Conserving The Carolinas

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Spring 2015

Source: Chad Sharpe and Lauren Wehrung
Since the dawn of civilization, humans have depended on fire and the burning of materials for energy. For that reason, the concept behind biomass energy is far from a new phenomenon. Be that as it may, over time human discovery and developments left the world less dependent on this form of energy, and shifted reliance on fossil fuels. Unbeknownst to the world these energy discoveries would result in negative consequences to our environment, leaving us once again in search of a new, and cleaner energy development. However, as it often does in many aspects of our culture, history has a way of repeating itself, and at this time we are experiencing a new movement in biomass energy.

Abstract

While a century ago, felling a forest was considered growth; today’s science on climate change has revealed far more complex needs of forests on our planet. Due to environmental concerns throughout Southern Forests, deforestation or the continued removal of trees from forest and wetlands is a term with a mostly negative connotation as well as being a heavily debated topic. This case study will examine both negative and positive aspects of deforestation in North and South Carolina, as well as globally, focusing specifically on its link to the production of biomass energy. The history of biomass energy is in the making and there are many positive and negative environmental and economic aspects. This case study will examine both areas by looking into current economics, science, and regulatory actions. For the purpose of this case study, sustainability will be defined as balancing human rights, environment, and economy. A sustainable energy would be one that is renewable, economically feasible, does not encroach on human rights, and is environmentally safe.

Steering our efforts away from fossil fuel dependency is a global concern due to recent environmental studies on the “greenhouse effect- warming that results when the atmosphere traps heat radiating from Earth toward space.” A sustainable energy source to lessen these effects has been highly sought after. With exploration of viable alternatives, like biomass energy, we can help manage and maintain fossil fuels that are already vulnerable due to human consumption. Biomass, or other alternative energy sources, can help create better resource management on existing fossil fuels, as well as help to preserve these resources for the future. These topics will be further discussed in our supplementary material and suggested solutions segment. Since the development of woody biomass is a new market, comparing it to a former innovative development, such as ethanol, may help understand the drive of the emerging market on a neutral level. As woody biomass energy is produced from the harvesting of trees, it is customarily seen in a negative perspective. Looking at things in comparison may help us gain a better understanding of the development of woody biomass as a new, cleaner energy resource. This will be explained in greater detail throughout the science and production portion of this case study.

History:

US Southern Forests

Forests have always played a key role in the history of the Carolinas. Dating back as far as the seventeenth century, the area’s inhabitants have depended on its trees for human settlement and economic growth. In the 1660’s, English land scouts were sent to the New World to survey possible locations for colonization. After arriving in South Carolina’s Lowcountry, they were immediately captivated by the landscape. The lush environment held many possibilities for settlers: “trees stood for the land the English came to inhabit. With their roots anchored in the soil, the girth of trunks and the reach of canopies testified to the land’s underlying fertility.”

This new land held countless possibilities for its new residents, as well as generations to follow. Throughout the next century settlers developed the land, clearing forests and swamps of trees, producing one of the most successful economies in the Western Hemisphere. To fully understand the importance of US Southern Forests, the World Research Institute provides a brief look at the history of Southern forest development in their Southern Forests for the Future journal. Organized in specific eras, this information gives a useful viewpoint and a better understanding of America’s Southern forest history and its current dilemmas:

“The history of southern forests since the last ice age can be viewed through a variety of lenses. One approach is to categorize it into roughly five eras: 1) pre-European settlement, 2) agricultural expansion, 3) industrial logging, 4) semi-regeneration, and 5) suburban encroachment (Table 1). Each era is characterized by the leading cause or driver of change in forest quantity (extent and distribution) and/or quality (composition and health) during that time period, the implications for people and forest ecosystems, and the ecosystem services people valued.”


4 Ibid.
These eras established the southern region as a leading agricultural producer, as well as a primary producer of timber and wood products. These summarized developmental periods ultimately helped facilitate the growth of a nation that became a leading world power. They also set the economic and ecological tone for centuries to come.

Table 1

<table>
<thead>
<tr>
<th>pre-European settlement</th>
<th>agricultural expansion</th>
<th>industrial logging</th>
<th>semi-regeneration</th>
<th>suburban encroachment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forests are burned and harvested by native American Communities. Large variety of forests and wildlife. Included grasslands and swamps.</td>
<td>New European settlers started clearing land for fields, livestock grazing, farm expansion and energy needs (95% of US energy came from wood). New railway system used Southern forests for expansion. Conflict between Native Americans and European settlers resulted in fewer native communities. Forest growth is further altered as forestry practices differ between the two groups.</td>
<td>Continued agricultural expansion, war and human development began to significantly diminish forests. Loss of forests in other regions began to depend on wood from the South, trains made this a speedy process and forests continued to decrease. Forests were reduced to the lowest acreage levels becoming largely uneven throughout the South.</td>
<td>The great depression, war and environmental changes to land (erosion and pests) caused agricultural abandonment. New energy developments made the country less dependent on forests. Private sectors began to invest in forests, as well as governmental action. Laws and forestry departments were set up to help maintain the nation’s forests as well as protect it. Forests in the South begin to recover.</td>
<td>Despite regrowth from transitioning agricultural land from the previous era, population growth and urban developments will continue to deplete forests.</td>
</tr>
</tbody>
</table>

Source: Courtney Ferreira

Presently the Southeast has been a leading manufacturer of wood based products. For example, today “the Southern forests of North America supply 60% of US and 15% of global paper demands.” Aligned, the United States ranks among the leading world producers of timber and pulp, followed by China and India ranked second and third, respectively. These high rated

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5 Ibid.
productions have stimulated extensive logging that has had a considerable effect on our nation’s forestland. And with our nation providing such a diverse landscape, harvesting forests is an extremely lucrative occupation in a worldwide market.

The United States Forest Service states, “The forests of the United States are very diverse in composition and distribution—from the oak-hickory and maple-beech-birch forests that dominate the North to the expansive pine forests of the South to the majestic Douglas-fir and ponderosa pine forests of the West.”

The United States has experienced major forest reduction since the first European settlement and throughout continued global development. “The United States has the seventh largest annual loss of primary forests in the world” according to FAO just behind Brazil, Indonesia, Russia, Mexico, Papua New Guinea, and Peru. In the 2000-2005 period, the United States lost an average of 831 square miles. Lately, population growth, urbanization and paper products have predominantly caused forest loss. Still, there are many additional factors to take into consideration, and not all forestland is used and or destroyed for human consumption. Table 2 illustrates key drivers of Southern forest change.

Table 2

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Ordinarily, one would assume that a leading economic industry like Forestry would be federally regulated and controlled. However, “fifty-seven percent of US forestland is owned by private interests, whether individuals or companies; 43 percent is “public” land under the control of federal and state agencies (Map 1).” Therefore, the actions happening on these lands are at the owner’s discretion, and often unrestricted.

**Science:**

*Biomass energy*

Recently, the United States has seen a push for using harvested wood for energy and today, “the forest production industry is also the leading generator and user of renewable

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This renewable energy is more commonly known as biomass energy. Biomass is the burning of organic materials from plants that can create fuel. There are several aspects of biomass; Table 3 gives a more simplified look at the natural producers of biomass energy.

Biomass fuel is being promoted as a sustainable and renewable alternative for electricity/energy. Biomass production companies have been around for many years and according to the Pellet Fuels Institute website, “there are approximately 1,000,000 homes in the U.S. using wood pellets for heat, in freestanding stoves, fireplace inserts, furnaces and boilers.”

The pellets can also be used in bigger settings and are becoming an increasingly popular method for large-scale companies to move away from fossil fuels. Biomass pellet manufacturers use the unwanted and unused parts of trees, sawdust, and any other leftover woody material and transform them into wood pellets. These companies also use diseased, oddly growing, and regular trees for wood pellets. The president of Biomass Power Association, Bob Cleaves, states: “These materials have no other use; they would otherwise decompose either in landfills, emitting

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the harmful methane gas, or on a forest floor where they would provide kindling to wildfires.”

Currently, this transition is creating a new industrial boom in the southern United States, and many forests as well as wetlands are being harvested to supply demands for those large-scale companies. The dilemma, however, is that these demands are coming from companies that are mainly overseas. “Wood pellet exports from North America to Europe have doubled in two years to reach 4.7 million tons in 2013 with the U.S. South accounting for 63 percent of the volume, according to the North American Wood Fiber Review.” Market trends and projections point to a major increase in biomass energy production over the next decade in both the United States and Europe. In 2012, total shipments from Southern ports skyrocketed 70 percent from the previous year, totaling 860,000 tons. This growth is expected to continue particularly in the U.S. Southeast, which is now the world’s largest exporter of wood pellets in the world. For example, the rapidly growing and largest Southeastern wood pellet company, Enviva, produces these pellets and ships them to Europe to be burned for energy.

Map 1

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Enviva Wood Pellet Plants
Proximity to North Carolina Managed Areas
Enviva, one of the largest manufacturers of processed biomass in the world, has constructed three wood pellet production facilities in northeastern North Carolina (Enviva Pellets Northampton, Garysburg, NC and Enviva Pellets Ahoskie, Ahoskie, NC) and southeastern Virginia (Enviva Pellets Southampton, Franklin, VA). See Figure 7.1. It has proposed construction of three more plants in North and South Carolina, and plans to add an export facility to the Wilmington, North Carolina port. Enviva is also looking to expand and build another wood pellet plant in Sampson County, North Carolina. Since Enviva prefers to work within a 75-mile radius (when asked at the plant, they like to stay within a 60-mile radius) of the plant and also cannot travel long distance to shipping ports, it is vital that Enviva expand. The new proposed plant would be using the Wilmington, NC port for shipping (Figure 1). Shipping ports along the East Coast would like to expand for increased shipping. The Port of Wilmington would be the shipping port for Enviva’s newest proposed Sampson County plant. Enviva would also like to store wood pellets at the Port of Wilmington, which “expands well beyond the boundaries of the port.” The proposed storage at the port has citizens concerned about “increased truck traffic, noise, and dust pollution.” The increased truckloads of wood pellets could cause infrastructural damage to the roads, on which taxpayer dollars will repair. The noise and dust would directly affect the ports neighbors. Piles of organic matter, when left, tend to start to decompose. When decomposition is occurring, the material will become very hot and has the potential to start a fire. While visiting the Port of Wilmington, our research team witnessed a large pile of woodchips sitting in the sun smoldering (Figure 2)

Figure 1

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17 Ibid.
Timber and paper mill companies are well established in the Southeast. Now, large biomass industries are making an appearance. Enviva does not directly buy timber from a seller. The company acts more as a cleanup agency. Large lumber companies bid on forested land and Enviva buys the left over and unwanted wood. It takes everything from sawdust to whole (unusable) trees. Enviva’s website states “Enviva does not source from primary forests, protected
forests or forests that are being harvested for land use conversion.” Enviva has strict guidelines in place by the European Union to attest to the company’s sustainability. The Natural Resources Defense Council (NRDC) reports that none of the states that Enviva is currently operating in “have laws or regulations that protect old growth and endangered forests.”

Enviva highly recommends the replanting of trees. Encouraging replanting of trees does not only abide by EU regulation, it also solidifies supply for timber demand. More trees equal a profitable timber and pellet industry. Landowners will want to maximize their utility by planting a crop of trees that will grow rapidly to harvest at a quicker rate. In this case, pine will be planted. Pine grows fast but like with any monoculture, it will need pesticides and could possibly lead to the weakening of biodiversity.

To create the pellets, Enviva uses a combination of the wood’s natural properties and heat. The raw materials from many different sources are delivered by the truckload and put through a wood chipper, then dried to remove moisture from the wood. The wood, now sawdust or woodchips, will be “pressed through dies at high pressure.” The high pressure causes heat, which makes the wood release lignin that binds the pellet together. The pellets are then cooled and stored in a silo awaiting distribution. When burned, wood pellets generate steam to create electricity.

Science:
Environment- Forests: Locally

Southeastern United States was “once covered by 90 million acres” of longleaf pine trees. Map 2 illustrates the longleaf tree canopy from the 1970’s surrounding Enviva’s current facility in Garysburg, North Carolina. Longleaf pines offer “one of the most diverse ecosystems in the world.” The discovery and colonization of the Carolinas led to the “exploitation” of the longleaf for agriculture, farming, and lumber. Later, urban sprawl led to much of the longleaf’s


22 Ibid.
demise. Today, there are “less than 3 percent of the original [longleaf] forests remaining.” Longleaf forests require wild fires to thrive, making them a challenge to reintroduce in an increasingly urbanized area. According to the North Carolina Wildlife Resource Commission “352 longleaf pine remnants examined in North Carolina, only 91 stands (26%) were being maintained by fire, while the rest (74%) were fire-suppressed and in transition to other forests types.” The longleaf pine and human coexistence seems to be at odds with one another. On one hand, the longleaf created this beautiful ecosystem that attracts so many tourists and residents. On the other hand, natural upkeep of the longleaf encroaches on human safety.

Map 2

Ibid.

Loblolly pines prefer a moist soil and are tolerant of younger trees, where longleaf pines prefer dry soil and are not tolerant of younger trees. Loblolly’s tolerance allows for hardwood to grow in the surrounding area. Longleaf does not compete with younger trees; the fire it requires kills the competition while providing the longleaf with optimal growing conditions. Longleafs are fire resistant, pest resistant, and their deep root system makes them more resilient to hurricanes. If growing time were not a crucial part of the timber growing industry, longleaf pines would be the best choice for tree farmers. Longleafs prefer a monoculture growing, meaning they need less herbicide to stifle out the competing trees. They are also more pest resistant requiring fewer pesticides. Less herbicides and pesticides would decrease the amount of nutrification taking place. Agricultural herbicides and pesticides directly affect the other biological organisms in the area and water quality. These pesticides absorb into the ground and wash into the streams and river, which end up in the ocean. Choosing longleaf pines would be environmentally beneficial. Choosing loblolly pines would be economically beneficial, if looking solely from a market viewpoint.

Plantation tree farms are the ample environment for a perfect pest storm. Let’s say a tree-ravaging beetle finds a plantation and it is not properly protected with pesticides, the entire plantation can be compromised. A natural forest houses many bio-diverse plants making it harder for a pest to move from the particular tree it likes to another. In a plantation, it is a free for all because the trees are planted one after another, row after row, almost like a pest buffet line. The increased need for pesticides causes the pest to adapt and overcome the pesticides causing an increased need to stronger pesticides. To combat this growing problem, ArborGen has been producing genetically engineered (GE) loblolly and longleaf pine trees. These trees “have been genetically engineered to enhance certain traits and speed up growth.”25 Will Bennington of the Global Justice Ecology Project warns that GE trees “would inevitably and irreversibly contaminate native forests with destructive GE traits, devastating forest ecosystems and wildlife.” He also grimly reminds the public that “Once GE trees escape, there is no way to call them back”26 due to the intermingling of pollination in nature. These GE trees would be a wonderful new source to the “Portugal-based Portucel S.A. [that] has announced plans to build a 460,000-ton-per-year pellet plant in Greenwood County, South Carolina.”27 This international


company exporting to foreign buyers would be the first pellet plant inside South Carolina along with Santee Cooper.

Science:

Environment- Forests and Carbon Absorption

On a global scale, forests are important for carbon reduction. Healthy trees use their leaves to do photosynthesis, which involves taking in carbon and converting it to oxygen. This process is vital for combatting global warming and climate change. The photosynthesis of deciduous (leafy) trees is greater than the photosynthesis of coniferous (needled) trees. Since the deciduous trees lose their leaves right before winter, they vigorously do photosynthesis to obtain as much glucose as they can to withstand the winter months. This overdrive work has the tree pumping out oxygen at a much higher rate than that of a relaxed coniferous tree. Hardwood trees are being cut for lumber and biomass, and fast growing pines are being planted in their place. This landscape transformation is interfering with the plant variety in carbon absorption.

Climate change could cause widespread complications in the southeast. Rising sea levels make way for greater, more intense hurricane systems that could flatten areas. These flattened forested areas could impact the community economically as well as increase the rate of climate change by the “elimination of the carbon-absorptive capacity of the forest.” The rising temperatures could change growth rates, soil moisture, and create competition for dwindling water supplies between the forests and humans. Climate change, at an artificially fast pace, makes it hard to assess the possible challenges and outcomes that the Carolinas will face.

Science:

Environment- Water

Humans need water to survive, making it the world’s most valuable resource. William Ryerson, a Fellow of Post Carbon Institute, explains: “freshwater constitutes only 3 percent of all water on Earth, of which about a third is found in underground aquifers and about two-thirds in ice caps and glaciers. Only 0.3 percent of freshwater is found on Earth’s surface in lakes, rivers, and wetlands.” Climate change drastically compromises that supply. Freshwater ice caps are


30 Ibid.
melting into salt-water oceans (Figure 4), unpredictable weather due to climate change, and the exponential population growth impact water supply. Water consumption of alternative energy sources should be thoroughly examined when determining if the source is sustainable and a viable option.

Figure 4 Glacial Lagoon in Iceland

Biomass energy plants rely on water for cooling. “A typical 50 MW plant requires 700,000 to 900,000 gallons of fresh water a day,” and “about 85% of this is evaporated; the balance is returned to the river as a heated solution containing concentrated pollutants like aluminum and phosphorus.” Compromising the supply and quality of the fresh water could drastically impact the ecosystem depending on the river water. If the soil pH is at or lower than 5

“Aluminum ions cause a stunting of the root growth and prevent the roots from taking up calcium. The result may be the overall slowing of the growth of the entire tree.”32 “Aluminum phytotoxicity may be alleviated either by liming” the forest but it is not economical to do so33. Slowed growth of trees could hinder the renewable aspect of this industry. The biomass industry relies on tree growth at a certain rate to remain sustainable and to remain carbon neutral. Polluting of the water and soil could pose a greater deforestation threat. The decline in forests around the wood pellet plants for production and the decline in forest growth around the biomass energy plants is due to pollution.

Increased levels of phosphorus in water can create algae blooms. The Environmental Protection Agency (EPA) explains: “increases in algae harm water quality, food resources and habitats, and decrease the oxygen that fish and other aquatic life need to survive.”34 The EPA also explains that the algae blooms can cause humans to get sick and also the “nutrient pollution in ground water - which millions of people in the United States use as their drinking water source - can be harmful, even at low levels.”35 The Carolinas many river systems carry water to the Atlantic Ocean. The increase in phosphorus is choking the oxygen out of the ocean and altering the chemistry. Changing the chemistry of the ocean could jeopardize the immense carbon absorption it currently does.

The Carolinas relies profoundly on their relationship with the Atlantic Ocean. Wetlands offer a protective barrier from the unpredictable nature of the ocean. The EPA explains, “wetlands feed downstream waters, trap floodwaters, recharge groundwater supplies, remove pollution, and provide fish and wildlife habitat.”36 Wetlands are vital to coastal communities and endangering them could mean endangering the safety of the community. The Natural Resource Defense Council (NRDC) and The Dogwood Alliance report that the wetlands around the Enviva


35 Ibid.

wood pellet plant “in Ahoskie, North Carolina, are in serious decline across the landscape.”\textsuperscript{37} The NRDC also states that the destroyed wetlands are being replaced with tree plantations in many cases. Enviva’s webpage indeed states they do source from wetlands but their suppliers “take extra care by using specialized harvesting equipment and techniques that minimize environmental impacts and protect soil and water quality.”\textsuperscript{38}

As of March 2015 Dorchester County, South Carolina’s “elected officials are making a push to shrink some protected lands”\textsuperscript{39} in order to be more economically appealing. Dorchester County lies to the west of Charleston, SC and is not directly on the ocean, but it has vast amounts of wetlands. The county is asking for parts to be removed from the coastal management program, which protects wetlands. This request has influenced other South Carolina counties to ask to be reevaluated and possibly removed from the program. If removal is successful, it could impact wetlands up and down the Atlantic coast, lessening wetland security. The prized hardwood within the wetlands could become available for the timber industry as well as the biomass industry.

Santee Cooper and EDF Renewable Energy partnered to open its first biomass energy plant in Dorchester County on November 1, 2013.\textsuperscript{40} The new biomass plants will use woody biomass to burn as fuel to produce energy. Since the opening of the Dorchester and Allendale biomass plants in 2013, Santee Cooper has been excitedly promoting their leadership in renewable energy. The possible decline of wetland regulation around the new Dorchester biomass energy plant could pose a problem since they do not have EU standards to abide by like Enviva (wood pellet producer). A topic of future research could be comparing and contrasting production between Santee Cooper and Enviva.

\textbf{Science:}

\begin{itemize}
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Environment- Air

The EPA explains that the decomposition of woody matter is releasing methane, “a gas more than 20 times more able to trap heat in the atmosphere than carbon dioxide.”\textsuperscript{41} Using some of this decomposing organic matter for fuel would lower the amount of methane released into the atmosphere. Enviva collects the leftover woody material from the timber industry that would be left to decompose. Table 4 illustrates the direct carbon emissions emitted via energy sources and their costs. This chart shows that biomass energy plants produce far less carbon dioxide than fossil fuels and are less expensive. The only alternatives that compare in price and emissions are hydro and wind, which are viable options considering the location of the Carolinas.

Table 4

\begin{center}
\begin{tabular}{|c|c|c|c|c|c|c|c|}
\hline
Energy Source & Cost ($/mWh) & CO2 Emissions (kg/mWh) \\
\hline
Coal & \textcolor{blue}{8} & \textcolor{red}{10} \\
Diesel & \textcolor{blue}{12} & \textcolor{red}{15} \\
Natural gas & \textcolor{blue}{6} & \textcolor{red}{7} \\
Biomass & \textcolor{blue}{1} & \textcolor{red}{2} \\
Hydro & \textcolor{blue}{2} & \textcolor{red}{3} \\
Wind & \textcolor{blue}{4} & \textcolor{red}{5} \\
Solar PV & \textcolor{blue}{5} & \textcolor{red}{6} \\
Solar Thermal & \textcolor{blue}{7} & \textcolor{red}{8} \\
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\end{tabular}
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\textit{Source: Viaspace: Clean Energy for a Cleaner Tomorrow}\textsuperscript{42}

The Partnership for Policy Integrity compiled a report of “88 biomass plants in 25 states”\textsuperscript{43} using biomass for energy. They found that “per capita, biomass [energy, not wood pellet production]...”\textsuperscript{44}


[producing] plants can release more volatile organic compounds, particulate matter, nitrogen oxides and carbon monoxide than a coal plant.” The report continued by stating that “many plants underestimate the amount of pollution they will release to avoid tighter federal air pollution regulations.” The Department of Health and Environmental Control in South Carolina states that the Allendale “plant [17.8 MW,] is regulated by at least five standards and regulations that protect public health and the environment,” including “stringent emission limits and stack test requirements.” Biomass plants are able to “release 2.5 times more pollution than a coal plant” due to “lax regulation and regulatory roll backs”, according to the report. “Biomass power plants” are “increasingly likely to emit toxic compounds like dioxins; heavy metals, including lead, arsenic and mercury; and even emerging contaminants.”

The drying process of making wood pellets heats up green wood to very hot temperatures, causing a release of “volatile organic compounds” including formaldehyde and manganese, which need to be controlled before being released into the environment. The actual biomass energy plants “most common pollutants include nitrogen oxide (NOx), sulfur dioxide (SO2), carbon monoxide, and particulate matter.” The EPA has proposed “tightening ozone standards in an effort to improve air quality across the country.” This proposal has been under some political backlash from GOP governors, including South Carolina’s Nikki Haley. This group has complained that these regulations could “hurt the economy.” The EPA states these

44 Fretwell, “Biomass plants take hit for pollution”.
45 Ibid.
46 Ibid.
47 Ibid.
48 Ibid.
“tighter ozone standards will make breathing easier for the public”\textsuperscript{52} which could prove very beneficial since nitrogen oxide “emissions causes ground-level ozone, or smog, which can burn lung tissue and can make people more susceptible to asthma, bronchitis, and other chronic respiratory diseases.”\textsuperscript{53} Since South Carolina is currently using biomass energy, these regulations could limit emissions, making the industry evolve and adapt to the new standard of human and environmental protection.

The United Nations has called upon “urgent leadership and joint action now.”\textsuperscript{54} Backtracking on forward thinking initiatives, like tighter EPA standards, would be detrimental to world progress of moving cooperatively towards a sustainable future. Year 2015, according to the UN sustainable development agenda, offers the planet a chance at a new age renaissance of “economic transformation, while protecting our environment, ensuring peace and realizing human rights.” According to this framework, our elected officials should be working in harmony to balance economics, environment, and human rights, not competing between/among them.

**Science:**

*Endangering Species:*

Endangered species vary from animals to plants. While it might be true species increase and decline in a natural cycle, human practices that deeply influence the cycle cannot be denied. Humans have taken themselves out of the cycle and placed themselves in the role of managing the cycle. Humans might benefit from this management in many aspects but it is our responsibility to recognize when our management becomes detrimental. This balance is encompassed within the spheres of sustainability: economics, environment, and humans.

The Carolinas offers a unique ecosystem to many. Dramatically changing the landscape, threatening the water quality, increasing our exports all have an effect on the organisms in the vicinity. Map 3 illustrates a few examples of endangered species in South Carolina’s Lowcountry and along its coastline, whereas Map 4 illustrates a few examples of endangered species along North Carolina’s coast and in close proximity to Enviva’s wood pellet plants. Shipping routes directly correlate with the decline and unintentional violence against the

\begin{itemize}
  \item Fretwell, “SC Gov. Haley, other GOP governors say air pollution rules too tough on business.” \textsuperscript{52}
  \item Ibid. \textsuperscript{53}
  \item “Environmental Impacts of Biomass for Electricity.” Union of Concerned Scientists: Science for a healthy planet and safer world \textsuperscript{54}
\end{itemize}
endangered Right Whale. The Right Whale has a migration route along the coast of the Carolinas. The container ships hit right whales causing large hematomas; propellers cut off tales, and even kill these mammals. Projected shipping growth along the East Coast will only increase the danger the right whales will face.

The red-cockaded woodpecker is also a prized resident of the longleaf pine ecosystem but is now endangered due to “loss of habitat and fire suppression.” These unique woodpeckers thrive in the longleaf pine habitat and have declined in unison with the tree. The protected red-cockaded woodpeckers on public lands are doing much better than the ones protected on private property. It is much easier to maintain a standard for public land protection of the bird than it is to get private landowners to adhere to the protection.

The southern hognose snake is another species among the endangered due to the decline in longleaf pine and introduction of fire ants. This snake is fascinating in the way it behaves and it has made the southeast and coastal areas it’s home. One reason the Carolinas should pay close attention to this snake is that it “is now only found in scattered locations in South Carolina, North Carolina, Georgia, and Florida.” It is the responsibility of these areas to protect that unique indigenous snake.

Map 3

138-status--distribution (April 7, 2015).

Economics:
The Biomass Industry - Globally

Structurally, the biomass industry is a subsidy driven market. European power companies receive different subsidy levels depending on whether their plants are dedicated biomass plants; plants built specifically to handle wood pellets, or conversion plants. Conversion plants are plants previously used to burn fossil fuels that have been converted to handle wood pellets instead. So if the government subsidies to these companies are not at the desired level, then demand for wood pellets will not grow. With the British power giant Drax Group expanding, the market is growing. But the sustainability of the export market for American wood pellet producers is questionable, as these exports are entirely dependent on European government subsidies for biomass companies to maintain their current level. The UK is the number one importer of wood pellets in the world, so a change in its governmental economic policy dictates the health of the market for American exporters. The proposition of expansion may be risky for wood pellet exporters, as European demand for the product could be substantially halted upon the implementation of new policy.

This may be the biggest issue regarding the viability of the biomass industry. In July 2014, the chief science advisor to the United Kingdom energy agency released a report on the carbon effect of burning woody biomass for energy. The report uses a comprehensive model to calculate the carbon emissions associated with the burning of wood pellets, and found that burning wood pellets made from whole trees from southeastern U.S. forests may emit four times as much carbon as the burning of coal. As of 2015, all power generators in the UK that burn biomass are required to meet sustainability criteria to receive subsidies. In response, UK and US science and policy experts have been pushing the UK government to follow the report's findings and deny subsidies to generators who cannot demonstrate actual carbon benefits. This is

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59 Ibid.

worrying for wood pellet producers, as some of their customers could potentially be denied these subsidies. If that were the case, those power companies may no longer have reason to import American wood pellets, dealing a massive blow to exporters.

Derb Carter, director of the North Carolina Office of the Southern Environmental Law Center, says, "Without government subsidies in Europe, this wood pellet export industry would not exist. This science report and potential policy change on subsidies is the beginning of the end of sourcing wood pellets from natural forests in the southern United States."61

It is clear that Enviva intends on continuing on the path of success in this growing market, but this report questions the viability of biomass business in the long term. However, Enviva maintains that “demand for sustainably produced biomass fuels is still expected to grow substantially through 2020 as coal fired power facilities attempt to meet regulatory targets and improve the environmental profile of energy generation.”62

Lately though, industrial pellet prices have been on downward trend after peaking at $180 per metric ton in October 2014. Pellet imports have been growing in the UK, but the Euro’s recent fall against the US dollar has resulted in less competitive prices for American pellet exporters like Enviva. As a result, the UK is looking to European pellets from Portugal and the Baltic region in smaller quantities where they can get them cheaper than importing overseas. As a result, US suppliers have dropped prices, but not drastically. It is still far more practical for the UK to secure pellets in large quantities from the US and Canada than in smaller amounts of only 2-5 thousand tons per shipment from European suppliers.63

While there is slowly increasing demand from Asian countries, most notably South Korea,64 it is not nearly as lucrative a market as Europe. These growing exports to Asia could


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have also led to raised prices for Europe. This is an important trend if demand for American wood pellets increases in Asia, as producers would have more customers and thus cause for expansion. This would lead to raised prices, which European companies may choose to forego more often in favor of cheaper European pellets as they have done recently.65

Economics: 
On a Local Level

In general, the United States has benefitted from the forestry industry and has maintained a healthy industry since the first European settlements, causing the US to be a leading consumer and producer of forest products. In the present day “the U.S. forest products industry produces $200 billion in sales a year and employs about one million workers.”66 Here in the South, specifically South Carolina, forestry accounts for “more than $17 Billion annually. With a delivered value of $783,894,293, timber is the state’s leading cash crop.”67 These trends make our economies heavily dependent on our forestland.

As the demand for woody biomass increases, the value of forested property suited for biomass production is also likely to increase. An increased property value of forested landscapes can benefit rural communities where biomass is sourced. More business options for forest owners and an incentive to keep land forested can benefit the local economy. Growth of biomass energy also creates local jobs in a variety of sectors along the entire supply chain of biomass fuel.68 The forestry and logging industries, along with their support industries, employ more

than 200,000 jobs. The healthier these industries are, the more jobs that can be created. Woody biomass is a market that directly contributes to these industries, and a growing biomass market supports the health of the former markets. In fact, in the New England and New York State region, it has been estimated that for every 100,000 tons of pellets manufactured, 342 jobs are created. Considering the fact that Enviva’s pellet plant in Northampton County, North Carolina has a production capacity of 500,000 metric tons per year, approximately 550,000 tons, the potential for job creation in the U.S Southeast on a local level is very promising.

Policies:
On A Local Level In The Carolinas

While in North Carolina, there was a great deal made about the governmental regulations and policies that were either against the biomass industry or standards that the industry needed to adhere to. All of these standards or regulations have loopholes and sometimes provide more questions than answers. The locals that we spoke to in North Carolina seemed to believe that this industry (Enviva), would bring more problems and fewer solutions to the surrounding areas, such as noise complaints, road damage, and potential particulates in the air. These were the main concerns along with the major deforestation possibility if the industry increases. In Europe there are laws protecting against pillaging of forests but there are none in North Carolina. One major policy that goes in the woody biomass industry’s favor is the personal property rights. The areas visited were more poverty-stricken and the selling of timber could be the only form of income for people in this area. Map 5 illustrates the median income values around Enviva’s Northampton plant. Some residents felt that the plants were strategically placed in low-income areas. Map 5 shows the placement of the plant in North Hampton County, North Carolina and the plant is located in one of the poorest areas. The plant is located in an area where the average income is $24,000 or less. The surrounding areas of the plant have average incomes of $24,000 to $39,000. Although the plants could bring economic opportunity to the low-income areas, some fear it might be easier to take advantage of the residents in the area due to their economic situations.

Map 5


There are not many government regulations on deforestation because a large portion of forested land is privately owned. There are a few regulations regarding the tribal land. For example, the American Indian Religious freedom Act protects sacred land since there is a large portion of Cherokee Indians in North Carolina. Also, since there is a great deal of historic land in the Carolinas, there are significant regulations and stipulations that would have to be gone through to log or cut down most of the forest. The NHPA or the National Historic Preservation Act...
Act makes sure that these resources are managed for future generations to enjoy, which was a major concern of the locals that were asked about the woody biomass industry.

One major question that was raised by the locals was the problem with noise. According to the Noise Control Act, the EPA regulates control standards on noise for the transportation in and out of the plant as well as the noise-emitting product itself. All the trucks passing through would not only be noisy but would also have a great impact on the quality of the road around. In North Carolina, taxpayers fund road maintenance and Enviva would be given a tax break from the government for opening the new plant. Enviva was granted the Job Development Investment Grant by the state Economic Investment committee. Reception of this award was based on proof of job creation as well as performance requirements. Enviva is eligible for twelve annual grants.

Hearing from the locals, the immediate areas around the plants would have problems with particles in the air. The Clean Air Act would be on the side of the locals because there are air quality standards in place that force mobile and non-mobile sources to require permits that would prove that the air in the area was clean. The EPA has recently proposed the Clean Power Plan that puts limits on carbon pollution. The EPA will finalize the rule this year and will allow the states tremendous flexibility for reducing emissions by 2030. Governor Pat McCrory of North Carolina has outright opposed the EPA plan. South Carolina Governor Nikki Haley has created stakeholder processes to get input on how to create the Clean Power Plans. Governor McCrory has been silent about how to achieve these goals.

One issue that is being looked at along the South Carolina coast is the loss of wetlands and how it affects local communities. The Carolina wetlands produce some of the most ecologically diverse animal species in the U.S.; they also provide hunting land for hunters as they pass down these skills to younger generations. In 1977 President Carter saw the need to protect the wetlands of the U.S for the future in an executive order guiding federal agencies to avoid the short and long term impact on the destruction of the wetlands or new building on the wetlands. Deforestation would be an extremely negative impact on the wetlands and would cause flooding and other potentially dangerous problems, which is why there are strict regulations on the logging industry.

Alternative Solutions:
Wind and Solar Energy For The Carolinas

Understanding different aspects of biomass engineering may help increase the public’s understanding of how and why our country is currently interested and exploring biomass energy. Looking at it in its entirety we have seen some optimistic developments. The recent push in ethanol fuel is an example of successfully incorporating new biomass energy into our daily use. Although ethanol is merely a stepping-stone, it has made an impact on our reliance of fossil fuels, and it has also been a factor in lowering our dependence on imported energy sources because it is internally produced. “In 2014, the use of ethanol in gasoline reduced CO2-equivalent greenhouse gas emissions from transportation by 39.6 million metric tons. That's
equivalent to removing 8.4 million cars from the road for an entire year.”\textsuperscript{72} According to the August 2014 monthly energy review, “ethanol fuel use in the U.S. has increased dramatically from about 1.7 billion gallons in 2001 to about 13.2 billion in 2013.”\textsuperscript{73} The biomass industry is a renewable alternative to fossil fuels. While it is a more arguably economically and ecologically friendly industry, it does have limitations. Relying on organic matter, the industry is dependent on materials that are often regulated and whose supply does not come in unlimited quantities. There are however, alternative energy solutions that may be considered a more sustainable option on both a global and domestic scale. Particularly, wind and solar energy are two sources that could provide a more infinite resource for energy production across the globe, specifically in the Carolinas.

Relevant information in regards to solar energy for recreational use in the state of South Carolina is shared as public knowledge through the SC PURC, more formally known as the Public Utilities Review Committee. The PURC, since 2010, has worked with the Energy Advisory Council (EAC) in regards to the continued exploration of this technology. A study done by the EAC shows that “our state (South Carolina) has up to 1,700 megawatts of near-term solar potential. That translates into about 3\% of the electricity used in South Carolina annually.”\textsuperscript{74} Although this percentage may seem low, harnessing solar energy in South Carolina may still be worth the effort, as the cost of using solar energy has decreased in recent years and the installation and management of these systems could provide jobs to locals.

Furthermore, harnessing solar energy will propel the local economy by fueling investments from companies who prioritize clean energy resources and keep their profits at home. Compared to other states, South Carolina has failed to achieve the same level of progress. According to the Coastal Conservation League: “North Carolina has installed 51 times more solar (388 megawatts) than South Carolina, and the Georgia Public Service Commission has approved almost 30 times more solar (785 megawatts) than is currently planned in our state.”\textsuperscript{75}

There are currently tax credits given to those who purchase solar power systems. In a recent study by the Energy Advisory Council of South Carolina, “a significant piece of the


economic puzzle for solar installations is tax credits. Under current South Carolina and United States tax law, such credits could pay for as much as 55% of the cost of a solar system. This tax incentive, along with the decreasing price of solar photovoltaics (PV), are making the installation of solar technology an affordable investment.

Wind energy is becoming an increasingly popular alternative to fossil fuels, as it is “abundant, inexhaustible and affordable.” Wind energy can be defined as “a source of renewable power which comes from air current flowing across the earth's surface.” In order to create power, wind turbines are placed in clusters on wind farms, where the groups of turbines “harvest this kinetic energy and convert it into usable power which can provide electricity.” There are two types of wind turbines: small-scale and large-scale. Both serve different purposes but share a common goal of supplying clean energy. Small wind turbines can operate on and off utility grids, with "'off-grid' application normally providing electrical power for home, farm, school, or business applications." Small-scale wind turbines are generally constructed with a “one-hundred foot tower and require average annual wind speeds of at least nine miles per hour.” Large-scale wind turbines are intended for greater use and power larger utility grids. They are “used to provide electrical power for entire communities and municipalities.” Large wind turbines can reach one hundred and fifty feet in blade length, generally host a tower reaching two hundred feet and have the capability to provide power to hundreds of residences annually.


79 Appalachian State University, “Introduction to Wind Power.”


81 Appalachian State University, “Wind Turbines.”

82 Ibid.

83 Ibid.
In addition, wind energy can be collected both onshore and offshore. Offshore wind is sometimes stronger and more frequent, which is why offshore wind farms are constructed in large bodies of water. Offshore wind power is a feasible alternative to onshore wind power for states that do not have the land capacity to house major wind farms. At present, “nearly 78% of the nation’s electrical demand is consumed by the 28 coastal states, most of which do not have substantial land based wind resources to develop.” Both types provide economic and ecological benefits, though onshore wind farms are easier to maintain and less expensive than their offshore counterpart.

Both North and South Carolina are working toward future use of and better implementation of wind energy. Wind energy in South Carolina has yet to take off. In fact, it is still being researched and developed in the hopes that it will be used in the future. One such effort has been provided through Clemson University and SCE&G, an electric utility company that “provides electric and/or natural gas service to homes and businesses across a 22,000 square mile service territory in central, southern and western South Carolina.” The two have collaborated with several governmental organizations, businesses and local colleges to create the Clemson University and SCEG Energy Innovation Center. Through the use of an estimated ninety-eight million dollars in grant money, the center will “build and operate a facility capable of full-scale, highly accelerated testing of next-generation wind turbine drive-train technology.” According to the center's website, the new testing facility will “provide high value, high quality and cost-competitive testing services to industry that will lead to lowering the cost of energy delivered by wind power.” Researchers will learn how to best serve the power needs of South Carolina with the potential of wind energy, which the institute believes will be largely beneficial.

In addition, experts believe that South Carolina's future in wind energy lies off its coast. South Carolina is unique in the sense that “it does not possess conventional energy resources (coal, oil, gas, or uranium), however, it does have plentiful supplies of renewable offshore wind energy.” Studies performed by the US Department of Energy have provided data which

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87 “Background.”

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suggests that South Carolina has “potential to produce over twice the amount of electricity that we consume today”\textsuperscript{89}, through the use of its offshore winds. Among the eastern shoreline, South Carolina hosts several qualities that make it an attractive candidate for future wind energy, including: “favorable winds, a shallow Continental shelf for 10 to 30 miles off the coastline, large port facilities, and one of the preeminent wind turbine manufacturers”\textsuperscript{90}. In the future, South Carolina may be one among many of the coastal states that will play a large role in wind energy production. Offshore wind energy facilities along the Atlantic Coast have potential to “power up to five million homes, and the United States has designated 1.5 million acres of ocean as wind areas.”\textsuperscript{91}

In North Carolina, wind energy is becoming increasingly popular. In the early 1900’s, the Wright brothers used the powerful winds off the coast of North Carolina to test their model aircraft.\textsuperscript{92} Their success has been a testament to North Carolinian’s that the state’s frequent and powerful coastal winds can be used to provide power to the state. With this in mind, many locals are finding more and more favor with the idea of wind energy. In a 2010 survey hosted by Appalachian State University, 85% of participants answered in favor of increasing wind energy production in North Carolina. In the same survey, 56% of participants answered that they had a “very positive” attitude toward wind turbines. Overwhelming public support may be indicative of coming change in the energy industry of North Carolina.

Several local universities have gone to great lengths to study the future of wind energy in North Carolina. While North Carolina currently has several wind farms throughout the state, much more can be done to implement greater use of wind energy, including installation of offshore wind facilities. The University of North Carolina (UNC) and the UNC Climate Action Program's study, which focused on determining what areas are most feasible for wind energy, concluded that “because of a promising wind resource, large areas offshore of the North Carolina coastline are potentially well-suited for wind energy development and worthy of further


\textsuperscript{90} Ibid.


investigation.” In addition, Appalachian State University has concluded via their own research that North Carolina is a good candidate for wind energy because it “has abundant wind resources on the western mountain ridges and eastern coastal areas, unique to the Southeast, and has an excellent opportunity to harvest this local source of power”.

While both states work toward greater utilization of wind energy, both must assess the ecological and economic impacts of the technology. One major advantage of wind energy includes increased job opportunities in the United States in both the installation of and maintenance of wind energy facilities. “The U.S. wind industry currently directly employs more than 2,000 people, and every megawatt of new wind capacity creates 15-19 jobs and about 60 person-years of employment”.

In addition to job creation, wind energy is a more inexpensive alternative to fossil fuels. “As a renewable resource, wind energy has no fuel cost, allowing electricity consumers and utilities to lock-in known electricity rates for 20 to 30 years through contracts called Power Purchase Agreements (PPAs).” Wind energy is also an industry that is gradually becoming more inexpensive. There are a number of factors that may contribute to declining costs of wind energy, a promising notion for powering states in the future. “Advanced technology, improved siting techniques, and learning across all sectors as the industry scales up have all influenced the cost of wind energy over time”. In a study cited by the U.S. Department of Energy (DOE), the cost of wind energy in the United States has continued to decrease nearly 90% since 1980.

In addition to reduced cost, wind energy has far less impact on global warming than does fossil fuels. Over its lifetime, wind turbines are estimated to have “global warming emissions ranging between 0.02 and .004 pounds of carbon dioxide equivalent per kilowatt-hour”. This is

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98 Ibid.

significantly less than natural gas, which is estimated to emit “between 0.6 and 2 pounds of carbon dioxide equivalent per kilowatt-hour” and coal, which is estimated to emit “1.4 and 3.6 pounds of carbon dioxide equivalent per kilowatt-hour”\textsuperscript{100}. Another positive aspect of wind energy is that “there is no water impact associated with the operation of wind turbines”\textsuperscript{101}. This makes wind energy an attractive source of energy for high-drought areas.

Noise and aesthetic are two areas of concern when constructing wind farms near communities. The sound of each turbine depends on “turbine design and wind speed”\textsuperscript{102}. In addition, “under certain lighting conditions, wind turbines can create an effect known as shadow flicker”\textsuperscript{103}. While annoying, neither poses a threat to public health and both can be mitigated with appropriate planning. Wind turbine noise can be minimized with “technological advances, such as minimizing blade surface imperfections and using sound-absorbent materials”\textsuperscript{104}. To reduce the effects of shadow flicker, “careful siting, planting trees or installing window awnings, or curtailing wind turbine operations when certain lighting conditions exist” are all plausible options to reduce its effect.

Wind turbines can also affect wildlife in a number of ways, both positive and negative. Specifically, birds and bats have been the center of most studies aimed at determining affected species. Deaths of these mammals have been recorded after having collided with wind turbine blades.\textsuperscript{105} In addition, “changes in air pressure caused by the spinning turbines, as well as habitat disruption” have also affected the animals.\textsuperscript{106} Another area of interest that researchers are exploring is the potential effects of offshore wind farms on sea-life. Offshore turbines may also affect marine birds, however “bird deaths associated with offshore wind are minimal”\textsuperscript{107}. Scientists speculate that offshore wind farms may even have a positive impact on marine life, as they “may actually increase fish populations by acting as artificial reefs”\textsuperscript{108}. In order to mitigate

\textsuperscript{100} Union of Concerned Scientists, “Environmental Impacts of Wind Power.”

\textsuperscript{101} Ibid.

\textsuperscript{102} Ibid.

\textsuperscript{103} Ibid.

\textsuperscript{104} Ibid.

\textsuperscript{105} Ibid.

\textsuperscript{106} Ibid.

\textsuperscript{107} Ibid.

\textsuperscript{108} Ibid.
future implications on the environment, the Union of Concerned Scientists recommends that “the impact will vary from site to site, and therefore proper research and monitoring systems are needed for each offshore wind facility”.

Conclusion

Energy is a complicated matter as we have learned throughout this paper. Renewable energy does not always mean it is clean energy. The world is waking up the supreme power of the fossil fuel industry. The havoc fossil fuels have reeked on our environment and the power it exerts within our governments has many scrabbling at opportunities to explore other options. We have been lucky, and unlucky, in many ways to get as far technologically as we have on cheap energy, but that time is coming to an end. We never dreamed that our rapid projection into the future would actually speed up the natural cycles of the earth causing mass extinction right before our eyes. We never dreamed that the carbon we spewed into the atmosphere would readily be absorbed by the ocean causing it to warm rapidly and teeter that domino that could propel us into a viscous positive feedback loop that we, as humans, have absolutely no control over. But, for some reason, we were placed here on earth, at this very time, the time were we can stop that first domino from catastrophically tipping off into the unknown. Biomass offers the allure of renewable energy. It is affordable and trees are abundant in the Southeast. It could offer that small stepping stone we need to bridge the gap between fossil fuels and clean energy, but are we willing to trust ourselves not to linger too long indulging in the cheap and easiness of biomass? Or is now the time to stop looking for an energy crutch? Is this the small window the world has to take a leap of faith for a future for generations to come? These are the questions we need to ask ourselves when considering the risks we are willing to take for our comfort in the now and our future of tomorrow. 2050 is the year many scientists predict we will start reaping what we have sewn environmentally. That is 35 years from now. Threatening the very forests and wetlands that will offer some relief to the hazards that are in store would be like icing on the cake. Our next move should be carefully calculated.

Sustainable energy sources are the equivalent to hunting for the proverbial tree. Can we find the perfect energy source? There is not a one size fits all for every area of the world. Solar works best for regions with an abundance of sunlight. Wind energy works in windy areas. Biomass has an aura of controversy around it. As the brilliant Rachel Carson wrote in her book Silent Spring “We stand now where two roads diverge. But

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Ibid.
unlike the roads in Robert Frost’s familiar poem, they are not equally fair. The road we have long been traveling is deceptively easy, a smooth superhighway on which we progress with great speed, but at its end lies disaster. The other fork of the road – the one less traveled by – offers our last, our only chance to reach a destination that assures the preservation of the earth.” She wrote this in 1962 and it is a haunting reminder of how we are in the same predicament decades later.110

Endnotes

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