THE EFFECTS OF THE RENEWABLE PORTFOLIO STANDARDS IN THE STATE OF ALABAMA

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Introduction

The major concerns throughout the world are global warming and climate change. Presently, many studies are being conducted to determine the catalyst responsible for these phenomena. Research is showing that we need to reduce the amount of carbon dioxide (CO_2) emitted into the atmosphere to correct or improve the problem. For 10,000 years CO_2 concentrations in the atmosphere have been consistent at 275 parts per million (ppm), in the past 50 years this level has risen to 378 ppm. If we continue with our current actions this level could possibly reach 840 ppm, by the end of the century[3].

Fossil-fuel-fired energy generation is the single greatest source of air pollution in the United States, in which power plants are the leading source of CO_2 emissions – the primary contributor the global warming. Currently in the United States, eighty-five percent of the electricity generation originates from the fossil fuels coal, oil and natural gas. The extraction and burning of these fuels contributes to global warming, chronic human health conditions, and degrades valuable land and water resources. The use of these fuels presents another problem, they are finite resources, meaning they cannot be replaced and will eventually run out. These facts inform us that it is time to find another primary resource to meet our current and future energy demands. The resource or resources selected need to be clean, cheap and comparable to that of fossil fuels. A standard has been established requiring electrical utility companies to replace a certain percentage of fossil fuel generated energy with renewable resources by a given date, known as the *Renewable Portfolio Standard* (RPS). Over half of the states in the country have already adopted this standard and are reaping its numerous benefits.

There are several renewable resources available to generate energy, the most common resources are biomass, geothermal, hydropower, landfill gas, solar, and wind. All of these resources excluding hydropower are accepted under the standard. Hydropower has been in use for so long and is almost at capacity that the standard does not allow states to incorporate hydropower in the percentage of renewable resources. Each state is encouraged to achieve the goal of replacing 20% of the finite fuel-generated energy with renewable resources by the year 2020. It is expected that this standard will significantly reduce the amount of carbon dioxide emitted into the atmosphere, which will improve overall air quality.

Why Consider Renewable Resources?

Renewable energy provides several benefits in the areas of economy, environmental benefits, risk management, energy assurance, reliability and public demand. States that import fuel from other locations for energy production lose vital financial resources because they leave the state and the local economy. The labor intensity of renewable resources can lead to a strong employment market in the

[3] http://www.architecture2030.org/

areas of construction, maintenance, manufacturing, and operation. Implementing local resources could potentially increase the local economy by reinvesting the dollars saved from renewables back into neighborhood projects. Implementing local biomass and wind farms can revitalize rural communities by providing new cash crops for farmers and new tax revenues.

Economics

Renewable energy resources can provide economical benefits to energy supplier's resources. During peak availability of renewable resources, utility plants can switch from costly purchased fuels to solar or wind sources, thus leading to less fuel purchased for energy generation and possibly a storage that can be used during peak energy demands.

Typically, energy efficient technologies can save money immediately and have short paybacks. Reducing costly fuel generated energy can lower operating costs and make industry, merchants and farms more economically competitive. Renewable technologies minimize the need to build new and expensive power plants to keep up with the current and future energy demands.

Environmental Impact

Renewable energy technologies improve the quality of the atmosphere by reducing carbon dioxide emitted into the atmosphere by fossil fuel-burned energy production. Solar and wind energy are emission free at the point of use and emissions from biomass are significantly lower than comparable conventional fuels. Biomass has the potential to be emission free with a closed carbon cycle. While the biomass is being combusted for energy production, new biomass crops are in the growing process taking in the carbon dioxide emitted. Renewable energy technologies have minimal impact on water resources in that they do not discharge harmful pollutants into surface water and toxins do not seep to groundwater. Minimal environmental impact will also lead to increased air quality resulting in improved human health.

Risk Management

Risk management and energy assurance go hand in hand. Renewable energy technologies contribute to the energy investment portfolio by providing diversification to evade against unplanned events that threaten delivery and affordability of energy. Unlike a central power plant, renewable energy supply sources are distributed in several locations thus reducing its vulnerability to security threats, natural disaster, and human error. Renewable energy can also offset fluctuating fuel costs for consumers, because many of the resources are free; when fuel prices rise renewable energy can be produced and used until fuel price decrease. Energy assurance provides the same benefits including that of when there is a peak in energy demand renewable resources can supplement fuel to keep prices down.

Reliability

Renewable resources are more reliable than fossil fuels. As this may seem contradictory, because certain resources are not always available, it is very easy to predict and plan their presence. When resources are in abundance, they can be captured, stored, and then used during times when conventional resources are unavailable. In combination with electricity generation, renewable energy can assist energy suppliers with stretching conventional fuels to mitigate the risks of interruptions during peak energy demands. The most reliable kilowatt is one that does not need to be generated, transmitted, distributed and stored. During California's energy crisis in 2001, energy efficiency and energy-conserving behavior increased system reliability by reducing the demand on the system. These methods also proved to be cost effective to taxpayers and ratepayers that invested $1.3 billion in energy

efficiency upgrades, compared to the $2 billion to $20 billion in potential losses from rolling blackouts, which were avoided.

Public Interest

Studies indicate that the public would rather invest in environmentally clean energy and are willing to pay extra for "green" power. Research shows that green power decreases as conventional fuel increases. Surveys that have been conducted across the country in many demographic categories show that the public is interested in environmentally friendly energy production and view it as being fiscally sensible and environmentally responsible.

> *"United States oil and natural gas production has been on the decline since 1970's and global oil and natural gas reserves are limited (the static lifetime of global oil reserves is 42 years and natural gas only 63 years). With the global energy demand increasing, coal is becoming the fossil fuel of choice. The United States, Russia, China and Australia and India have plenty of it and it is cheap (and dirty) .Clean coal technology is decades away as is capturing and storing CO_2, and they are costly[5]."*

Renewable Energy Technologies

Renewable technologies tap into the ever-present energy that exist around us and turn it into a useful form. The movement of wind and water, the heat and light from the sun, heat in the ground, and carbohydrates in plants – are all natural resources that can supply our energy needs in a sustainable way. The capturing, storing, and processing of each of these resources will convert them into energy to supply power where needed. The most common types of renewable energy are biomass, geothermal, hydropower, landfill gas, solar and wind.

Biomass

Biomass is any organic material made from plants or animals. Domestic biomass resources include agricultural and forestry residues, municipal solid waste, industrial waste, and terrestrial and aquatic plants specifically grown for energy production. Some of the biomass producing resources includes the following: energy crops, trees, grasses, other crops, biomass residues, oil plants, forestry, agriculture and cities.

Energy crops, as known as "power crops," are can be grown on farms, in large quantities, similar to food crops. Trees and grasses prove to be the best crops for energy production. Some varieties of trees that are cut off close to the ground can grow back. This process called coppicing, allows trees to be harvested for 3 to 8 years for 20 to 30 years before replanting. Thin stemmed perennial grasses, switch grass, big bluestem and other native varieties grow quickly in many parts of the country and can be harvested for up to 10 years before replanting.

Oil plants are plants that produce oil that can be processed into energy. Examples are soybean and sunflower plants. This concept is similar to the idea of processing the oils from corn and producing energy. A different type of oil crop with great promise for the future is microalgae. These tiny aquatic plants have a potential to grow quickly in hot, shallow, saline water found in some lakes located in the

[5] http://www1.eere.energy.gov

desert southwest. Some research has shown that carbon dioxide can be used to stimulate algae growth. The algae can be converted into various ranges of fuels.

Biomass residues are the leftover wastes after plants have been used for a specific purpose. Forestry, agriculture and manufacturing industries generate large volumes of plant and animal waste. City waste, from garbage and sewage is another source for biomass energy. People generate biomass waste in many forms including "urban wood waste" (such as shipping pallets and leftover construction wood), the biodegradable portion of garbage (such as paper, food, leather and yard waste), and gas released in landfills because of waste decomposition. Sewage is another biomass resource. Some sewage treatment plants capture the off gas of methane from sewage and burn it for heat and power, reducing air pollution and emissions of global warming gases.

Forestry wastes are the largest source of heat and electricity, since lumber, pulp and paper mills use them to power their factories. After timber harvesting, treetops and branches are typically left behind and are the largest source of forestry waste. Some of the waste is left behind to provide essential nutrients and provide habitats for birds and mammals, but the rest could be used to generate electricity. Other sources of wood waste are sawdust and bark from sawmills, shavings from furniture manufacturing, and organic sludge (or "liquor") from paper and pulp mills.

Biomass is solar energy stored in organic matter. The process of photosynthesis uses the sun's energy to convert carbohydrates (sugars, starches, and cellulose), as trees and plants grow. Carbohydrates are the organic compounds that form biomass. When plants die, the process of decay releases the energy stored in carbohydrates and discharges carbon dioxide back into the atmosphere. Biomass is considered a renewable resource because the growth of new plants and trees replenishes the supply.

One of the major benefits to biomass energy production is it causes no net increase in carbon dioxide emissions into the atmosphere. As trees and plants grow, they remove carbon dioxide from the atmosphere through photosynthesis. In addition, using biomass for energy generation is a way to dispose of waste materials that otherwise would create environmental risks.

Biomass resources provide approximately 3% of all energy consumed in the United States. In 2002, biomass supplied about 47% of all renewable energy consumed in the United States. Electric generation from biomass (excluding municipal solid waste) represents about 11% of all generation from renewable resources in the United States. Biomass supplied more energy throughout the United States in 2002 than other renewable resources, including hydroelectric. Providing almost six times the energy of geothermal, solar, and wind energy resources, biomass has a high potential to meet the increases needs of the world's energy demand[4].

Geothermal

Geothermal energy is the conversion of hot water or steam from deep beneath the earth's surface into energy. The resources of geothermal energy are volcanoes, hot springs, fumaroles, pools of boiling mud, and geysers. A volcano is a fissure of earth's crust through which molten lava and gases erupt. There are three types of geothermal plants used to generate electricity, in which the type is based on depth, temperature and quality of water and steam in the area. The three types of plants are dry steam, flash steam, and binary-cycle.

The dry steam geothermal plant is where steam (no water) shoots from the well and passes through a rock catcher and then a turbine. Dry steam fields are very rare. Flash steams geothermal

[4] http://www.ucsusa.org

plants utilize water over 182^{o}C from geothermal reservoirs. The water below ground is well above boiling point of water, at sea level, but remains in liquid state due to the high pressure. As the water is pumped from the reservoir to the power plant, the drop in pressure causes the water to convert or "flash" into steam to power the turbine. Any unused water, not flashed into steam, is re-injected back into the reservoir for reuse. Flash steam geothermal power plants are most common type of geothermal power plants in operation today.

Water used in binary-cycle geothermal power plants is typically cooler than the water used in flash steam plants, ranging from 107 to 182^{o}C. The hot fluid from the geothermal reservoir passes through a heat exchanger, which transfers heat to a separate pipe containing fluids with a much lower boiling point. These fluids are usually iso-butane and iso-pentane, vaporized to power the turbine. The cooled water is returned to the reservoir. Some of the additional benefits of using a binary-cycle plant are lower operating cost, increased efficiency, no emissions of excess gas, able to utilize lower temperature reservoirs (which are most common), and many future geothermal power plants that are planned for construction are binary-cycle plants, offering more examples to learn from.

Hydropower

Hydropower generation is simply taking the mechanical energy present in moving or falling water, turning it into kinetic energy and using the kinetic energy in a useful form. The harnessing of moving water to provide electricity prevents the building of new dams that have a major impact on wildlife and water quality. Since water is 832 times denser than air, water features such as tides, waves and ocean currents, which represent a powerful, highly concentrated and clean-energy resource.

Solar Energy

Solar energy is free and exhaustible. As a viable alternative to the fossil fuels that continuously pollute our air and water, threaten human health and contribute to global warming, solar energy is a vast and clean energy technology. Solar energy is the largest supporter of life on earth and is the main ingredient for all energy used. Plants utilize the sun's energy for growth, which can be burned as biomass fuel or if left in the swamp and compressed underground for millions of years, in the form of coal and oil. Heat from the sun causes temperature difference in areas, producing wind that can power turbines. Water evaporates because of the sun, falls on high elevations, and rushes down to the sea, spinning hydroelectric turbines as it passes. Solar energy in the renewable portfolio standard refers to the exploitation of the sun's energy into electricity, lighting and heating.

The amount of energy that is absorbed in the earth from the sun is abundant. Energy collected from 20 days of sunshine is equal to the total amount of energy stored in oil, coal and natural gas reserves. Outside of the Earth's atmosphere, the sun's energy contains about 1,300 watts per square meter. Inside of the Earth's atmosphere, it has decreased to 1,000 watts per square meter, at noon on a cloudless day. Averaged over the entire surface of the planet, 24 hours per day, each square meter collects the equivalent of almost one barrel of oil per year or 4.2 kilowatt-hours of energy per day.

Wind Energy

Harnessing wind energy is one of the cleanest and most sustainable energy generating technology. Wind energy generation does not contribute harmful greenhouse gas emissions into the atmosphere and does not contribute to global warming. Wind power is also one of the most abundant and cost-effective energy generating technologies available, which makes them an increasingly viable resource. In 2005, wind energy produced 11,500 megawatts (MW) of electricity. In the United States, 2,431 MW were installed in 2005, providing enough energy to power 650,000 typical homes. Wind turbines collect wind energy. Modern turbines generally have two or three blades placed upwind on the

tower it sits on. Inside of the wind turbine, motion is turned to energy and that energy used for a useful purpose.

Alabama's Potential for Renewable Energy Production

Alabama's potential for renewable energy includes biomass, hydropower, wind and solar. The potential of wind power in the state of Alabama is possible on a small-scale project, typically individual buildings and residential structures. There is a high potential for hydropower energy generation in Alabama, but this resources has already been used to the maximum capacity. Alabama has a high potential for biomass energy production. With 22.5 million acres of timberland forests in the state, biomass proves to be the state's most reliable renewable resource. Solar generated energy has a potential in the southeastern region in the state for both flat-plate collectors and concentrating collectors[6].

Alabama currently has 18 natural gas power plants, 14 hydroelectric power plants, 9 coal powered plants and 2 nuclear power plants. It is important to evaluate the existing electricity infrastructure to determine if these existing plants can support renewable energy technology. In addition to evaluating the existing plants, the impacts on the state's resources must also be evaluated.

Impact on the State of Alabama

If the state of Alabama were to implement the renewable portfolio standard, requiring it to replace 15% of finite resources with renewable resources, excluding hydropower, the state of Alabama would have to install: 6,600 wind turbines, each collecting 2MW of power, occupying 500 square miles of land, which is equivalent to the city of Phoenix, Arizona; 190 square miles of solar panels, an area equivalent to the city of Columbus, Georgia; or 5,500 square miles of switch grass, an area equivalent to the state of Connecticut. The implementation of the use of renewable resources would require a massive impact on existing land. Biomass energy is the choice resource for Alabama. Several obstacles are involved with the use of biomass energy[2].

Potential Obstacles with the Use of Biomass Energy

Biomass is typically grown in remote areas throughout the state, thus having to be transported to the power plants. The transporting of this material could essentially contribute to CO_2 emissions producing a negative impact on the atmosphere. Straw and forest residue biomass typically has a low volumetric density compared to its converse fossil fuels. A large variety of biomass materials have different chemical compositions resulting in different processing techniques. This can create problems when retrofitting existing power plants to support renewable energy technologies. This issue forces the state to select biomass materials with similar chemical compositions to simplify the conversion of existing power plants. The processing techniques of biomass materials cause a high ash content, which leads to corrosion and agglutination of machinery. It requires additional maintenance to keep equipment running properly. The most common vulnerability of biomass is the socio-economic aspect, that is using crops or land that could be used for human food sources for energy. A plan must be designed to avoid disrupting the food production in the United States.

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[6] http://www.forestry.state.al.us/forest_facts.aspx

[2] Presentation given by Thomas W. Johnson, Research Program Manager at Southern Company Birmingham.

Case Study: Germany

Germany is the forerunning country in renewable energy production. In 2005, 20.2% of the electricity produced in Germany originated from renewable resources. Germany's renewable energy output was 26.5 tetra-watt (TWh) hours compared to 21.5 TWh of hydropower. Power production from biomass materials has reached an all time high in Germany at 13.2 TWh, and has increasing possibilities. Photovoltaic and geothermal energy still play a marginal role in Germany, but is continuing to increase from the year 2000. Germany is well on their way to meeting the goal to replace 20% of their fossil fuel generated energy with renewable resources, by the year 2020.

Another growing sector in Germany is heating from renewable energy sources. In 2005, space heating from renewable resources was 5.4%, with an annual production of 76.5 TWh from biomass resources. Germany uses renewable resources to produce heat using traditional wood burning combined with modern methods of wood-pellet heating systems. Solar thermal heating using rooftop collectors and other surface collectors are growing rapidly. The amount of heat produced from solar technology has more than doubled since the year 2000, and since 1990, it has increased more than twentyfold.

Fossil fuels still dominate energy production in Germany, in 2005 accounting for approximately 82% of the energy demands. In addition to fossil fuel use, nuclear power is responsible for 12% of the electric power generated. Renewable energy sources supply 3.6% of the primary energy consumption, increasing from the mid 1990's at about 1.5%. More than 50% of the energy produced from renewable resources is generated from biomass materials; wind energy contributes 14.6% and waterpower 11.9%.

Germany's motivation to reduce reliance on fossil fuel sources is politically driven. Over the past ten years, public, legal, and economic framework have been established to give renewable energy a chance to be implemented in the energy market, in spite of their relatively high power-generating costs. Several energy credit programs have been established which says that power generated from renewable sources can be sold to the public power grid preferentially, and will receive a guaranteed price. The costs are covered by adjusting the price of power sold.

The prices established for renewable–source power are created on a decreasing scale according to source and specific requirements of the individual energy carriers. These resources are graded on a declining scale (decreasing from year to year), to make renewable energy technology more competitive with other energy producing resources. This can only be accomplished with the implementation of temporary subsides, such as tax credits and incentive programs. During this period, renewable-resource energy will have a chance to prove its efficiency and reliability in practice, as well as demonstrate economic viability.

Germany is at the stage that is proving that renewable energy resources are reliable, efficient and economically viable, with an increasing potential over time. Based on the increase of use of renewable energy over the years, Germany could possibly be the first country to meet the 20% goal by the year 2020, and possibly might surpass this percentage soon thereafter. Germany's implementation demonstrates renewable energy can be our next electric fuel source.

Germany's use of renewable technologies to produce energy illustrates that renewable resources are capable of producing a sufficient amount of energy for the growing energy demand. The amount of energy produced from renewable resources in Germany has surpassed the amount of energy produced from hydropower. This demonstrates that there are alternative energy resources available to offset the amount of fossil fuels that are burned to produce energy[1].

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[1] Wengenmayr, Roland. *Renewable Energy: Sustainable Energy Concepts for the Future.* Weinheim: Wiley-VCH, 2008.

Conclusions

At this point in the project, research indicates that Alabama has a potential use for biomass, solar, and wind power for energy generation. Solar and wind power generation is on a smaller scale, but any portion of fossil fuel-powered energy that can be replaced with a renewable resource makes a positive contribution to the ultimate goal. It is very possible for Alabama to replace at least 15% of the fossil-fuel generated energy with renewable resources, primary utilizing biomass technologies. Based on the success of Germany's renewable energy production, renewable materials are a viable resource to produce energy.

In order to determine a recommendation for Alabama, several factors need to be addressed to create a plan for Alabama to incorporate renewable energy generation. The potential vulnerabilities of renewable resources need to be researched and a plan must be created to avoid possible interruptions in electricity production. If biomass materials are the primary resource for energy production, a plan that does not disrupt food production will also have to be implemented to separate energy-producing materials from food supplies. An inventory of all the electricity plants in the state will have to be evaluated to determine how they can adapt to support renewable energy technologies. Weather and agricultural data from at least the past ten years will need to be analyzed to determine if the state can support renewable energy material production. Investigating the potential benefits of landfill gas technologies will determine if this is a possible resource for Alabama to take advantage of.

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