that the NCCN and other non-profit environmental groups should advocate for a universal standard for identifying green businesses, which can be embedded into the NAICS code system. Additional recommendations can be found in the recommendations section of our report.

Introduction

In recent years, green practices and products have gained a lot of attention from organizations, as both producers and consumers are seeking to become more sustainable. The plethora of green labels - for everything from organically grown produce to green buildings and green, renewable energy - is a testament to this trend. Organizations are catching on. A growing number of firms are going green, specializing in the production of green products or the greening of the production process. But what, exactly, is meant by "green"? Despite its colloquial use, the exact terms and characteristics of a green business or job are not standard, which makes identifying and analyzing the "green" industry especially difficult. It also makes finding the impact of the "green" industry on the economy of North Carolina very challenging.

This study sought to quantify the impact of the "green" industry on the North Carolina economy. For our analysis, the "green" industry includes economic activity from non-profit organizations, government agencies, and for-profit businesses that results in or promotes reduced environmental impacts. We use the term "firm" in this study to represent all of groups within the green industry, inclusive of the ones listed above. We split the industry into eight sectors and estimated the number of green jobs, businesses and annual sales in each sector, where applicable.

This study was the focus of a UNC Capstone project with the university's Environment and Ecology program. A capstone is a semester-long group project charged with tackling an environmental research question for a client. For this project, our client was the North Carolina Conservation Network - a coalition of environmental organizations that produces a report each year on green businesses in North Carolina. The NCCN tasked our group with finding a simple, replicable methodology for estimating the annual contribution of green industries to the North Carolina economy. As such, this study is intended to create a methodology that the NCCN can use each year to measure the impact of the green industry in North Carolina. In addition, this report also seeks to use the findings on economic contribution to garner support for sustainable businesses and the green industry as a whole in quantifying its influence in the North Carolina economy.

The primary objectives of the study are as follows:

- Estimate the number of businesses, jobs, and total revenues in the green industry in North Carolina,

- Create a procedure to estimate the impact of the green industry in North Carolina, and

- Contribute to other green economy studies, providing data that researchers and the North Carolina Conservation Network can analyze further.

Defining a Green Business

There are many different definitions of what constitutes a green business. We reviewed definitions used by other organizations, including the Brookings Institution, the State of California, and the U.S. Bureau of Labor Statistics. Drawing from these, we developed our own definition of a green business. A more detailed examination of these studies is provided in the Literature Review in the methods section of our report. Our definition is based on six pillars, summarized below, as well as fully expanded later in the Appendix.

In order to be included in our analysis, an operation must adhere to at least one of the following six pillars:

1. **Generate and/or rely on renewable energy and/or conserve energy.**

   Examples include wind, solar, geothermal, and hydropower.

2. **Reduce, reuse, or reconstitute waste.**

   Businesses that specialize, are actively involved in, or promote these actions. Businesses that meet this pillar essentially limit the amount of waste circulating in our environment.

3. **Conserve and remediate natural resources and ecosystems.**

   This pillar constitutes any action taken to preserve the environmental or cultural integrity of an area by way of maintenance or restoration, depending on the site. Examples include wildlife conservation organizations and Brownfield clean-up crews.

4. **Invest capital in green initiatives and companies.**

   This pillar captures organizations or businesses that support the green industry monetarily. 25% of total capital investments must qualify as green.

5. **Environmental compliance, education and training, and public awareness.**

This pillar is meant to encompass all educational efforts, not limited to consulting, specialty programming, and community outreach and action initiatives as they relate to restoration and sustainable living.

6. **Manufacturing green or sustainable products or materials.**

Examples include turning plastic waste into usable goods or manufacturing compostable materials.

Overview of the Report

The remainder of this report is organized into six sections. The first section, Methods, describes the process followed to gather data and develop estimates of green businesses, jobs, and revenues using our definition. It also includes our Literature Review, which includes a brief summary on the relevant literature on green industries we used and found helpful when conducting our research. This is followed by our Findings, which presents our results for employment and economic impact by sector as well as for the green industry in North Carolina. The Recommendation section follows and highlights potential areas of improvement for the study, how to increase support and awareness of the green economy, and steps the NCCN can take to both use and further improve the job ranking procedure to fit their needs and future changes in the industry. The paper comes to a close with the Conclusion, which provides analysis for the measured economic impact of North Carolina's green industry based on our findings. Conclusions are made for both the process of capturing green businesses in North Carolina as well as the quantifiable results that the process provided. The Appendix that follows fleshes out any aforementioned topic that was not fully explained, including an expanded look at our definition, the math behind the numbers in our findings, limitations we faced, and any justification for our conclusions.

Methods

NAICS and ReferenceUSA

Once we identified the relevant categories for our analysis, we looked for data on what concrete sectors could be formed across the brainstormed categories. During this beginning phase of our research, we came across the North American Industry Classification System (NAICS) codes, and determined that they were the most straightforward way to identify the firms in our respective sectors. It was important to us to have the same classification system for almost all of our sectors, as it would yield the most accurate and consistent results across our research. These NAICS codes that we chose for our research are identified below in Table 2. After we chose to utilize NAICS codes for our research, we met with Todd BenDor who pointed us in the direction of the ReferenceUSA database. Reference USA is a business and residential database created by the Infogroup marketing company that allows users to search business statistics nationwide, filtering information based on location, NAICS or SIC codes, and numerous other specificities. With ReferenceUSA, we were able to filter results to include North Carolina organizations that fell under our individual NAICS codes. The database provided information on each organization's economic contribution such as total sales volume, as well as an employment metric. ReferenceUSA continually maintains its database and phone-verifies their records annually to provide accurate, up-to-date information. Because of this, we chose to use ReferenceUSA as our main source of data. ReferenceUSA and NAICS codes were very helpful tools in identifying and gathering data relevant to our study, but unfortunately, could not be used for all of our identified sectors. The renewable energy, research and development, and agriculture sectors did not use either of these tools, and outline their methods of data collection in their respective methods sections below.

Sector	NAICS Code Used
Renewable Energy	N/A - NC Clean Energy Industry Census
Recycling and Waste Management	5621 - Waste Collection 5622 - Waste Treatment and Disposal 5629 - Remediation and Other Waste Management Services
Remediation and Conservation	813312 Environment, Conservation, and Wildlife Organizations 562910 Remediation Services
Research and Development	N/A -- Research Triangle CleanTech Cluster
Manufacturing	31-33 Manufacturing
Agriculture	N/A -- USDA Organic Integrity Database
Transportation	4851 - Urban Transit Systems 4852 - Interurban and Rural Bus Transportation 4821 - Rail Transportation

Generating a Job Ranking System

With the definition in place, our sectors identified, and a database of businesses and organizations to pull from, we needed a way to quickly identify and compile a list of businesses that qualified as "green". As NAICS codes were the primary form of industry identification for ReferenceUSA, a system was needed that could take advantage of these federal classifications to capture those "green" businesses. There are hundreds of possible NAICS codes that can further be divided into subsectors and other specialized groups. Following the organizational hierarchy of the codes, our procedure took a top-down approach to capturing green businesses in North Carolina by first searching within broad industry classifications and eventually making our way

down to sub sectors if necessary. For example, the larger Renewable Energy sector can be further divided into sub-sectors like solar, energy efficiency, wind, and others. Sectors that are not outwardly green are analyzed further and are categorized according to their contribution to the green economy as determined by our definition and information from both ReferenceUSA and the company's website.

Procedure:

1. Identify NAICS codes, two-digit "core" industries, that would be considered 100% green and are fully contributing to a green economy. In other words, core industries whose sectors and subsectors meet our definition criteria. For example, industries devoted to recycling or renewable energy would be considered core industries.
   a. As all of the sectors underneath this core industry would be considered green, all of the jobs would as well.
   b. Search in ReferenceUSA for company listings and job numbers.
2. All other industries are now considered "non-core" industries, such as Transportation and Warehousing (49-49) or Manufacturing (31-33), where the industry is either not easily defined as green or difficult to attribute greenness to the industry as a whole. These non-core industries will be identified according to their contribution to a green economy and the function green practices have in their business. The three identifiers include "primary", "secondary", "none", or "unknown".
   a. Within these non-core industries, identify all sub-sectors that would be considered green according to our defined criteria. These sub-sectors are considered to have a **"primary"** contribution to the green economy. Count 100% of the jobs in this group. For example, the Urban Transit Systems subsector (4851) listed under Transportation and Warehousing would be considered a primary contributor as urban transit includes public transportation and passenger rail services, such as Amtrak, that reduce dependence on single-use vehicles and thus conserve and remediate natural resources and ecosystems, meeting pillar three of our definition criteria.
3. The remaining sub-sectors that, as a whole, are not considered green are now analyzed at the firm level.

a. Visit the company's website and view their mission statement. If any of the defined criteria for a green business is mentioned in their mission statement, the company is considered **"secondary"**. Count 50% of the jobs for this company. For example, a winery that practices sustainable and low-impact farming methods would have a secondary contribution to the green economy as its parent sector - Beverage and Tobacco Product Manufacturing (312) - is not an outwardly green service.

b. If none of the above are true or applicable and information on the mission statement or website does not involve our defined criteria, the company is considered to have no contribution to the green economy and is therefore identified as **"none"**. Count 0% of jobs for this company.

c. If there is no information available for the company, including a website or any known documents, they will be identified as **"unknown"**.

A guide to following this procedure is visualized in the flowchart below.
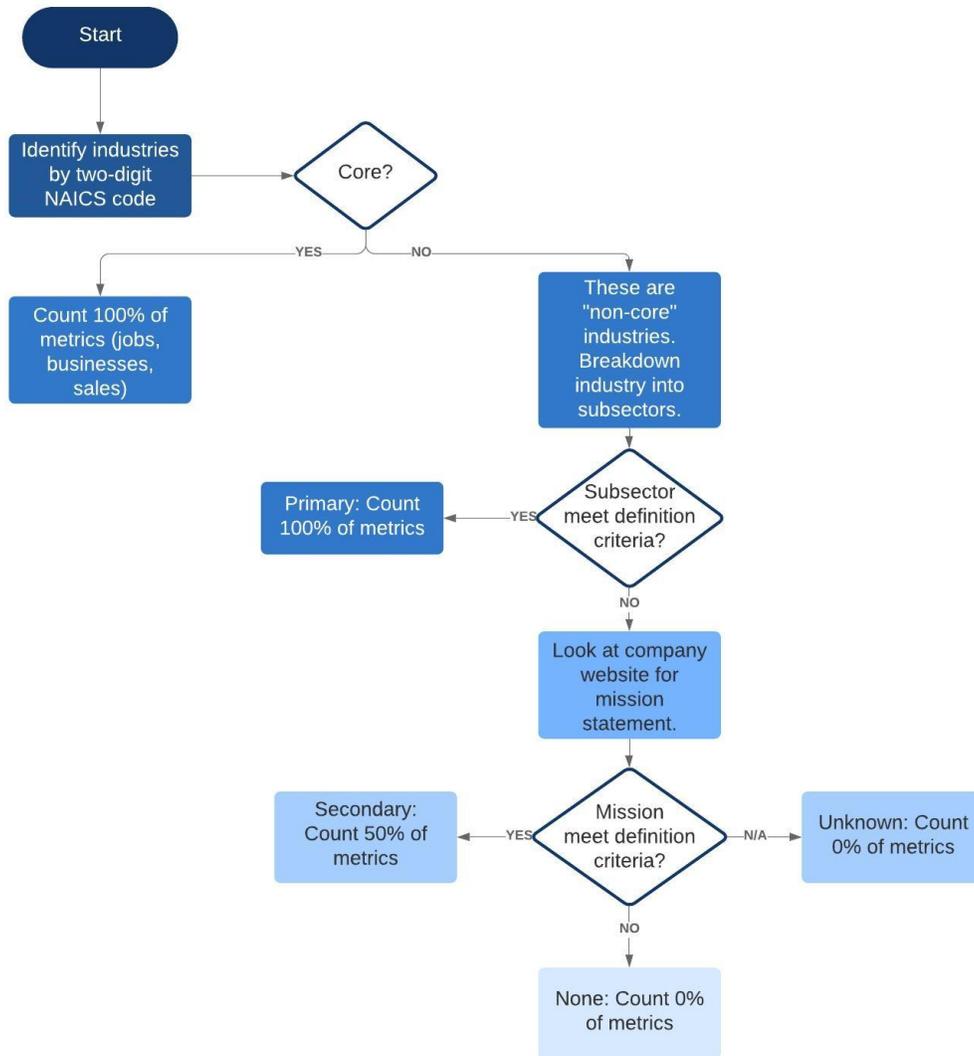
Diagram 1. Procedural Flowchart

Literature Review

We reviewed several relevant studies that evaluated and defined green industries in the U.S. to aid in the construction of our own definition as well as how to conceptualize the project as a whole. From these studies, we gained a more complete understanding of the green industry and gathered ideas and methods that guided our own research. Definitions used by the literature to characterize the green economy are outlined in the table below, followed by a brief summary of the studies we reviewed.

Table 3: A Collection of Green Definitions

Source	Definition
Brookings Institution	"The clean economy is economic activity - measured in terms of establishments and the jobs associated with them - that produces goods and services with an environmental benefit or adds value to such products using skills or technologies that are uniquely applied to those products"
OECD	"The environmental goods and services industry consists of activities which produce goods and services to measure, prevent, limit, minimize or correct environmental damage to water, air and soil, as well as problems related to waste, noise and ecosystems. This includes cleaner technologies, products and services that reduce environmental risk and minimize pollution and resource use"
PEW Charitable Trust	"A clean energy economy generates jobs, businesses and investments while expanding clean energy production, increasing energy efficiency, reducing greenhouse gas emissions, waste and pollution, and conserving water and other natural resources"
Hongtao Yi, Ohio State University	"The clean energy economy is not a single industry, but an overarching umbrella that covers burgeoning business activities that contribute to the conservation of energy and the growth of alternative energy resources"
State of California	"One whose activities: 1) generate and store renewable energy; 2) collect and/or process recyclable materials; 3) manufacture, distribute, construct, installation, and maintain energy efficient products; 4) foster education, environmental consulting, regulatory compliance, and awareness; or 5) manufacture natural and sustainable products"

Sizing the Clean Economy, Brookings Institution. 2011.

The Metropolitan Policy Program at the Brookings Institution published a report in 2011 detailing employment and industry statistics for green industries in an attempt to establish a detailed database of information related to the clean economy in the U.S. We constructed the criteria for a green business similar to that of the Brookings study which only includes "establishments and jobs of U.S. enterprises whose products have an environmental benefit" and

excludes ones that "conduct themselves in an environmentally-friendly manner". In this way, we can be sure that the businesses and occupations we are accounting for are having a direct impact on the green industry. The Brookings report notes the lack of classification for green or sustainable businesses within the NAICS and Standard Occupational Classification (SOC) codes. To combat this, researchers identified eight-digit SIC codes that would be classified as part of the clean economy and counted all the jobs within these codes. Our study decided to use NAICS codes as they provide a broader industry classification that includes both goods and services whereas the SIC codes are a more product-based classification system. In addition, "NAICS codes are based on stable, economic models, while SIC codes are not", meaning NAICS codes are current with new and emerging industries - a key point considering the newness of the green industry (AMB-Amega, 2014). This multi-faceted approach inspired our own efforts to reach out to large corporations or companies directly as a supplement to the information the NAICS codes provided.

Measuring Green Entrepreneurship, OECD. 2011.

The Organization for Economic Cooperation (OECD) published a study on measuring green entrepreneurship in their 2011 report titled, *Entrepreneurship at a Glance*. The study was quite similar to ours in that a definition of green entrepreneurship needed to be established by the researchers and a procedure needed to be created in order to collect relevant business data. In the report, the OECD defines green entrepreneurship based on the output or service that a firm provides. To break down the green industry, OECD identified "core" and "non-core" industries by reviewing the two-digit International Standard Industrial Classification (ISIC) codes. "Core" industries were defined as those that contributed wholly to green entrepreneurship while "non-core" industries were a mixture and therefore unable to be counted for in full. These "non-core" industries were then broken down and classified as either primary or secondary contributors to green entrepreneurship. We adopted the OECD's methodology for our own study, taking advantage of the quick and efficient nature of the procedure to inspire our own top-down approach of gathering green business data in North Carolina. Instead of using the ISIC codes, we identified sectors by NAICS codes. We also added a third potential classification for the "non-core" industries if their business data was unavailable or otherwise unable to be accessed. While

the OECD study released a survey with questions to determine a firm's contribution, we consulted our definition criteria as well as company websites to come to this conclusion.

The Clean Energy Economy: Repowering Jobs, Businesses, and Investments across America, The PEW Charitable Trusts. 2009.

The Metropolitan Policy Program at Brookings Institution called this report "the most notable and comprehensive cross-sectional study to date remains the 50-state comparative research collaborative economics". The trust counted businesses and jobs supplying products and services generated by the clean energy economy, not the companies using these products and services to make themselves "greener". In this study they also defined clean energy businesses as companies that "expand clean energy production, increase energy efficiency, reduce greenhouse gas emissions, waste and pollution, and conserve water and other natural resources". These elements allowed us to further narrow our focus on businesses on the "supply" side of the green economy rather than those on the "demand" side.

Green Business in a Clean Energy Economy: Analyzing Drivers of Green Business Growth in U.S., Hongtao Yi. 2014.

Hongtao Yi of Ohio State University's School of Public Affairs conducted a study on the factors affecting the growth of green businesses in the United States. Yi identified four broad categories - clean energy policies, labor market conditions, economic environment, and political environment - as affecting green businesses. Breaking these into subcategories, a fixed effect regression analysis was applied to each factor to quantify the level of its contribution to the green industry. In order to analyze these factors, the green industry portion of the economy needed to be defined. Yi's report adopts the definition used in The Clean Energy Economy: Repowering Jobs, Businesses, and Investments across America by the PEW Charitable Trusts .Using this definition, seventy-four SIC codes were identified that met this criteria and, through the use of the National Establishment Time Series database, the businesses listed under each code were summed up to capture the total number of green businesses. In this way, the bounds of the green economy were clearly defined and able to be analyzed within Yi's study. The report shows that the adoption of renewable energy policies, the permission of Renewable Energy Certificate

(REC) imports, the stringency of minimum wage legislations, and the presence of clean energy business associations are the top factors influencing green business development.

Yi's study steps beyond the scope of our report in that he not only identifies the scale of the green economy but the various factors that affect its development as well whereas our study's main goal was to create a procedure by which to capture the contribution of the green industry in North Carolina on an annual basis. Yi's procedure of capturing green jobs through the use of occupational codes and business databases was key in our own method of creating a list of green businesses in North Carolina. In addition, Yi's identification of business establishments and jobs as the two pillars to the clean energy economy influenced our decision to use them as metrics in how we measured the green industry.

Presentation, Todd BenDor, Professor of City and Regional Planning and Director of the Odum Institute, University of North Carolina at Chapel Hill

Todd BenDor gave a presentation to our class in which he described a recent study he conducted that was relevant to our study. His study, titled "Estimating the Size and Impact of Ecological Restoration Ecology", aimed to both define and quantify the economic scope of ecological restoration. BenDor was faced with similar limitations to ours when conducting his study: attempts to quantify restoration work were few and limited research and data was available regarding economic statistics specific to ecological restoration. He deployed a web-based survey of firms and organizations that were involved with ecological restoration. The survey asked groups to identify themselves by NAICS code and this information was entered into an input-output software that calculated the level of economic impact each organization had according to their NAICS code. Through his presentation, BenDor further explained the NAICS codes and how they could be used to not only classify industries, but to gather valuable business data. He also introduced us to ReferenceUSA, a database we eventually put to use in our own study, for its ability to search businesses by NAICS code.

California's Green Economy, State of California. 2010.

The State of California conducted the California Green Economy Survey in 2008 that studied California's green economy, the number of green jobs, and the effects of environmental

policy initiatives on the growth of the green industry. To estimate the number of green jobs, researchers deployed a statewide survey. We mainly utilized this study to come up with our own definition of green. The study defines a green business according to criteria laid out in their GREEN acronym which includes Generating and storing renewable energy, Recycling existing materials, energy efficient product manufacturing, distributions, construction, and maintenance, Education, compliance, and awareness, and Natural and sustainable product manufacturing. The California Green Economy Survey aided in the construction of our own definition of a green business, specifically in the strategy of identifying multiple aspects of a business that could be considered green so that a company that met at least one of the criteria would be considered a green business. The focus on businesses that provided these green services was also a characteristic that we adopted from California's definition. For ease of data collection as well as to prevent overestimation, we did not include businesses that were consumers of these products (e.g., a restaurant that had solar panels on its roof would not be counted while the company that manufactured those solar panels would).

Measuring Green Jobs, U.S. Bureau of Labor Statistics, U.S. Department of Labor. 2013.

The Bureau of Labor Statistics (BLS) is a bureau of the federal Department of Labor. It provides data about the state of labor and employment within the United States. The BLS Green Jobs report produced information regarding the creation of "green" jobs within the US between 2010 and 2013, until budget cuts defunded the program. The BLS analyzed both jobs that produced green goods and/or services, and those who used environmentally friendly processes for production of non-green goods and/or services. Surveys were sent to a sample of establishments that belonged to any of the 333 specific NAICS industry sectors where green goods and services could be classified. Unfortunately, this program no longer produces current data regarding the state of green jobs in the United States, but the BLS definitions and categorizations of green jobs were valuable in constructing a new metric to measure sustainable businesses in North Carolina.

The "Output Approach" classified establishments which produced green goods or provided green services. These establishments had to fall into one or more of five groups: energy from renewable sources; energy efficiency; pollution reduction and removal, greenhouse gas

reduction, and recycling and reuse; natural resources conservation; and environmental compliance, education and training, and public awareness. The "Process Approach" identified establishments where workers' duties involved making production processes more environmentally friendly. These establishments fell into one or more of four groups: energy from renewable sources; energy efficiency; pollution reduction and removal, greenhouse gas reduction, and recycling and reuse; and natural resources conservation.

Analysis of Each Sector

Renewable Energy

All data regarding the Energy Sector was collected from the North Carolina Sustainable Energy Association's 2018 NC Clean Energy Industry Census. This report was completed primarily through phone banking and online surveys. The data collected may not reflect the full scope of the industry due to the nature of the survey method, but NCSEA does its best to approximate missing data. To estimate total firm distribution, NCSEA took a systemic sample of companies that did not respond to the survey and identified if they were active in the clean energy industry. Then, NCSEA calculated the distribution of non-respondents from all of the industry's sectors and used that information to estimate the total number. To estimate each sector's jobs, NCSEA calculated a 90 percent trimmed mean of jobs per responding active company. The trimmed mean was multiplied by the number of responding firms to estimate the total and include firms that did not respond to the survey. NCSEA used the same methodology to estimate total revenue. The total revenue and jobs include this calculation in addition to the actual responses to the survey. The Clean Energy Industry Census is generally completed annually around April or May with data from the previous year.

Recycling & Waste Management

In our primary research of the Recycling & Waste Management sector, we identified three main categories: recycling, upcycling, and composting. Recycling included the collection of materials to be converted into a reusable material. Upcycling included the collection of materials to be remade into reusable products (no conversion). Composting included the collection of biogenic waste for decomposition into compost.

However, we decided to dissolve the upcycling sub-sector because after further research, there was no straightforward way to either obtain information on the number of businesses. We also decided to add the waste collection and disposal sectors so we would be able to capture the recycling industry in North Carolina, along with any companies that prevent waste from polluting our local ecosystems.

These three main categories were helpful at first to identify a starting point, but after further consideration and research we decided that basing our research on an already well-established sector and subsectors would produce more concrete numbers and results for the NC Conservation Network. Our group and our class decided that using the NAICS codes for waste collection and for recycling would be the most straightforward, all-encompassing way to collect data for this sector in order to create metrics with. The sectors are defined as follows:

NAICS Sector 5621-2, and 2629: Recycling & Waste Management Sector includes these sectors as defined by ReferenceUSA.com: Waste Collection (5621), Waste Treatment and Disposal (5622), Remediation and Other Waste Management Services (2629) and SIC code 287503: Composting Facilities. The Waste Collection category is comprised of solid, hazardous, and other waste collection. Under Waste Treatment and Disposal was the hazardous waste treatment and disposal, solid waste landfill, Solid waste combustors and incinerators, and other non-hazardous waste treatment and disposal. Under the Remediation and Other Waste Management Services subsector was remediation services, materials recovery facilities, septic tank and related services, all other miscellaneous waste management services. Composting Facilities are facilities which produce compost.

Ideally, we would conduct a survey to figure out how many North Carolina businesses and jobs are considered green across the sector, but we do not have this capacity as we are a one semester capstone class. Instead we decided to conduct a random sampling across all of the NAICS waste collection sub sectors because we thought it would be the best way to get an understanding of how many waste jobs in NC are considered green. There are 12 relevant sub sectors for the waste collection NAICS codes and 1 sector for the SIC code. Because the Recycling & Waste Management sector team comprised two people, each person was responsible for sampling 6 subsectors. Over these 12 subsectors, we established that we would sample 4 businesses from each and use our definition and our decision guide to rule each firm "green" or "not green". Each person randomly selected one business from each subsector, and 4

would be selected for 12 of the sub sectors to reach the number 48. The random sampling processes was completed using these steps:

1. Use a random number generator beginning with 1 and spanning the number of pages under the designated sub sector. That number will be the page number of businesses to randomly select a business from.

2. Use a random number generator beginning with 1 and ending with 25 (or however many businesses are on the selected page- if it is the last page there are often less than 25 businesses listed). That number will decide which business on the page you will choose. Starting from the first business on the page (1), go to the business that your random number corresponds to.

3. Click on said business' profile page. Record the number of jobs that the business provides and its total revenue or average sales.

4. Look for mission statements online or contact the business to determine if they count as a "green" business under our definition and job ranking decision guide.

5. Make a decision on whether or not to include the business and provide reasoning.

However, the composting subsector was added after all of the other research and findings because of the use of the SIC code rather than NAICS codes (which does not have a sector for composting).

Conservation

To discover the number of businesses related to conservation in North Carolina, we used the NAICS code 813312, (Environment, Conservation & Wildlife Organizations) which provided us with a basis for all the businesses in the state that associate with conservation. Using Reference USA, a source that includes a database for all US Businesses, we entered the Conservation NAICS code and searched within North Carolina to discover all businesses in the state that fell under the category of conservation according to NAICS. After reviewing the list of 200 businesses, we determined 193 were considered green according to our criteria. Data for number of employees and total sales volume was displayed in Reference USA in ranges rather than specific numbers for each business. For example, under the number of employees for each business, Reference USA showed "1-4 employees," and for total sales volume, it showed "less than $500,000," rather than a fixed number. As a result, we determined a fixed number from

these average ranges to find the average number of employees and average total sales volume, which is displayed later in the findings section.

Additionally, while a range of number of employees was readily available for each company, Reference USA only provided sales volume for 65 of the 200 conservation businesses displayed. We found the average sales volume for the 65 companies and used that number to account for the closest attainable estimate of the total sales volume. Because the capstone extends only the period of a semester, (roughly 4 months) we were not able to contact each of the 200 businesses to find the exact number of employees and sales volume; however, this would be a topic suitable for future research by the NC Conservation Network or other network with abundant resources.

Remediation

Using Reference USA, we analyzed businesses with a primary NAICS code of 562910, which represents Remediation Service Businesses. This search resulted in 70 total businesses. To create a fair assessment of these companies, a random sampling of 35 businesses in this list were analyzed using our definition of green. In Remediation Services, we classify businesses as "green" if their primary objective is to negate previous environmental contamination for a site to be used again without health concerns. This would include firms that remediate brownfields or superfund sites, asbestos removal and abatement, and oil cleanup services, but would exclude businesses focused on pest control, air conditioning repair, and water damage repair. These excluded businesses serve a useful purpose but their primary focus is not to remediate environmental contamination. Firms that are included in this list have shown a commitment to environmental health.

Research and Development

Our original methodology for identifying research and development jobs in North Carolina involved using the NAICS code for Physical, Engineering, and Life Sciences Research and Development (54171) and then selecting for the SIC code for Environmental and Ecological Services (873111). This produced a list of 437 businesses of which we randomly selected 10. Out of the 10 businesses selected, only two met the criteria of our definition of "green". Further, the NAICS code selected was the secondary code for many of the companies, and most were not even involved in research and development, but in consulting or inspections. When analyzing the breakdown of companies in our search, the majority had only 1-9 employees, which is why many

of the companies we encountered in our search had no websites or records online, limiting further analysis and research. We believe that by utilizing both NAICS codes and SIC codes in this instance included the union of Research and Development and Environmental and Ecological Services, instead of the intersection of the two factors that we were aiming for.

Since our original methodology did not produce accurate or usable results for the research and development sector of NC, we decided to instead focus on the information provided by the Research Triangle Regional Partnership (RTRP) and the Research Triangle CleanTech Cluster. The Triangle region hosts three major research universities as well as the Research Triangle Park, and therefore provides a prime environment for the development of research and development in the "CleanTech" sector. CleanTech companies "can generally be identified by the fact that they are working towards preserving natural resources" (Research Triangle Regional Partnership). These companies are therefore considered "green" under item 3 of our definition criteria: *conserve and remediate natural resources and ecosystems*. CleanTech is a regional economic development priority for the Research Triangle, and this area contains the majority of firms involved in researching and developing this technology for the state (Research Triangle CleanTech Cluster). The Research Triangle Regional Partnership and Research Triangle CleanTech Cluster work together to support these CleanTech companies and provide data about this industry within North Carolina. Since data provided through this organization would capture a large portion of the green research and development jobs for the state, we decided that it would be better to use this resource than to continue sampling from the inaccurate results in the Reference USA database.

From the Research Triangle Regional Partnership's website, we pulled numbers that they gathered for their "CleanTech at a Glance" section with regards to the number of companies, employees, and average annual earnings. Data provided on the RTRP website accounts for not only the Research Triangle Park, but the eleven surrounding counties as well. Specific research and development focus areas captured within the Research Triangle Region CleanTech industry include smart grid technology, smart metering, and renewable energy technology (Research Triangle Regional Partnership). The organization compiles a comprehensive list of all of the members in the CleanTech Cluster and analyzes this data to produce statistics regarding the number of companies, number of jobs, annual sales, and industry growth from the past year. As the group compiles these numbers each year, the NCCN and others using this procedure can pull

the numbers from RTRP to represent the number of research and development jobs for North Carolina for that year.

We compared the CleanTech data to both the numbers from the other sectors listed on the RTRP website and to the entire state's data listed on Reference USA. The RTRP website publishes data for general Technology, Life Sciences, AgTech, and Advanced Manufacturing that could be totaled along with the CleanTech numbers to see the sector of the Research Triangle Region's economy that is "green". To determine the extent of the entire research and development sector in North Carolina, we ran a search on Reference USA. Our search parameters were for the NAICS code 5417 "scientific research and development services", "verified and unverified" businesses, and the state of North Carolina. From this search, we could compare the "green" CleanTech portion of RTRP to the entire sector of research and development for the state. By using just the NAICS code for research and development and not including a SIC code, the results show an accurate representation of only research and development firms. However, the total amount of companies and employees delivered with the Reference USA search was less than the RTRP's data. Since it is not possible for there to be more research and development firms in just the Research Triangle Region than in the whole state of North Carolina, more investigation is needed to determine which numbers are more accurate. Our findings reflect the CleanTech companies in comparison to the entire RTRP data since they are from the same source, but we have included the Reference USA for comparison.

Manufacturing

In our primary research of the manufacturing sector, four main categories were found: materials, energy, water and health. The materials category includes material durability, reused and restored materials, low VOC materials, and low moisture-retaining content. Construction of wind turbines, constructing solar panels, natural light windows, low energy appliances, and passive solar design all pertained to energy. The water sub sector included pipe construction and water storage including grey water and water catchment systems. Health was the last sub category, which included non-toxic materials and ventilation systems.

After further research there were certain sub sectors we chose to rearrange and exclude. Every detail for the materials category had to be debated because of the definition guidelines, and it proved to be an extremely tedious task. With the time constraints that were present and no straightforward answers, we chose to eliminate this category. We discussed including the

production of materials and construction of renewable energy farms, but ultimately determined that both of these processes required energy and that this should be reassigned to its own sector in our research, Renewable Energy. The remediation and conservation sector was produced after determining that the wetland restoration and natural disaster mitigation programs should not be included in the manufacturing sector, but within their own different sectors. We also chose to exclude LEED certified buildings; there was major difficulty in finding the number of jobs and the impact on the NC green economy that LEED buildings would have.

These aforementioned four categories were helpful to identify a starting point, but after further research and consideration we decided that basing our research on well-established sectors and subsectors would produce more concrete numbers and results. Our class decided that using the NAICS codes for manufacturing would be the most straightforward, all-encompassing way to collect data for this sector in order to create metrics. The sector is defined as follows:

NAICS Sector 31-33: The Manufacturing sector comprises establishments engaged in the mechanical, physical, or chemical transformation of materials, substances, or components into new products. The assembling of component parts of manufactured products is considered manufacturing, except in cases where the activity is appropriately classified in Sector 23, under Construction.

Ideally, a survey would be conducted to figure out how many North Carolina businesses and jobs are considered green across the manufacturing sector. Conducting a survey requires substantial time and resources and is beyond the capacity of our capstone class. Instead, we produced a random sample of 30 businesses across all of the NAICS manufacturing codes, as it was the best way to get an understanding of how many manufacturing jobs in NC are considered green. There are 21 sub sectors for the manufacturing NAICS codes and 43,564 firms. The manufacturing sector team comprised three people, therefore each person was responsible for sampling 7 subsectors. We established that we would sample 30 businesses across the subsectors and use our definition and decision guide to rule each firm "green" or "not green". Using Reference USA, each person randomly selected a total of 10 businesses across their seven respective sub sectors for a total of 30 firms. The random sampling processes was completed using the following steps:

1. Use a random number generator beginning with 1 and spanning the number of pages under the designated sub sector. That number will be the page number of businesses to randomly select a business from.

2. Use a random number generator beginning with 1 and ending with 25 (or however many businesses are on the selected page- if it is the last page there are often less than 25 businesses listed). That number will decide which business on the page you will choose.

3. Starting from the first business on the page (1), go to the business that your random number corresponds to.

4. Click on said business' profile page. Record the number of jobs that the business provides and its total revenue or average sales.

5. Look for mission statements online or contact the business to determine if they count as a "green" business under our definition and job ranking decision guide.

6. Make a decision on whether or not to include the business and provide reasoning.

   a. Some of the decisions produced were simple "yes" or "no" answers, whereas other decisions were more difficult, and had to consult our job-ranking system to make an informed decision regarding what level (%) of contribution a particular business had (see Table 10: Analysis of Three Selected Firms).

Agriculture

For the agriculture sector, we estimated the number of jobs and revenues by randomly selecting 10 certified organic farms in each of the three regions of North Carolina (Coastal, Piedmont, and Mountain). Organic farms eliminate the use of harmful pesticides and fertilizers. These practices are thought to be better both in terms of human health and environment. Organic farms operate in a way that recognizes the intrinsic value of the land and soil that they occupy. Another reason we decided to only look at USDA certified organic farms is because most of the data had already been collected by the USDA so there was not a lot of secondary research involved. With the time constraints of the project this was the most logical way to measure green agriculture in NC. The data that the USDA had collected was extremely reliable and easily accessible.

The farms we selected were numbered and then randomly selected using a random number generator. We then contacted the farms by email and phone and asked about how much revenue they generated and how many employees they had on payroll for 2019.

It is important to note that all farms that employee organic practices do not go through the USDA certification process. Many small family farms choose to forgo this process because of the annual certification cost. It can be assumed that our numbers underestimate the contribution of agriculture because they do not include these smaller operations.

When asking for the number of employees, we chose to count only full-time employees. It's important to note that many farms rely on seasonal employees. We didn't feel that seasonal or part-time positions should be added to the total number of green jobs in North Carolina. Thus, our method likely underestimates the true number of agricultural employees.

Farmer responses varied. Some farms were open and willing to share, while others were not. Unless the operation is publicly traded, which very few farms are, the farm is not required to provide information about finances or employees. Only 10 out of the 30 farms in question were willing and able to provide details on their business footprint. It can be assumed that the COVID-19 pandemic had some impact on the willingness of farmers to be open about their finances. A few farms were willing to disclose the number of employees, but not any financial information. When calculating our final numbers to use for scale, we only used data from these 10 farms. The process used to select and contact farms is very simple to scale up or down. A scale of this process would not alter resources required, only time. Out of the 10 farming operations that responded the average sales revenue was $1,790,900 and the average number of employees was 21.

Transportation

In our primary research of the transportation sector we decided to exclude travel associated with personal automobiles, due to their emissions and contributions to anthropogenic climate change. We elected to focus on public transit, since it fits our definition of a green business by allowing people to make sustainable lifestyle choices. While many transit systems may utilize diesel vehicles, they are still sustainable by reducing the amount of people in single-occupancy vehicles which are a less efficient use of fuel and space in cities. These transit systems also give all different types of people access to transportation. In addition, we excluded

electric cars, buses and hybrids because of the conflicts with our definition of a green business by not relying on renewable energy since the power grid is not fully "green" it is unsure if the use of an electric vehicle is actually reducing emissions. By utilizing NAICS codes we split the sector into 3 different categories: Interurban and Rural Bus transportation, other Urban Transit Systems, and Commuter Rail Systems. We utilized the North Carolina Department of Transportation as a starting point in our research since they have categorized all of the transit systems across the state based on size and components. For the data collection, we estimated the jobs and revenues by randomly selecting 10 number of transit companies that fell within the NAICS codes of our three categories. The companies were numbered and then selected using a random number generator. After the list of companies was finalized, we looked at the number of employees each of the companies had on their payroll and how much revenue they generated. This information was found on the NAICS website.

Total Findings

To calculate our total green figures, we added each of the three metrics from each sector to the other sectors. We determined total NC firms through a search on Reference USA, selecting for "North Carolina", "verified" and "unverified" businesses. We added this number to the total number of farms in North Carolina. We determined total NC jobs through the Bureau of Labor Statistics's figures for total NC nonfarm employment for February 2020, since this was before the economic downturn caused by the COVID-19 pandemic. We added total nonfarm employment to total farm employment figures. We were unable to calculate total sales volume figures for the state to determine economic contribution because Reference USA does not provide summary data for searches with over 500,000 results.

Findings

Our original goal in producing findings was to include the same metrics for each of our sectors: number of jobs, total sales volume, and total number of firms. Unfortunately, for a few of these sectors, we were unable to gather all of these metrics. The research and development sector could not produce accurate metrics for annual sales volume due to limitations of data found. The omission of this metric will cause an underestimation of the total economic

contribution of all green firms. Please see the appendix section for the breakdown of the math conducted to produce the final metrics for each sector. We have also included a table explaining why each sector might represent an underestimate or overestimate of the actual metrics and why.

Table 4: Finding Estimates

Sector	Underestimate or Overestimate	Why?
Renewable Energy	Underestimate	Data was collected through a survey by NCSEA. Since some firms did not respond, NCSEA was forced to estimate some of the numbers which are still likely lower than reality.
Recycling and Waste Management	Underestimate	Data was collected through a random survey that did not fully capture the breadth of this sector. Unique firms were often missed due to our method, like composting facilities.
Remediation	Considerably Accurate	The data collected was from a large sample of 35 of 70 total firms and it can be assumed that this information is an accurate representation.
Conservation	Underestimate	Data was collected through examining each of the 200 conservation firms on Reference USA. We were unable to find data on non-profit organizations due to the lack of information available and limitations of this course.
Research and Development	Underestimate	Data was obtained from a secondary source and does not represent all R&D firms statewide, but in the hub of the Research Triangle Region where a majority are found.
Manufacturing	Unsure	Since we only took a sample of 30 firms, and then multiplied our results to project our findings for the entire industry, we cannot be sure whether or not we are over or under estimating this sector.
Agriculture	Underestimate	The data included only refers to USDA certified organic farms. It does not account for farms that may follow green practices but are not certified. It also doesn't capture the footprint of big agriculture in the state.
Transportation	Overestimate	This sector is an overestimate because we counted 100% of the firm's revenue and jobs that we looked as green since they were taking automobiles off the road.

Renewable Energy:

      The clean energy industry in North Carolina is comprised of 1,717 companies, offers 43,238 jobs, and is responsible for $14.2 billion in annual revenue. The industry is divided into nine sectors: energy efficiency, solar, alternative fuel vehicles, energy storage, bioenergy, geothermal, wind, hydropower, micro grid and smart grid. Each of these sectors is described briefly below and summarized in Table 3.

Energy efficiency is the largest sector in North Carolina's clean energy industry with 1,310 active companies. It includes a variety of industries, such as building design and construction, lighting, high-efficiency HVAC, and building materials manufacturing and distribution.

Solar is the second largest clean energy sector with 533 active companies in North Carolina. Within this sector, there are three sub-sectors: residential, commercial or industrial, and utility-scale.

Alternative fuel vehicle companies represent five percent of the companies in the clean energy industry. There are 140 active companies and the number of firms in this sector has doubled since 2016.

The **energy storage** sector is composed of several sub-sectors: chemical, electrical, mechanical, and thermal. The sector is composed of 149 companies. Nearly one-third of the time in this sector is dedicated to manufacturing and production.

The **bioenergy** sector primarily includes electricity generation and fuel sales, and includes 180 companies.

There are 225 active companies in the **geothermal** sector. Most of the activity in this sector is attributed to energy efficiency and renewable energy installation companies that also offer geothermal services.

The **wind** industry in North Carolina is composed of 136 companies. Although North Carolina has substantial potential for offshore wind development, this sector has not yet been fully developed.

Hydropower accounts for 61 companies among the clean energy industry. Nearly 40 percent of this sector's activity is in manufacturing and production. There is little potential for growth in North Carolina's hydropower industry as most sites have already been developed.

The **microgrid and smart grid** sector is composed of 131 companies, however, the data collected by NCSEA is limited and likely does not represent the full scope of this industry.

Table 5: Renewable Energy Findings

Sector	Firms	Employment	Economic Contribution
Energy Efficiency	1,310 Firms	23,892 Jobs	Total Revenue: $6.35 billion
Solar	553 Firms	6,457 Jobs	Total Revenue: $2.9 billion
Alternative Fuel Vehicle	140 Firms	2,542 Jobs	Total Revenue: $148 million
Energy Storage	149 Firms	1,749 Jobs	Total Revenue: $436 million
Bioenergy	180 Firms	1,629 Jobs	Total Revenue: $613 million
Geothermal	225 Firms	1,075 Jobs	Total Revenue: $253 million
Wind	136 Firms	1,062 Jobs	Total Revenue: $440 million
Hydropower	61 Firms	689 Jobs	Total Revenue: $580 million
Microgrid and Smart Grid	131 Firms	746 Jobs	Total Revenue: $148 million
Total Green Economy	1,717 Firms	43,238 Jobs	Total Revenue: $14.2 billion
Percent of Sector Considered Green	100%	100%	100%

Addendum:

The total numbers in this chart reflect estimates evaluated by NCSEA in their surveying and sampling process. As such, it may not be a completely accurate portrait of the clean energy sector. More information on their methodology can be found in the 2018 NCSEA NC Clean Energy Industry Report.

Recycling and Waste Management

North Carolina has 872 businesses in Recycling and Waste Management, spanning three primary NAICS codes: Waste Collection, Waste Treatment and Disposal, or Remediation and Other Waste Management Services. This sector employed about 9,400 employees and contributed about $1.6 billion in sales volume. By utilizing our metrics from our random sampling across the sector, we estimate that this sector has 3,218 "green jobs" and has contributed $852,800,000 to the "green" economy in sales volume with 339 firms. The table below shows the percentages used to calculate the total green jobs and contribution to the green economy based on our random sampling.

Table 6: Recycling and Waste Management Findings

Sector	Firms	Jobs	Economic Contribution
Green Recycling and Waste Management	339 Firms	3,218 Jobs	Sales Volume: $852.8 million
Total Recycling and Waste Management	872 Firms	9,400 Jobs	Sales Volume: $1.6 billion
Percent of Sector Considered Green	38.8% of Firms are Green	33.6% of Jobs are Green	53.5% of Sales volume is Green

Addendum:

For some of the businesses we researched, only a rough estimate of employees was able to be found. As such, the numbers outlined here are a rough estimate of the number of green jobs within the industries. In addition, many businesses lacked websites that would allow us to

determine if they meet our definition of a green business. We decided to omit any businesses without websites to avoid overcounting the number of green jobs.

Remediation and Conservation

In North Carolina, according to our research through Reference USA, there are a total of 70 businesses with "remediation services" as their primary NAICS code. After taking a random sample of half of these businesses, we found that they contributed $81,636,000 in sales volume in 2019 and employed a total of 528 people. Employment measurements were calculated using the same methods and both are presented in the table below.

Table 7: Remediation Findings

Sector	Firms	Jobs	Economic Contribution
Green Remediation	26 Firms	350 Jobs	Sales Volume: $53,084,954
Total Remediation	70 Firms	528 Jobs	Sales Volume: $84,037,030
Percent of Sector Considered Green	37% of Firms	66.3% of Jobs	63.1% of Sales Volume

These numbers show that green remediation services realize a higher sales volume than non-green remediation services. Green Remediation services also have a mean employment of approximately 13 people per firm, whereas non-green remediation services have a mean employment of approximately 4 people. Green remediation services employ twice as many people total and on average employ more people per firm than non-green remediation services.

Table 8: Conservation Findings

Sector	Firms	Jobs	Economic Contribution
Green Conservation	193 Firms	1,621 Jobs	Sales Volume $290,242,278
Total Conservation	200 Firms	1,724 Jobs	Sales Volume: $311,538,400
Percent of Sector Considered Green	96.5% of Firms	94% of Jobs	93.2% of Sales Volume

Addendum:

Reference USA's list of North Carolina businesses corresponding to the NAICS conservation code 813312 displayed 200 businesses. We deemed 193, or 96.5 percent of the 200 conservation businesses green according to our criteria. Because Reference USA provided only a range of number of employees and total sales volume, we compiled an average range of these metrics, rather than a fixed number. Data for sales volume was limited, since sales volume data was available on just 65 of the 200 businesses, four of which were considered green.

Research and Development

The Research Triangle Region of North Carolina is composed of 6,826 research and development firms and supplies about 130,710 jobs. Within the research and development sector, we defined only CleanTech companies as "green", as they are defined as research firms developing ways to preserve natural resources.

CleanTech companies comprise a significant portion of this sector with 1,859 companies, 29,950 jobs, about $210,067,000 in total earnings, and contributes $4.6 billion to the Gross Regional Product. CleanTech accounts for 27.2% of companies and 20.6% of employees within the total R&D sector in the Research Triangle Region of North Carolina.

Table 9: Research and Development Findings

Sector	Firms	Jobs	Economic Contribution
CleanTech (Green R&D)	1,859 Firms	26,950 Jobs	Contribution to Gross Regional Product: $4,600,000,000*
Total R&D Sector	6,826 Firms	130,710 Jobs	Contribution to Gross Regional Product: $32,400,000,000*
Percent of Sector Considered Green	27.2% of Firms	20.6% of Jobs	14.2% of Gross Regional Product Contribution
* The RTRP data only provided data for contribution to Gross Regional Product, and not sales volume or revenue. As this data is still a measurement of economic productivity, it was included in the overall contribution to the green industry measured in this report.			

Addendum:

We also searched the entire research and development sector of North Carolina on the Reference USA database (explained further in our R&D methods), but it produced numbers lower than found for just the Research Triangle Region. Our Reference USA findings are included here for comparison:

- Total R&D firms in NC: 6,335
- Total R&D jobs in NC: about 65,484
- Total R&D sales volume in NC: $10,458,500,000

Reference USA does not provide data on contribution to Gross Regional Product. The calculations for jobs and sales volume is a total sum of the average of ranges (e.g. 50-99 jobs) provided for the firms. Jobs ranges were provided for 6,313 firms, and sales volume ranges were provided for 791 firms.

Manufacturing

As previously mentioned, we sampled 30 industries across the sectors' 21 sub sectors and analyzed them against our definition and our job ranking system in order to determine if the industry contributes to the green economy of North Carolina, and if so, which tier of contribution it falls under. Recall that these findings are very rough due to the fact that they are a sample of 30 industries across an entire sector made up of a total of 43,566 industries -- we could not get totals for each sub sector as a whole. By utilizing our metrics from our sampling data, we estimate that this sector has 467,899 "green jobs" and has contributed $155,269,224,000 to the "green" economy in sales volume with 17,426 green firms. The time and resource limitations that we faced forced us to conduct our research in this manner. Our results are included below; we highlighted our decision-making process for three businesses to illustrate our methods (see table #9 below).

Table 10: Manufacturing Findings

Sector	Firms	Jobs	Economic Contribution
Green Manufacturing	17,426 Firms	467,899 Jobs	Sales Volume: $155.27 Billion
Total Manufacturing	43,566 Firms	1,829,772 Jobs	Sales Volume: $930.78 Billion

Percent of Sector Considered Green	40% of Firms	25.6% of Jobs	Percentage of Green Sales Volume: 16.7%

Table 11: Analysis of Three Selected Firms

	McRitchie Winery and Ciderworks in Thurmond, NC	Sonoco Recycling in Statesville, NC	Hydrotex Partners in Claremont, NC
Yes/No	Yes	Yes	No
Why	This green business falls under our third criteria in our definition "conserve and remediate natural resources and ecosystems" under "conservation of ecology, maintaining the delicate balance of an ecosystem". McRitchie Winery and Ciderworks is dedicated to sustainable farming, low-impact farming and dedication to energy efficiency including gravity flow techniques.	This green business falls under our second criteria of our definition guideline to "Reduce, reuse, or reconstitute waste" through their "EnviroSense portfolio [which] crosses a range of packaging materials, including cans made from 100-percent recycled paperboard, rigid plastic packaging containing post-consumer recycled content, mono-material flexible pouches that are recyclable, and innovative packaging made from agricultural fibers."	This is not a green business. It does not meet any of our requirements stated in the definition guidelines. Their mission is to improve fuel and make diesel "clean". Though their effort is recognized, diesel is not renewable and continues to negatively affect the environment.
Contribution Type (%)	Primary- 100%	Primary- 100%	None- 0%

Addendum:

For some of the businesses we researched, only a rough estimate of employees was able to be found. As such, the numbers outlined here are a rough estimate of the number of green jobs within the industries.

Agriculture

For the agriculture sector, we estimated the number of jobs and revenues by randomly selecting 10 USDA certified organic farms in each of the three regions of North Carolina (Coastal, Piedmont, and Mountain). We only considered USDA certified farms in our research; there are 624 operations registered in the database.

Table 12: Agriculture Findings

Sector	Firms	Jobs	Economic Contribution
Certified Organic Food Operations	624 Firms	13,166 Jobs	Estimated Total Revenue: $1,117,522,000
Total Food Operations	49,500 Firms	333,600 Jobs	Total Revenue: $15 billion
Percent of Sector Considered Green	1.3% of Firms	3.9% of Jobs	7.5% of Revenue

There are currently 49,500 farms in NC, but only 624 are certified organic by USDA, which represents only 1.3% of the farms in the state. With regard to the economic contribution, agriculture is one of the sectors that has the largest estimated total revenue: it has the third largest estimated total revenue in comparison to all the other sectors that we looked at. Agriculture has the fourth largest number of employees in comparison to all the other sectors. There are 333,600 agriculture jobs in NC and out of those jobs only 13,166 are certified organic farm jobs. This means that 3.9% of agriculture jobs in NC are certified organic/green.

Transportation

There are 182 transportation companies in NC that fall under the NAICS codes we selected for the transportation sector. A sample of 10 businesses were selected for each of the 3 NAICS code sections that we had selected. The average sales volume and the average number of

employees were computed for the 10 sub-sector companies that were randomly selected. These numbers can be found in the table below.

Table 13: Transportation Findings

Sector	Firms	Jobs	Economic Contribution
Urban Transit Systems	96 Firms	298 Jobs	Average Sales Volume: $7,213,600
Rail Transportation	5 Firms	254 Jobs	Average Sales Volume: $4,376,000
Interurban and Rural Bus Transportation	81 Firms	144 Jobs	Average Sales Volume: $5,781,300
Total Transportation	182 Firms	696 Jobs	
Percent of Sector Considered Green	100% of Firms	100% of Jobs	100% of Sales Volume

Addendum:

A sample of 30 companies is a relatively small sample size which can affect the reliability of the data. This can lead to higher variability in the data findings and the possible presence of bias.

Overall Findings

Table 14: Green Economy Findings by Sector

Sector	Firms		Jobs		Economic Contribution[1]	
	# of Green	% of Sector Considered Green	# of Green	% of Sector Considered Green	Sales Volume of Green Firms *in millions*	% of Sector Considered Green
Renewable Energy	1,717	100%	43,238	100%	$14,200.0	100%
Recycling & Waste Management	339	39%	3,218	34%	$852.8	54%
Remediation	26	37%	350	66%	$53.1	63%
Conservation	193	97%	1,621	94%	$290.2	93%
Research & Development	1,859	27%	26,950	21%	$4,600[2]	14%[3]
Manufacturing	17,426	40%	467,899	26%	$155,269.2	17%
Agriculture	624	1.3%	13,166	3.9%	$1,117.5	8%
Transportation	182	100%	696	100%	$17.4	100%
Total Green Economy:	**22,366 Green Firms**	**1.1% of All Firms in NC are Green**	**557,138 Green Jobs**	**11.3% of All Jobs in NC are Green**	**$218 trillion in sales volume contributed to the NC economy**	
Total NC Economy:	**1,882,632 Total Firms**		**4,945,600 Total Jobs**			
1. Economic Contribution = Average Total Sales Volume 2. Economic Contribution to Gross Regional Product 3. Percent of Gross Regional Product Contributed						

Our main takeaways are as follows:

- Green firms comprise a small percentage of the total number of firms in NC: there are over 22,300 green firms in North Carolina, representing about 1% of all firms in the state.
- Out of nearly 5 million jobs in North Carolina, an estimated 557,138 (or about 11%) of those jobs are green.
- The vast majority of those green jobs, (467,899) were in Manufacturing, followed by

Renewable Energy (43,238).

- Similarly, the Manufacturing and Renewable Energy sectors led the way in terms of their economic contribution to the state.

- 100% of the Renewable Energy and Transportation sectors, along with 97% of the Conservation sector, were considered green, compared to only 1.3 of the Agriculture sector.

Recommendations

The primary goal of this capstone project was to produce a set of metrics that could be replicated annually to provide consistent and accurate data on the impact of green businesses on the North Carolina economy. We believe that our research has accomplished this goal, however, there are several recommendations that should be considered when repeating our research in the future. The recommendations are as follows:

- Industries such as Manufacturing were difficult to uncover findings for, as there were numerous subsectors with hundreds of different firms spanning many different areas. Because of this, we decided to sample firms, as we could not count the entire manufacturing industry as core. We chose to randomly sample a small portion of the companies and record the data we could find. In future studies the NCCN should conduct a broader survey annually to determine how many North Carolina businesses and jobs are considered green across each of our identified sectors. Unfortunately, our capstone class did not have the time or resources to conduct a larger survey.

- We believe that all 8 defined sectors have high potential to see an upward trend in employment and total sales volume. We recommend that the NCCN push for policies that incentivizes these 8 sectors to increase their dedication to green practices. An example of this could be something along the lines of advocating for tax incentives for businesses or manufacturers that rely on recycled materials as their primary inputs. Businesses that qualify would help increase revenue streams for recycling facilities, while simultaneously creating another green business.

- We recommend that the information pulled every year be compiled into a database that could be analyzed to identify trends in the green industry.

- Although we developed a definition of green businesses, drawing in part from other studies. Still, we were unable to locate a standard or universal set of criteria for our purposes. Future research and attention by the NCCN should be directed toward identifying a single set of criteria to define green businesses and jobs in North Carolina.

- We recommend that the NCCN advocate for increased investment and government subsidies to support the growth of sustainable research and development in the state. This sector was one of the largest contributors to the green economy, and the presence of several large research universities and Research Triangle Park makes North Carolina a prime environment to be a leader in sustainable innovation.

- Encourage the Research Triangle CleanTech Cluster to expand its data collection on sustainable research and development to the whole state of North Carolina. They should also include more detailed data regarding how they obtained their figures in order to improve the reliability of results, and which could also be used to account for any overlap with other sectors as well. Their data collection could also be made more specific with statistics for different types of clean technology (e.g. microgrid or renewable energy).

- The NCCN should contact ReferenceUSA and recommend updating their next set of surveys to include questions that gather data specifically related to green organizations, such as the metrics we have identified in our research. The NCCN should share its criteria for identifying green organizations, jobs, and economic contribution with ReferenceUSA to provide an example for how green organizations can be defined. This would not only benefit the state of North Carolina, but the country as a whole as the green economy continues to expand.

- Use cluster analysis to improve the reliability of the survey estimates. For sectors that have numbers in both extremes (i.e. really large or really small numbers, e.g. sales volume, employment, firms), dividing this sector into clusters of organizations based on, for example, sales volume and then finding the percentages that these clusters hold of the industry or sector as a whole and then base the random sampling on this percentage.
  - Example: you have a sector of 100 organizations of which 25% are large, 25% are medium, and 50% are small based on sales volume. For the random sampling (with an example amount of 40), you would take 10 random samples of the large

cluster, 10 of the medium, and 20 of the small. You would do this to try to mitigate errors which may occur from year to year based on the random sampling.

We believe that if the NCCN would like to reproduce our study on a yearly basis, following our guidelines along with the recommendations above will produce the best results in the timeliest fashion. We also encourage that the NCCN combine their resources with other environmentally focused non-profits, such as the NC Renewable Energy Association and the NC Department of Environmental Quality, to advocate for a universal definition of green industries that can be applied by the U.S. Census Bureau in their NAICS organization process. This collaboration would simplify this process for the state of North Carolina, and any other states who would like to adopt this research question and conduct a study of their own.

Conclusions

To conduct this study, we came up with our own definition for "green" and then used it to generate a replicable set of methods to help identify the impact of the green industry on the North Carolina economy. We then estimated the number of green jobs and revenue that businesses in each industry contributed to the North Carolina economy, and did our best to obtain findings for each sector that were straightforward and comprehensive. As we have stated previously, this topic of study is of utmost importance because it is extremely difficult to identify and analyze green businesses due to the difficult nature of obtaining a universally accepted definition of a "green" business or job. Through analyzing the information in this study, we hope that readers gain a more detailed understanding of what the green economy consists of and who it includes. We also hope to be part of the effort to inspire a bigger, more all-encompassing environmentally-focused economy in North Carolina and beyond. The development of this study is important to us, and everyone and everything that follows. North Carolina is doing well in many areas regarding sustainability and its green economy, but still has a long way to go.

<u>Appendices</u>

Expanded Definition:

In order to be included in the North Carolina Conservation Network's annual report of the North Carolina green economy, an operation must adhere to at least one of the following five pillars. These pillars are as follows:

1. **Generate and/or rely on renewable energy and/or conserve energy.**

   a. We define "*renewable energy*" as energy produced from sources that do not deplete or can be replenished within a human's lifetime. The most common examples include wind, solar, geothermal, biomass, and hydropower. This is in contrast to *non-renewable sources* such as fossil fuels.

   b. We set the cutoff at 25% or more renewable energy reliance.

2. **Reduce, reuse, or reconstitute waste.**

   a. "*Hazardous waste*" is defined by the EPA as waste that is inclusive of properties or materials that are dangerous or capable of having a harmful effect on human health or the environment. Hazardous waste is generated from many sources, ranging from industrial manufacturing process wastes to batteries and may come in many forms, including liquids, solids gases, and sludges (EPA). This form of waste will be excluded from our study.

   b. We define "*solid waste*" as any other materials that are destined for landfills, including sludge from wastewater treatment plants.

   c. We define "*wastewater treatment*" as the process of speeding up the natural processes by which water is purified (EPA).

   d. "*Wastewater treatment*" is also a process used to remove contaminants from wastewater or sewage and convert it into an effluent that can be returned to the water cycle with minimum impact on the environment, or directly reused.

e. We define "*reduction of waste*" as actions taken prior to waste generation to reduce or prevent the generation of waste.

f. We define "*reuse*" as utilizing an object or material again for a similar purpose to its original use without significantly altering the physical form of the object or material.

g. We define "*reconstitution of waste*" as utilizing waste as a material to manufacture a new product. Recycling alters the physical form of the object or material to manufacture a new product from the new material. Composting utilizes organic waste as a material to create new products from them.

3. **Conserve and remediate natural resources and ecosystems.**

a. We define "*conservation*" as taking action to restore something to its natural state. Typically, this covers three broad areas:

    i.   Cultural heritage and the built environment of archaeological monuments, buildings of historic importance, and landscapes.

    ii. Conservation of ecology, maintaining the delicate balance of an ecosystem or wildlife to ensure population numbers of threatened or endangered species are not put at risk, to maintain a landscape for study or enjoyment, or for biodiversity.

    iii. Resource conservation is the active way in which we seek to limit the use of resources to reduce the strain put on supply. This can include energy-efficient homes to reduce inputs into the production of electricity or more efficient use of water resources.

b. This includes organic agriculture and sustainable forestry; land management; soil, water, or wildlife conservation; and stormwater management (BLS).

c. We define "*remediation*" as the reversal or containment of environmental damage at a contaminated site.

d. Under these criteria and aforementioned definitions, we will include the remediation of both Brownfield and Superfund sites in North Carolina.

4. **Invest capital in green initiatives and companies.**

    a. 25% percent of total capital investments must qualify as green.

    b. We define *"green"* as being focused around the preservation and protection of the natural world.

5. **Prioritize environmental compliance, education and training, and public awareness.**

    a. These establishments enforce environmental regulations, provide education and training related to green technologies and practices, and increase public awareness of environmental issues.

    b. This pillar is meant to encompass all educational efforts, not limited to consulting, specialty programming, and community outreach and action initiatives as they relate to restoration and sustainable living.

6. **Manufacture sustainable products or materials.**

    a. *Sustainable materials* may include reconstitution of waste (turning plastic waste into building materials), and/or utilizing sustainable materials in the production.

Findings Math

Recycling and Waste Management:

Economic Contribution

- Average green revenue: 309,000 + 1,079,000 + 2,152,000 + 2,828,000 + 399,000 + 4,035,000 + 2,146,000 + 4,763,000 + 5,547,000 + 8,096,000 + 477,000 + 6,526,000 + 7,196,000 + 2,824,000 / 14 = 6,453,642.86
- Estimated total revenue: 6,453,642.86 (339) = 2,188,502,000

Employment Statistics

- Average number of employees: 10 + 0 + 7 + 11 + 2 + 28 + 10 + 17 + 12 + 1 +20 +16 +20/ 14 = 11
- Estimated number of jobs: 11(339) = 3,730

Research and Development Sources:

Justification: http://www.researchtrianglecleantech.org/why_the_triangle

Statistics: https://www.researchtriangle.org/industries/cleantech/

CleanTech Cluster website: http://www.researchtrianglecleantech.org/

Manufacturing:

Economic Contribution

- Average green revenue: 381,000 + 5,780,000 + 471,000 + 7,500,000 + 10,000,000 + 3,125,000 + 1,010,000 + 45,600,000 + 6,904,000 + 8,329,000 / 10 = 8,910,000
- Estimated total revenue: 534,147,000(43,564) = 23,269,579,908,000

Employment Statistics

- Average number of green employees: 6 + 8 + 55 + 66 + 5 + 51 + 3 + 74.5 / 8 = 33.56
- Estimated number of green jobs: 33.56(43,564) = 1,642,007.84

Agriculture:

Economic Contribution

- Average revenue: 6,000,000 + 900,000 + 17,200 + 80,000 + 10,000 + 20,000 + 2,000,000 + 5,300,000 / 8 = 1,790,900
- Estimated total revenue: 1,790,900(624) = 1,117,522,000

Employment Statistics

- Average number of employees: 53 + 100 + 2 + 2 + 30 + 5 + 1 + 2 + 14 + 2 / 10 = 21.10
- Estimated number of jobs: 21.1(624) = 13,166.40

Other

Agriculture:

List of farming operations that did not respond: Hickory Meadows Organics|Bailey Bros Ag Partnership|Coastal NC Organics, LLC|Winslow Brothers Farms|Trask, William K|Tyson Family Organic Farms|Gentle Harmony Farm, LLC|Cecil Farms Inc.|Barnhardt Manufacturing Company|Bay State Milling Co.|Santa Fe Natural Tobacco Company|Twinings North America, Inc|Counter Culture Coffee|Ramblerill Farm, INC|Klooster Bros, LLC Dba Banner Greenhouses|Jones Family Farms|Riverview Farms|AG1 LLC|Eliza Farms|NCDA-Mountain Research Station

Justifications

Definition Justifications:

1. We chose to quantify the cutoff for renewable energy at 25% because this will not only include the larger industries but will also include companies that are making a significant (25% or more) commitment to moving away from nonrenewable energy sources.

2. We included the remediation of both Brownfield and Superfund sites in North Carolina because this activity provides important environmental benefits.

3. We chose to quantify the cutoff for investing capital in green initiatives and companies at 25% as a minimum, because it will not only include the larger industries but also include companies that are making a significant commitment to green efforts and the green economy. This minimum of 25% of investments must be allocated towards green initiatives; this constitutes a significant portion of funds devoted to green efforts and represents a company's contribution to the green economy. Examples of this could include investment in environmentally focused non-profits, innovative recycling and repurposing programs, purchasing carbon offsets, or any other means of reducing a company's carbon footprint. Simply following an environmentally focused law or regulation does not place a company within this sphere.

   4. Taken from BLS green jobs definition criteria 5.

Job Ranking Part B

If green or sustainable practices are included in an organization's mission statement, these ideals represent a core focus of theirs and therefore a significant number of resources and employees are dedicated towards upholding these practices.

Data Collection Justifications:

Green Industry Sectors

To measure the economic impact of the green industry in North Carolina, we categorized the workforce into eight sectors:

1. Renewable Energy

2. Recycling & Waste Management

3. Remediation

4. Conservation

5. Research & Development

6. Manufacturing

7. Agriculture

8. Transportation

As each sector provides different services, they interact with the green industry in various ways; some on the production side while others specialize in more service or expertise-related fields. For example, a solar panel manufacturing company operates in a different realm compared to that of an urban transit system. Further still, the level of production or service varies, which makes breaking up the workforce into sectors all the more practical. This allows us to more easily identify green characteristics in a company and adequately represent those companies across sectors. In addition, dividing the workforce into sectors makes it easier to use the North American Industry Classification System (NAICS) codes when searching for companies in an area. These codes were developed in part by the U.S. Economic Classification Policy Committee (ECPC) for use in gathering statistical business data to study the U.S. economy. Identifying these categories also provided interesting comparisons in terms of how much each sector is contributing to the green economy, hopefully providing information for researchers interested in promoting sustainable businesses and identifying which sectors to focus on to have the greatest impact. Within each sector, we applied our green definition and, using business databases and NAICS codes, gathered a list of businesses that met these criteria and their respective employees and annual sales.

Research and Development Measurements

We decided to include the economic contribution values for Research and Development in our analysis as Gross Regional Product (GRP) is still a measure of economic productivity. GRP takes a value-added approach, only counting the "profit" side of a transaction rather than the value of all sales in an exchange. In this sense, GRP is comparable to sales volume which

measures the total number of units sold for a reporting period; both measurements are based on a firm's earnings. As such, the GRP values for Research and Development were included as it represents an economic value being contributed as a result of clean tech.

Limitations:

Job Ranking System

We acknowledge that there are some current issues with our job ranking system methodology. We question if a mission statement is a defensible justification for a company's contribution to sustainability, or if it is necessary to see actual proven action by these industries. We realize that not all companies will have websites or even a section where mission statements are listed, which is why in some cases we contacted companies and did more research on them. We wish that there was a quantifiable way to measure a business' contribution to a green economy that would be applicable across all of our sectors, but were unable to fully develop one in our short period of time conducting the research and developing our approach.

Research and Development Sector:

We had several limitations in collecting data for "green" research and development in North Carolina. Our biggest limitation was imperfect data from Reference USA. Our first searches for environmental research and development companies produced results for consulting and inspection companies that were neither sustainable nor involved in research. We were able to collect more accurate data from the Research Triangle CleanTech Cluster and Research Triangle Regional Partnership. While this does comprise the main research hub within North Carolina, Research Triangle Park in Durham, it does not account for all the green research and development in the state. We encountered limitations with Reference USA again when collecting data for the entire research and development sector within the state. While our search provided a total number of companies at 6,335, there were only jobs estimates for 6,313 of these companies, and sales volume estimates for only 791 companies. These estimates also were provided as ranges (ex. 100-249 employees, $10-20M sales volume) so it was not possible to determine the exact values of these figures. We took averages for all these ranges and used those to estimate jobs and sales volume. Further, the Reference USA data listed 6,335 total firms, but the RTRP website listed 6,826 total firms. Since it is not possible for one region of North Carolina to have

more research and development firms than the entire state itself, further investigation would be needed to determine the accuracy of the Reference USA results in comparison to the RTRP data. For the sake of consistency, we used just the RTRP data for both green and total research and development figures. This is certainly an underestimate since it only represents data from one region, but as stated in our methods, the Research Triangle Region is the hub for research in the state and represents a majority of firms.

Another limitation of this data is that certain firms may overlap with firms in the Renewable Energy sector, since they both can be involved in renewable energy technology. Further investigation would be needed to determine the extent of the overlap.