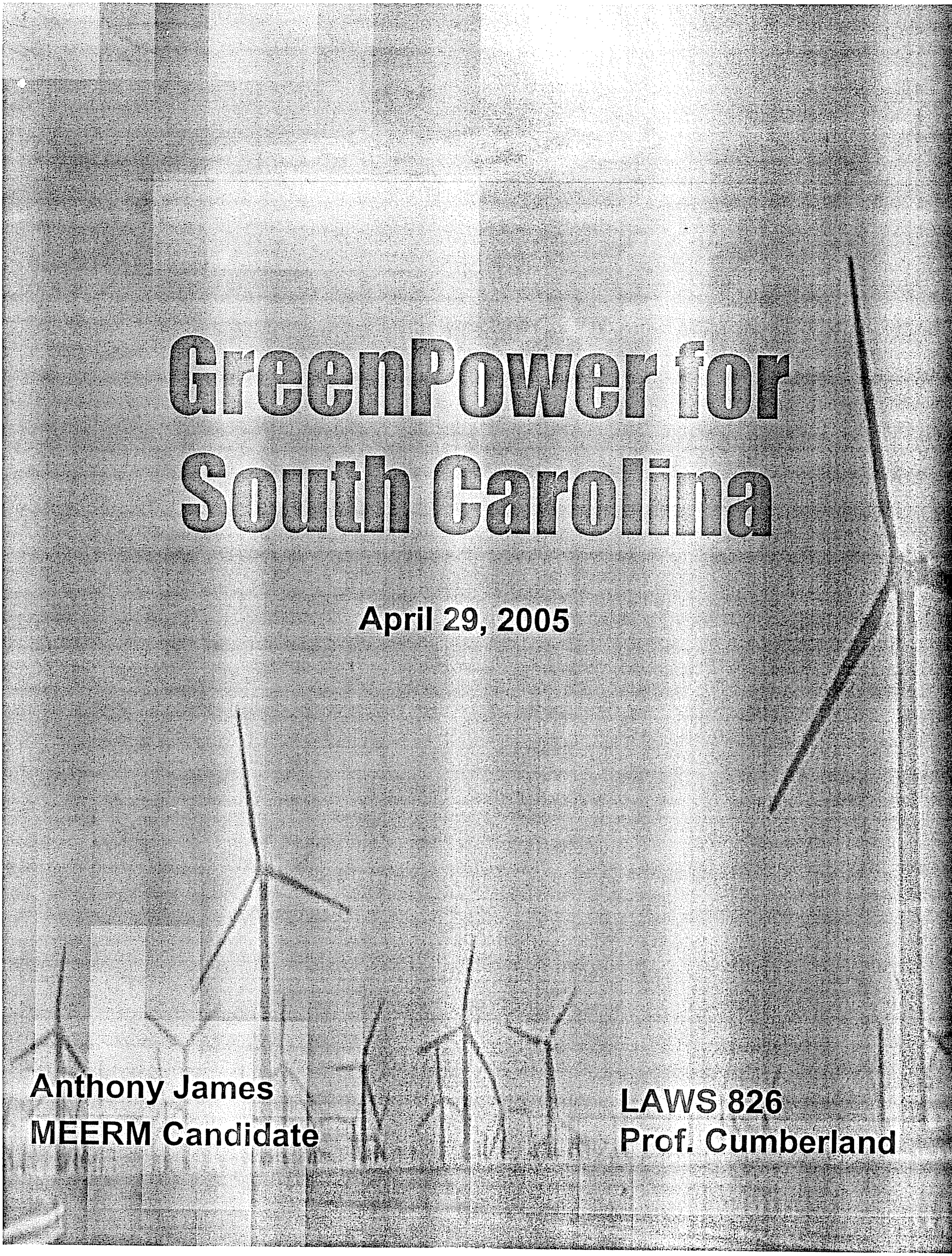

GreenPower for South Carolina

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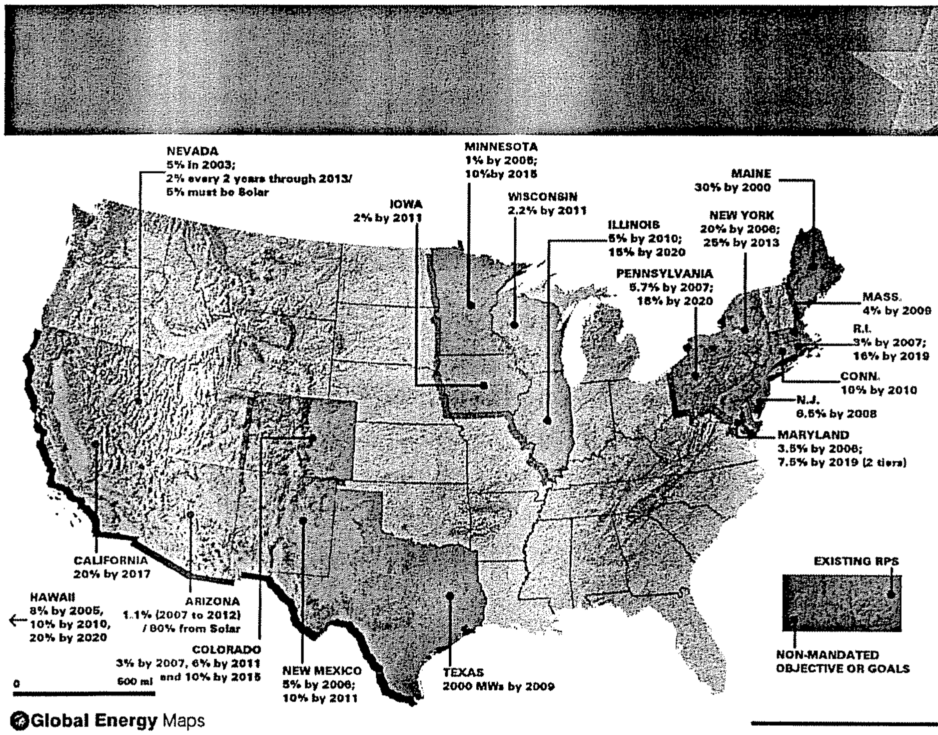
GREENPOWER FOR SOUTH CAROLINA

This paper will evaluate the feasibility of establishing a statewide voluntary renewable energy program in South Carolina.

Background

Currently, 19 states have enacted renewable energy portfolios (See Figure 1). 17 of the 19 states function under state-mandated renewable portfolio standards.[1] These standards set measurable requirements for regulated investor owned utilities to include renewable energy projects in their portfolio.[1] Although the state-mandated renewable portfolio standards primarily hinge on wind power projects, the mandates have generated considerable interest in renewable energy projects and is becoming more and more popular.[1] Several states, such as North Carolina, already have successful GreenPower programs.[2] South Carolina also offers GreenPower through Santee Cooper Power Company but on a much smaller scale[3]

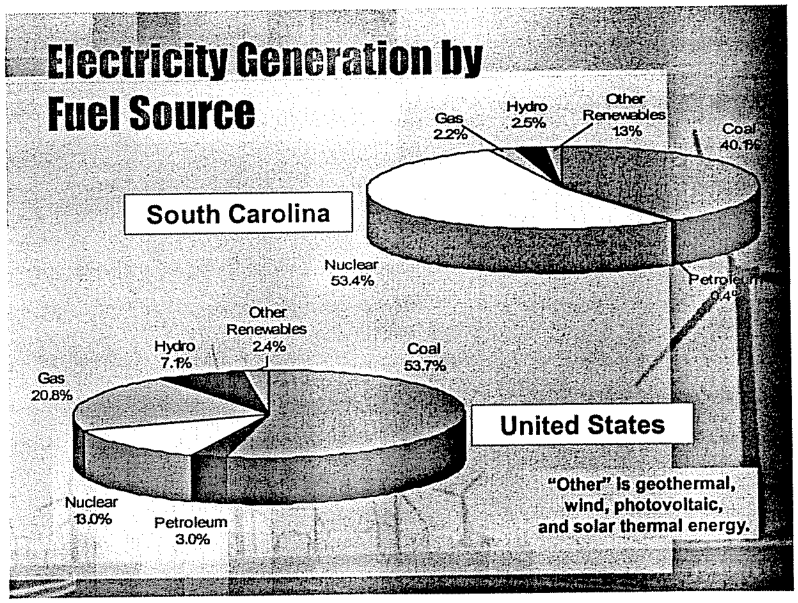
This paper will research South Carolina's current GreenPower program, available renewable energy resources, and ultimately, propose a process the will give all South Carolinian's access to GreenPower. This paper will focus on renewable energy sources that can produce power on a large scale basis to supplement conventional power generation from fossil fuel plants. The goal is to consider adequate renewable power sources that can be placed on the electric utility grid. Given the vast quantity of indigenous resources available in South Carolina and its environmentally conscious citizens, South Carolina is a state that should be an attractive candidate for a statewide GreenPower program.



[1]**Figure 1**

Energy and South Carolina

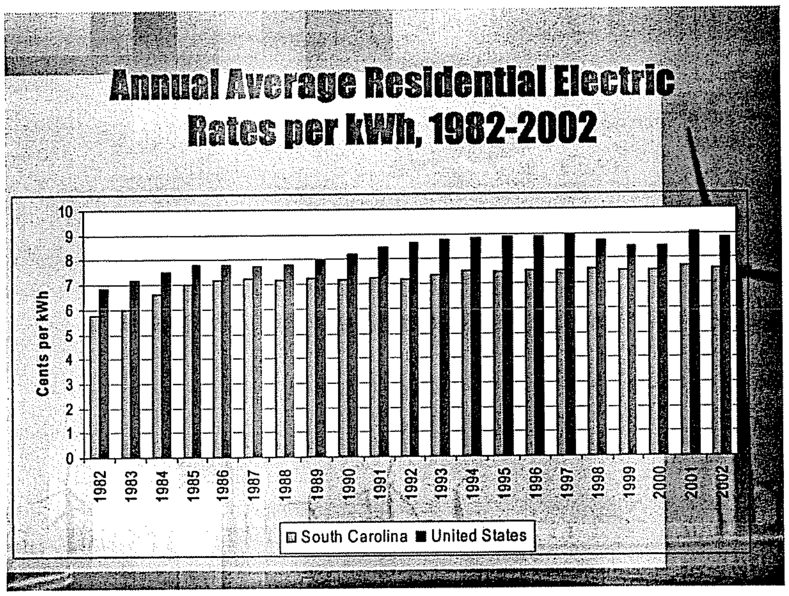
South Carolina currently provides electricity to its customers via four investor-owned utilities (Duke Power, Lockhart Power, Progress Energy, and South Carolina Electric and Gas Company), twenty-one municipalities, one state-owned utility (Santee Cooper), and twenty electric cooperatives.[4] These utilities generate power utilizing various types of conventional power systems. South Carolina's power generation mix includes nuclear (53.4%), Coal (40.1%), Hydro (2.5%), Gas (2.2%), and Renewables (1.3%).[5] South Carolina's generation mix is compared to national percentages in Figure 2. Also, as shown in Figure 2, South Carolina only produces approximately 1% of its energy from renewable energy sources. With reference to



[5]**Figure 2**

Figure 2, South Carolina would need to increase its use of renewable energy sources by 85% to achieve the current national percentage rate.[5] It is noteworthy to observe that South Carolina has vastly larger energy contribution from nuclear power compared to the national percentage rate.[5] The percentage comparisons for South Carolina and the rest of the nation are 53% and 13%, respectively.[5] The comparison represents an astonishing 310% more usage of nuclear power in South Carolina. South Carolina maintains noticeably lower residential electricity rates when compared nationally.[5] Figure 3 illustrates this standing.

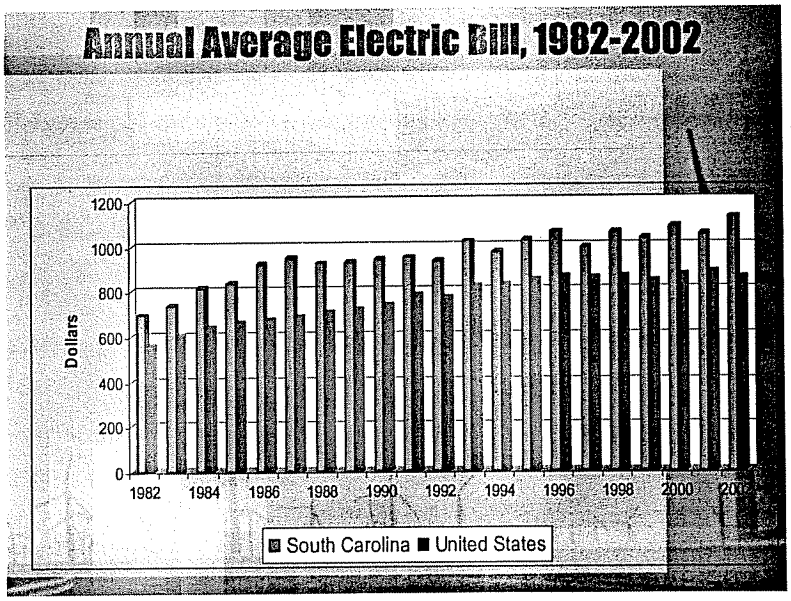
However, due to extreme temperatures in South Carolina, the average residential electric bill in South Carolina is considered well above the national percentage rate.[5] This fact primarily can be attributed to consumption.[6] Annually, southern states such as South Carolina uses more electricity to power air conditioners during the extended warm season.[6] Also, during the winter months, residences of southern state like South Carolina primarily heat their homes by electricity.[6] Other regions of the nation such as the northeast rely more on alternate heating sources such as fuel-oil.[7] These circumstances can skew any electricity/cost comparison. That is, South Carolina uses more electric heat, whereas other parts of the nation have the ability to utilize electric heat as well as heat from oil and gas.[6, 7] Figure 4 shows the average electric bill comparison between South Carolina and the United States.[5]



[5]Figure 3

Renewable Energy

The United States Department of Energy, Office of Energy Efficiency and Renewable Energy, defines renewable energy as, "*Energy derived from resources that are regenerative or for all practical purposes can not be depleted.*"[8] Given this definition, the benefits of encompassing renewable energy sources are obvious. Also, renewable energy reduces US dependence on foreign oil supplies, improves air quality, and has low environmental impacts.[9]

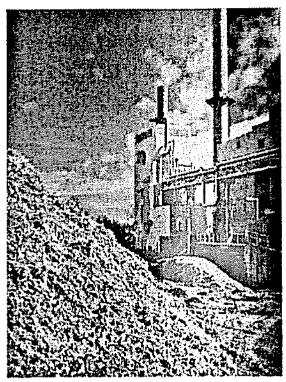


[5]Figure 4

The Office of Energy and Efficiency and Renewable Energy identifies renewable energy sources to include: biomass, geothermal, hydrogen, hydropower, ocean, solar, and wind.[10] Geothermal, hydrogen, and ocean power are relatively new technologies and require refinement before being considered as practical options to generating electricity.[11, 12, 13] Therefore, this paper will not evaluate the above renewable energy sources. Also, hydropower is a well-established renewable energy source already utilized by the electric industry.[14] Therefore, in addition, this paper will not evaluate hydropower. Thus, this paper will concentrate on bioenergy, solar energy, and wind energy as resources offering practical applications for producing electricity. This paper will then evaluate the feasibility of these three technologies to be utilized in South Carolina.

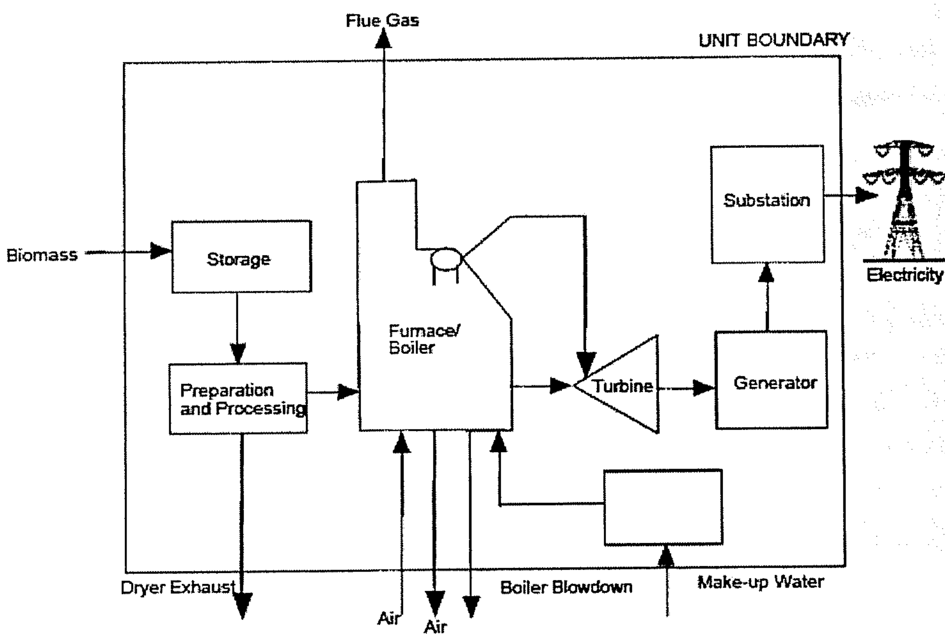
Bioenergy

The Office of Energy and Efficiency and Renewable Energy defines biomass as: "*any organic matter which is available on a renewable basis, including agricultural crops and agricultural wastes and residues, wood and wood wastes and residues, animal wastes, municipal wastes, and aquatic plants.*"[15] From biomass, bioenergy is produced. The forms of technologies this paper will consider are direct-firing, co-firing, animal waste methane and landfill methane.



Power from biomass is a proven method of generation electricity in the United States.[16] With about 9,733 megawatts (MW) in 2002 of installed capacity, biomass is the single largest source of non-hydro renewable electricity.[16]

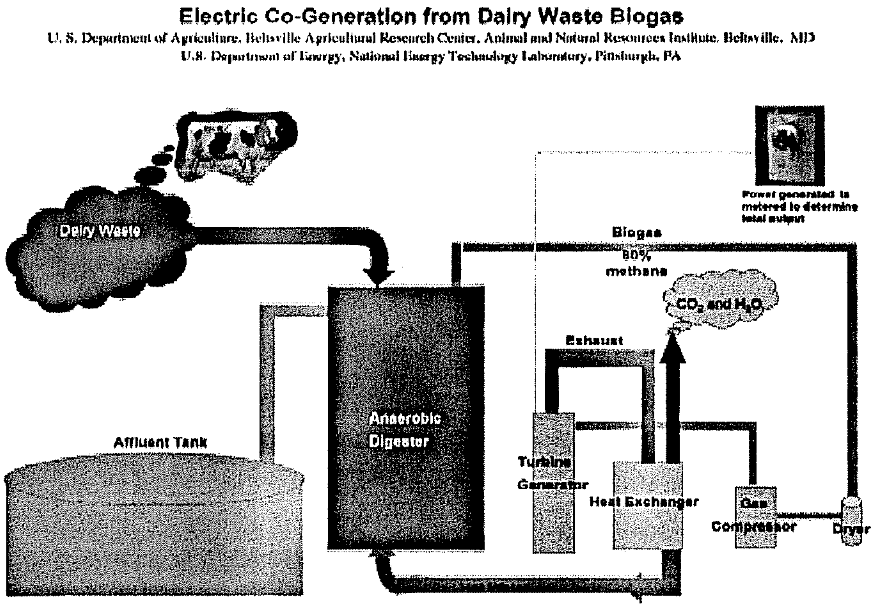
Direct combustion of biomass in a direct-fired biomass system is illustrated in Figure 5.[17] This technology was once a premier process for generating electricity.[16] Even today, it generates approximately 5,886 MW of electricity across the nation.[16] However, this technology is becoming obsolete. The standard biomass boiler can produce only 20-50 MW.[16] Most coal-fired plants produce 200-1500 MW.[16] Using biomass boilers to generate electricity is considered widely as a highly inefficient, obsolete process.[16]



[17]Figure 5

Another technology known as "co-fired" energy production which uses biomass to supplement fossil fuel combustion plants is also available.[18] Co-firing systems reduces greenhouse gas emissions, sulfur-dioxide emission, and nitric-oxides emission, and can increase plant competitiveness through reduced fuel costs.[19]

Animal methane produced from animal waste is a realistic option currently being used to generate electiricty.[20] It is a technology that utilizes animal manure from dairy farms.[20] The wastes are processed in an anaerobic (without air) digester to breakdown and neutralize the waste.[18] This decomposition process produces heat and methane.[18] Biogas from a large 500 herd dairy farm can produce electricity from 3.7 to 5.4 cent per kilowatt-hr.[20] This is a considerable higher cost to generate electricity as compared to the 2.8 cents per kilowatt-hr from a combined-cycle fossil fuel power plant.[20] As the technology continues to evolve, animal waste will continue to be a favorable consideration as a renewable energy source.[21] Figure 6 illustrates how electricity can be generated from animal wastes.



[22]**Figure 6**

Biomass renewable energy from municipal landfills is the final major renewable energy resource this paper will assess. It is important to note that municipal waste landfills currently generate approximately 3,308 MW of electricity nationwide.[23] It's a growing and practical approach to offsetting conventional energy generation with a renewable energy source.[24] It is a proven and reliable technology.[24] The process is very similar to the process described above concerning generating electricity from animal waste. In a landfill, the decomposition process of municipal waste under anaerobic conditions, again, generates heat and methane.[25] The methane, or biogas, can be compressed and used to turn a turbine/generator to produce electricity.[25] According to the Environmental Protection Agency, every 1 million tons of waste deposited in landfills produces enough landfill gas to generate 7 million kilowatt hours of electricity per year, which is enough power for 700 homes.[26] As detailed above, biomass provides a "real" opportunity to utilize a renewable energy source to generate electricity for stand alone systems and/or supplement the conventional fossil fuel power plants.

Although bioenergy appears to be a very promising option as a renewable energy source, there are concerns that should be addressed. The largest concern centers on the declining availability of the biomass.[27] Burning biomass is more expensive that burning traditional fossil fuels.[27] That is, it takes more biomass to sustain the same temperature as compared to coal. This hurdle translates into an additional expense to transport the biomass to the power plant.[27] Also, biomass burning facilities are typical sparsely located and small in size.[27] The negative affects the ability of biomass plants to effectively compete for electricity market share.[27] Lastly, the question remains whether or not direct burning wood chips and or co-firing would be considered a "green" process.[28] This question is significant because combustion emissions inherently are associated with both processes.[28]

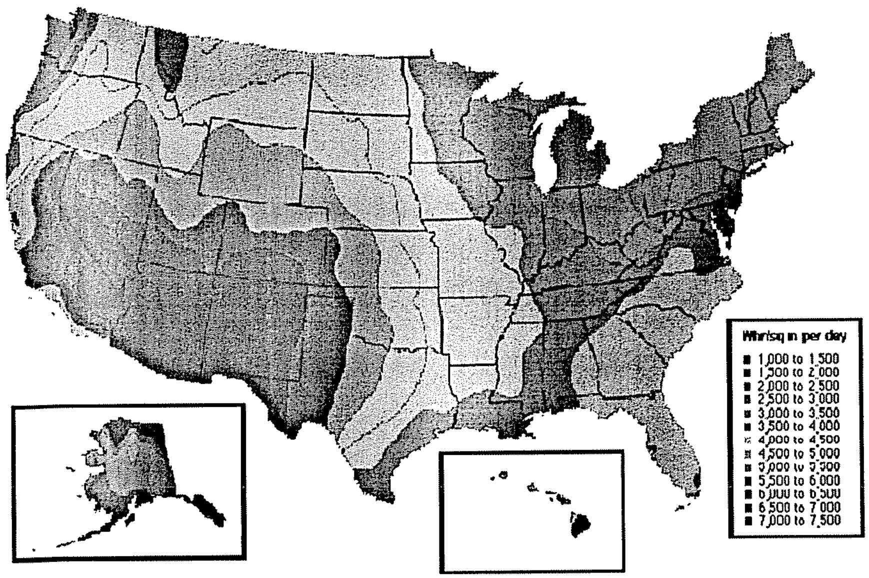
The concerns with producing electricity from animal waste deal with the cost and needed volume of waste.[20]

Landfill gas also presents concerns with regard to generating electrical power. There are a limited number of landfills that are capable of producing a sufficient amount of methane.[29] Also, once a site is secured, this process requires the construction of treatment systems to convert the methane into electricity.[29] Gasification is a treatment system used for the conversion.[30] It entails heating the biomass in the landfill in the absence of air to produce a combustible gas.[30]

Solar Energy

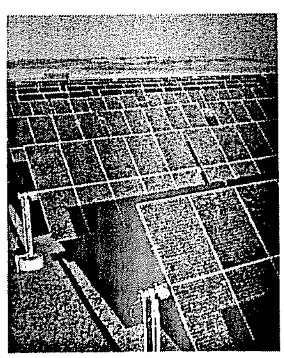
Advancing solar energy technologies has been the focus the U.S. Department of Energy.[31] The Department of Energy has sponsored various research in the effort to improve solar technologies as well as find means to make solar energy more affordable.[31] The Office of

Energy and Efficiency and Renewable Energy defines solar energy as: *Electromagnetic energy transmitted from the sun (solar radiation).*[32] Solar technology ranges from the common solar panels, or photovoltaic, to passive solar systems that allow for more efficient heating of homes.[33]



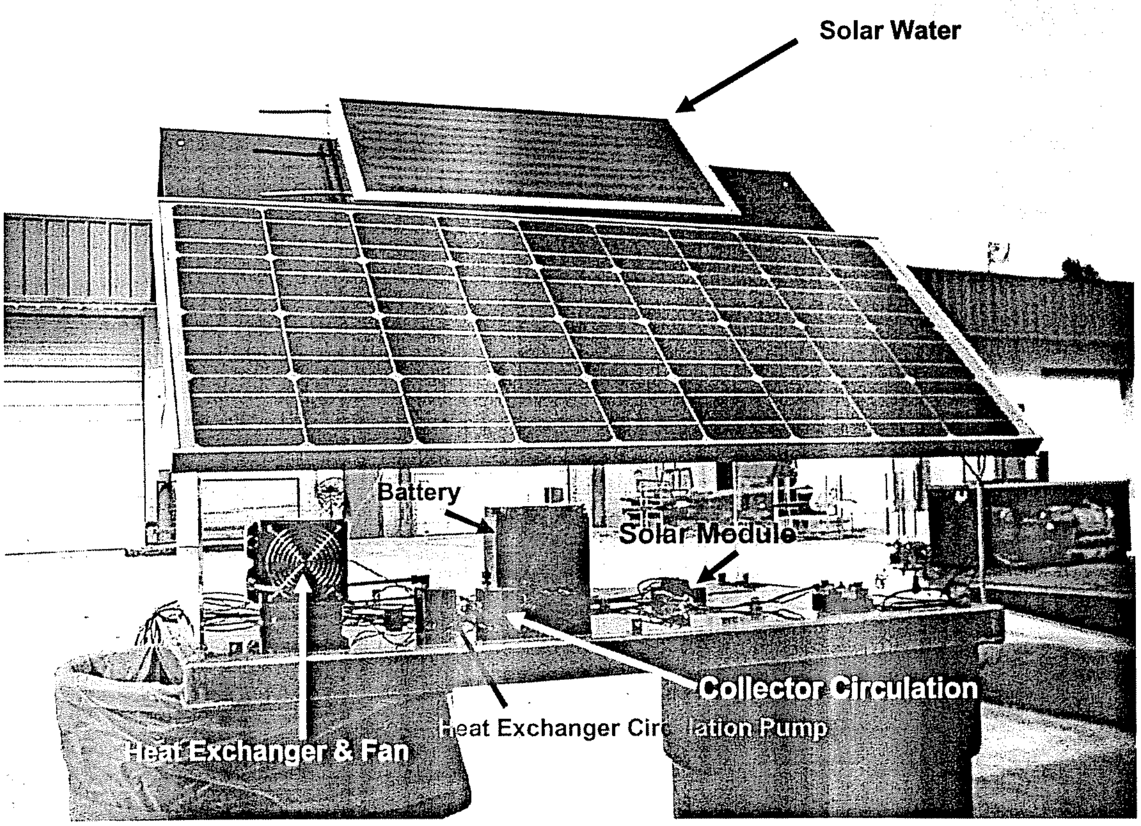
[34]Figure 7

The southern states of the west and midwest offer the most attractive solar power resources.[34] Figure 7 shows this region of the United States, which produces between 6,000 to 7,000 Whr/in^2/day (Watt-hour per square-inch per day).[34] For the purposes of this paper,



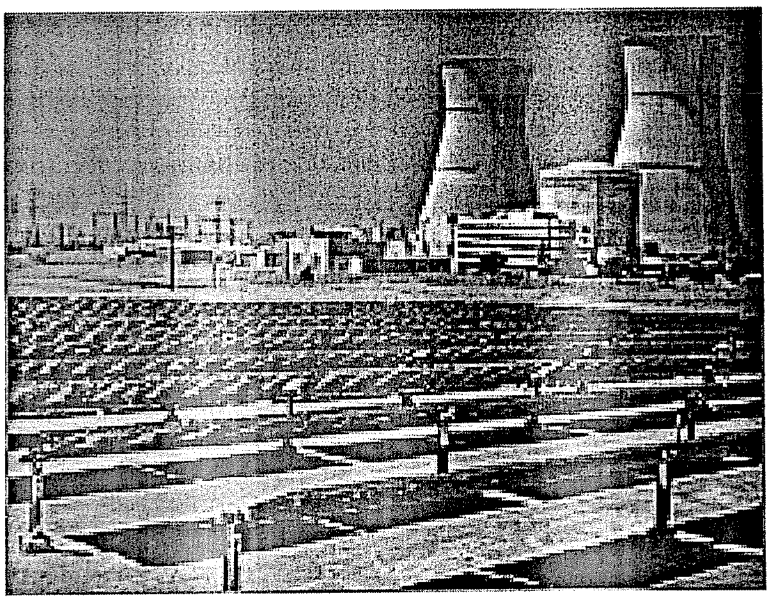
[36]Figure 8

only the photovoltaic technology will be evaluated. In 2000, photovoltaic systems generated 844 million kilowatt-hours of electricity.[35] Figure 8 shows an example of a standard solar panel system.[36] Photovoltaic panels convert direct sunlight into electricity.[33] According to the Office of Energy and Efficiency and Renewable Energy, the PV systems installed since 1988 provide enough electricity to power 250,000 American homes or more than 8 million homes in the developing world.[35] The photovoltaic process can be seen on small scale, simple systems such as aesthetic lawn lighting, solar-powered watches, and solar-powered calculators.[33] This



[36]Figure 9

technology is relatively inexpensive but produces a very small amount of electricity.[35] More complicated systems require additional panels to generate additional electricity but are much more expensive.[35] A larger system (1 kW) is capable of generating enough electricity to heat hot water for a single family home.[35] Figure 9 illustrates this technology.[36] More advanced systems are capable of generating larger quantities of electricity but require additional and larger solar panels as shown in Figure 10.[38] Large scale advanced systems are rare but are capable of generating electricity to be placed on the electric utility power grid to directly benefit customers.[37] The Sacramento Municipal Utility District has reached 10 MW of electricity power generation.[37] The system remains a viable with and ever expanding customer base.[37] Figure 10 shows the Sacramento Municipal Utility District solar panel system adjacent to the decommissioned nuclear power plant in Rancho Seco, California.



[38]Figure 10

As discussed above, the solar photovoltaic technology offers many convenient uses for our daily activities. These simple forms of solar energy used in calculators, etc., have a stable and necessary purpose in the marketplace.[35] They are very inexpensive and widely available.[35]

Solar systems can be used to heat hot water and supplement indoor heating systems.[33] A residential solar energy system is very expensive and typically costs about $8-10 per Watt.[39] Where government incentive programs exist, together with lower prices secured through volume purchases, installed costs as low as $3-4 per Watt or some 10-12 cents per kilowatt hour can be achieved.[39] Without incentive programs, solar energy costs (in an average sunny climate) range between 22-40 cents/kWh.[39] 22-40 cents/kWh represents a 370% increase in cost when compared to conventional energy residential rate of 8.5 cents/kWh.[40]

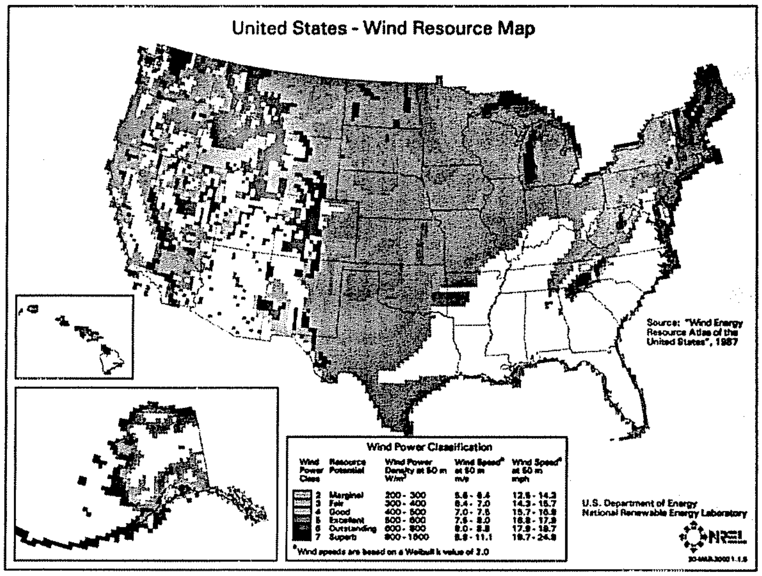
Although the interest is growing, the technology continues to be an unattractive option for utilities because of the capital costs associated with converting solar energy into electricity. Also, customers demand a continuous supply of electricity where as the solar systems produce intermittent power.[41] That is, photovoltaic technology can produce electricity only in the daylight hours.[41] To sustain the power supply, a solar system must employ elaborate storage batteries.[41] In short, generating electricity via solar technology is clearly cost prohibitive for utilities – about ten times that of conventional methods.[41] However, it should be noted that a utility that engages actively in some form of solar power may translate into consumer interest and ultimately lead into an increase in the installation of residential solar energy systems.[37] It is the ideal case of "leading by example." This was obviously the case for the customers of the Sacramento Municipal Utility District.[37] Their solar customer base has grown continuously since their pioneer solar program was initiated in 2001.[37] The activity has resulted in a rippling effect of even more requests for residential solar systems and an increase in job opportunities to install the systems.[37]

Wind Energy

The Office of Energy and Efficiency and Renewable Energy defines Wind Energy as: *Energy available from the movement of the wind across a landscape caused by the heating of the atmosphere, earth, and oceans by the sun.*[8] Wind energy is converted into electricity by large

[46]Figure 11

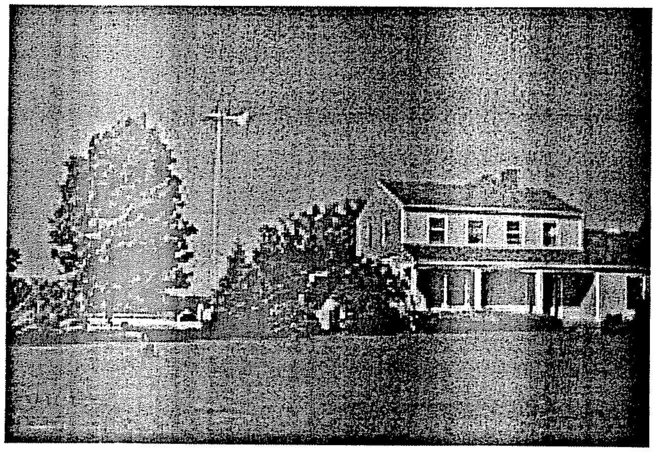
blades connected to turbines that turn a generator to produce power.[42] Currently the total installed wind power capacity in the United States exceeds 6,000 MW.[43] The midwest is known for its vast wind resources.[44] Wind farms combine the output of multiple wind turbines to generate electricity.[45] Figure 11 illustrates a modern wind farm.[46] Figure 12 shows regions of the nation where wind resources are available.[47] The central and northern midwest regions appear to be the most promising.[47] In contrast, the southeastern states show very limited sustainable wind energy.[47] As reasonably anticipated, several wind farms in the midwest



[15]Figure 12

generate a considerable amount of energy. In southwest Minnesota, a 138 turbine wind farm has an installed capacity of 103.5 MW.[43] In northwestern Iowa, a 151 turbine wind farm has an installed wind power capacity of 113.25 MW.[43] In Abilene, Texas, a wind farm consisting of 100 turbines has an installed capacity of 150 MW.[43]

The above provides examples of wind farms that have the capacity to generate sufficient electricity to supplement baseload electricity produced by conventional power plants. Also, in target regions of the country, the wind can be utilized on a smaller scale.[45] A single turbine can generate sufficient electricity to provide power to a single family home.[45] However, a normal application would work in conjunction with a supplemental power supply from a local utility.[48] Figure 13 shows a residential wind turbine.[46] At approximately $16,000 for a typical 10 kW residential wind system, a home turbine is considered an affordable source of renewable energy.[49] Most homeowners see an immediate reduction in their monthly bill through placing electricity back onto the electricity utility grid.[50] This technique calculates a net consumption rate known as "net-metering."[50]



[46]**Figure 13**

To summarize, wind energy offers a viable option for generating electricity from a renewable energy source. It is considered competitively priced in producing electricity when compared to large-scale fossil fuel or nuclear power plants.[51] They are also an affordable option to residents seeking to reduce their reliance on environmentally unfriendly technology.[49]

However, wind energy, also has obstacles to overcome. That is, wind farms must be located in regions where adequate wind resource is available.[47] This greatly limits entire regions of the United States as potential candidates for wind energy.[47] Additionally, wind energy, even after being placed in an ideal region of the country, is highly dependent on sustainable winds.[47] Also, although the cost of generating electricity from wind energy is considered competitive, the initial investment require more capital more than conventional power plants.[52] Further, wind farms are very difficult to site.[52] They require vast amounts of land that usually is located in remote regions of the nation.[52] This situation complicates matters by requiring the electricity to