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Compilation of Colleges and Universities in the United States using Renewable Energy Integration

Philip O. Adebo, Aida Ndaw
College of Science, Engineering & Technology, Texas Southern University
Houston, TX 77004

***Abstract*:- In this 21st century, renewable energy is becoming indispensable; many countries around the globe are moving away from non-renewables and harnessing energy generated from renewables to service their energy needs across all sectors. The energy industry is undergoing an unmatched revolution because of the acceptance of renewable energy. Renewable energy is obtained from energy resources that are naturally and constantly replenished. This includes hydroelectric power, solar energy, wind energy, fuel cell, geothermal energy, and biomass energy. This paper presents a collection of Universities in the United States, who have integrated renewable energy into their existing utilities while many others have integrated renewable programs in their academic curriculum in a bid to provide qualified engineers, reduce utility cost, cut down on greenhouse gas emission and provide eco-friendly environment.**

Key Words: Renewable energy, green power, Environmental Protection Agency (EPA)

INTRODUCTION

Global climate change and sustainable economic development are the two major challenges faced by energy sector [1]. It is advisable to move to an environment with sustainable energy sources to avoid a devastating damage to our planet. Renewable energy comes from natural resources such as sunlight, wind, hydro, tides, and geothermal heat, which are renewable (naturally replenished) forms of energy. It is often inexhaustible, which makes it more attractive energy source option because they have limited negative environmental impact when compared to fossil fuels. Energy from fossil fuels such as coal, peat, oil, and gas are nonrenewable because it draws on finite resources that will eventually diminish with time [2, 3]. Additionally, the combustion of fossil fuels for energy results in significant amount of greenhouse gas emissions that contribute to global warming [4]. In contrast, most sources of renewable energy result in little to no gas emissions and emits low air pollutants. The U.S. Environmental Protection Agency (EPA) established the Green Power Partnership (GPP) in 2001 to encourage organizations to use Green Power voluntarily to protect human and the environment. This partnership includes a wide variety of leading organizations, including large corporations; small and medium-sized businesses; local, state, and federal governments; non-profit institutions; and colleges and universities [5]

RENEWABLE ENERGY SOURCES

Renewable energy sources are known to have excelled among others in low-carbon energy economies. Renewable energy opportunities include solar energy, wind energy, biomass, and hydroelectric energy, and tidal energy [6, 7]:

i. **Solar Power:** This is the most readily available and free source of energy since primitive times. It involves converting the energy of sunlight directly into electricity using solar cells. Solar-thermal technology uses tracking mirrors to concentrate sunlight onto a receiver, which may be centralized or distributed.

ii. **Wind Power:** Wind turbines typically consist of rotor blades mounted on a tower and connected by gears to a drive shaft that spins a generator. The energy derived from wind is very sensitive to wind velocity and varies with the square of the velocity. Wind powers is widely used for electric power generation in remote areas.

iii. **Biomass Fuel:** Biomass refers to all the earth's living matter. Biomass resources include material derived from growing plants or from animal manure, such as wood wastes, wastepaper, sawdust, grass, etc. Carbon dioxide is emitted whenever biomass materials are burned. Plant biomass can be used as energy supply to small-scale industries.

iv. **Hydropower:** The power plant uses falling water to generate electricity. This implies the conversion of dynamic energy into electricity. Using water wheels to harvest the energy flowing in streams, rivers, and waterfalls is old. The first hydroelectric plant was built at Niagara Falls in 1879.

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v. **Tidal Energy:** This is a renewable energy powered by the natural rise and fall of ocean tides and waves. This irregular energy source uses pneumatic (air-filled) systems to pressurize air, which is then passed through an air turbine to generate electricity. This form of energy is not common because the investment is too large to justify the savings in energy.

Benefits of Installing Renewables in Colleges and Universities

Colleges and Universities are centers for cutting edge knowledge and pathways to the future. Obviously, renewable sources have a bright future since they cut energy costs, reduces current greenhouse gas emissions, and provides a sustainability design [8].

i. **Free Energy from the Sunlight**: Once the equipment to produce solar cells is paid for, free energy from the sun will eventually offset installation and material costs, leading to a return on investment within a matter of years. Unlike a home solar array, which can only allow a certain number of panels due to the limitations of roof space, universities have broad structures that can accommodate hundreds of panels, which can power an entire campus. The more panels you install, the more unlimited free energy you can produce.

ii. **Autonomous Power Sources:** Basically, renewable energy can operate in two methods as a stand-alone and could be integrated with the traditional grid system as backup power. Alternative colleges and universities that invest solar power can operate outside of the traditional grid system, which may be helpful during a utility power outage. Just like how solar power companies deliver clean energy electricity to residential homes, universities can operate as independent energy hubs for their campuses. In cases of natural disaster, a solar array can help improve emergency response and provide backup power until local utility power is restored. With the rise of several solar plants that generate several megawatts or gigawatts of power, it's possible for solar energy to eventually be 100 percent renewable and completely independent of the grid.

iii. **Opportunity for Press Coverage:** Universities that consistently experiment with new solar developments such as Stanford or MIT are routinely covered by the media, particularly publications that specialize in alternative energy. By building money-saving solar arrays and giving a name to your solar installation such as "Project Solar Energy," a university can get positive press, which may attract big investors who want to enhance the quality of their communities. They understand to invest solar power now means big energy cost savings in the future as well as providing clean energy electricity, which promotes a healthier environment.

iv. **Green Energy Attracts Millennials:** Millennials overwhelmingly favor green energy, so installing solar panels on a university roof could help increase enrollment. Tax credits from the government and solar panels produced cheaply are two environmental topics that have drawn interest from young people who want to participate in project solar energy. Even eco-minded students who cannot afford panels want to learn how to install their solar own panels to prepare for the future. Current greenhouse gas emissions suggest that society needs to convert to renewable energy in the next few decades to avoid extensive irreversible damage to the environment. For this reason, young people see sustainability design as essential for the planet's survival.

v. **Low Maintenance cost:** Another major benefit to solar panels for alternative colleges and universities is that once they are installed, they don't need much maintenance. The glass and frame that protects solar cells are very strong and durable. Certain panels are strong enough to withstand hurricanes. Most modern solar panels are designed to last at least 25-30 years, but it's possible to last longer in mild climates. One of the keys to panels being low maintenance is that they don't have any moving parts. Both a university and home solar array must be periodically inspected, but in warmer climates solar panels have more longevity. The panels can be damaged by wind and other severe weather conditions but tend to be unbreakable.

Top 30 College & University using Green Power in the United States

As of October 24, 2022, the combined annual green power use of EPA's Top 30 College & University Partners amounts to more than 3.8 billion kilowatt-hours of green power, which is equivalent to the annual electricity use of more than 361,000 average American homes. Figure 1 shows the analysis of the top 30 college and universities using Green Power in the United States. It depicts the total percentage of green power use with the corresponding universities. Table 1 depicts different types of renewable versus the sum of annual green power usage (kWh). Figure 3 depicts top 10 colleges with solar and renewable energy programs in their academic curriculum. This is a remarkable effort by these universities because they foresee the need for qualified people to work in the renewable energy sector. It's also an inspiration to other colleges and universities to join the renewable energy bandwagon [5, 9].

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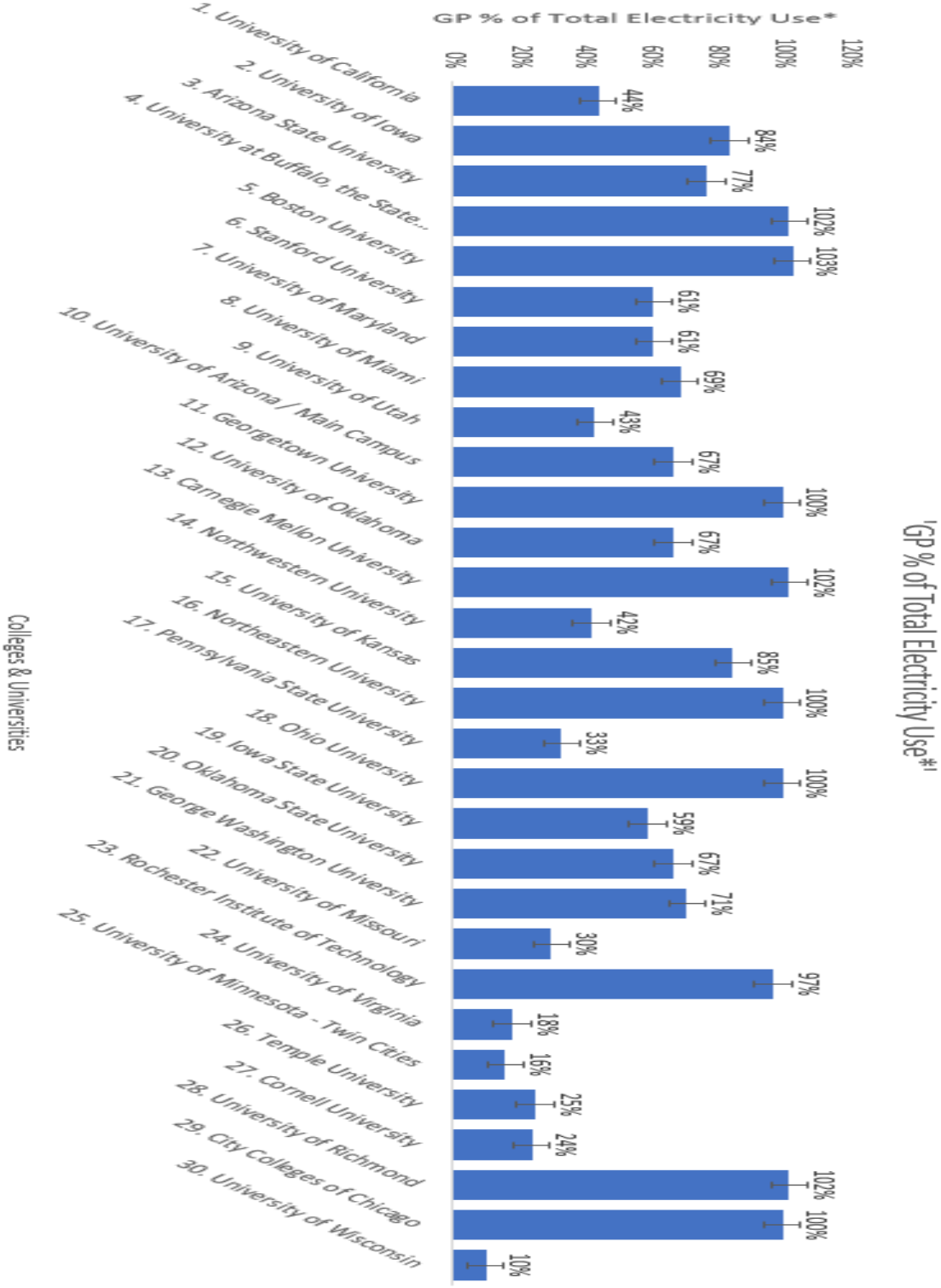

Figure 1. Top 30 College & University using Green Power in the United States [5].

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Table 1. Sum of annual green power usage (kWh)

Row Labels	Sum of Annual Green Power Usage (kWh)
Various	1,335,792,570
Wind	693,995,621
Solar, Wind	574,867,533
Biomass, Solar, Wind	468,534,980
Solar	246,402,973
Small-hydro, Solar	152,739,783
Small-hydro, Solar, Wind	149,745,825
Geothermal, Solar	131,736,867
Biomass, Solar	87,398,672
Grand Total	**3,841,214,824**

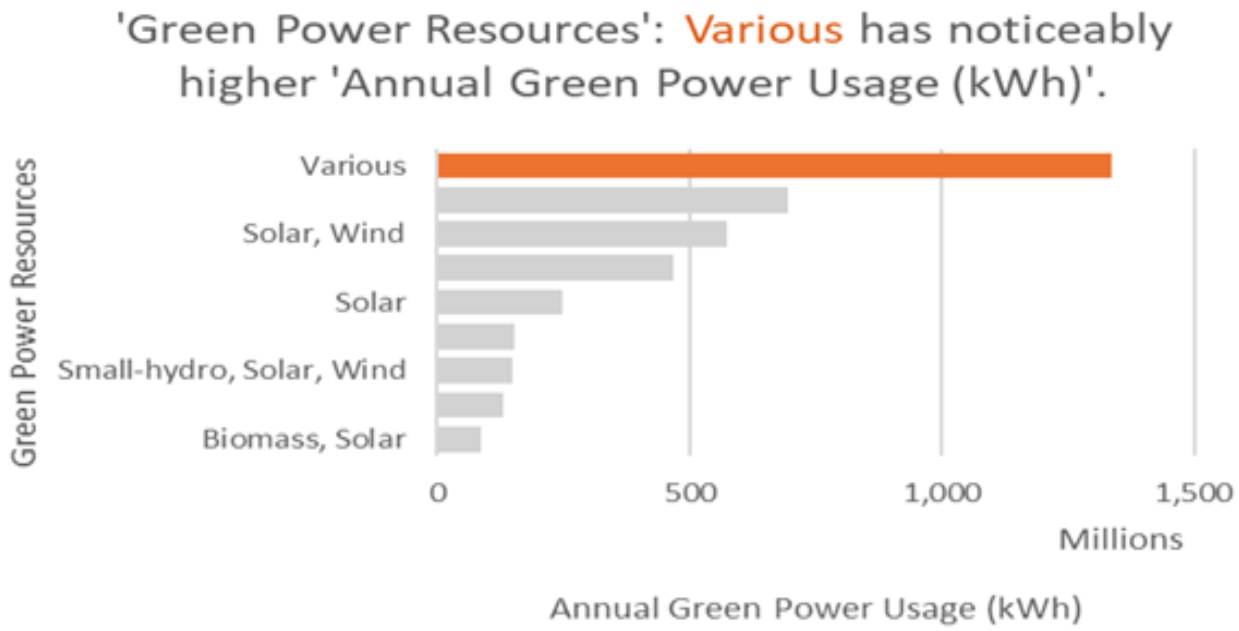

Figure 2. Green power resources versus annual green power usage (kWh)

CONCLUSION

As Renewable energy companies across the globe continue to build vast solar farms, blade and bladeless wind turbine generators, Biomass, Geothermal etc. to power stadiums and big office complexes, colleges and universities are also playing an influential role in the conversion to sustainable energy design. The reason why it's significant that campuses are adopting renewables, especially solar energy source is that they tend to cover plenty of land and serve thousands of people. By setting examples for adopting solar as financial and environmental necessities, more organizations within the community will be inspired to join the clean energy revolution as well.

From the data shared above, it's obvious that the following institutions: University at Buffalo, Boston University, Georgetown University, Carnegie Mellon University, Northeastern University, Ohio University, University of Richmond, and City college of Chicago have all set an impressive goal by using 100 percent and above of renewables in 2022 to service their electricity needs. The adoption of renewable in colleges and Universities have improved significantly, and it's trending upwards. According to the U.S. Department of Energy, taxpayers spend $6 billion annually on grade schools, which are far more numerous than colleges. Imagine the dramatic savings if smaller schools follow the lead set by major college & universities and own their renewable generation system.

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AUTHORS

Philip O. Adebo is an instructor at Texas Southern University. He completed his PhD in Electrical and Computer Engineering Department, Prairie View A&M University with emphasis on power systems. His research interests include power system, renewable energy, microgrid, smart-grid, Integration of renewables and optimization of power systems.
Aida Ndaw is a student at Texas Southern University Majoring in Electrical and Computer Engineering. Her research interest includes power system and renewable energy

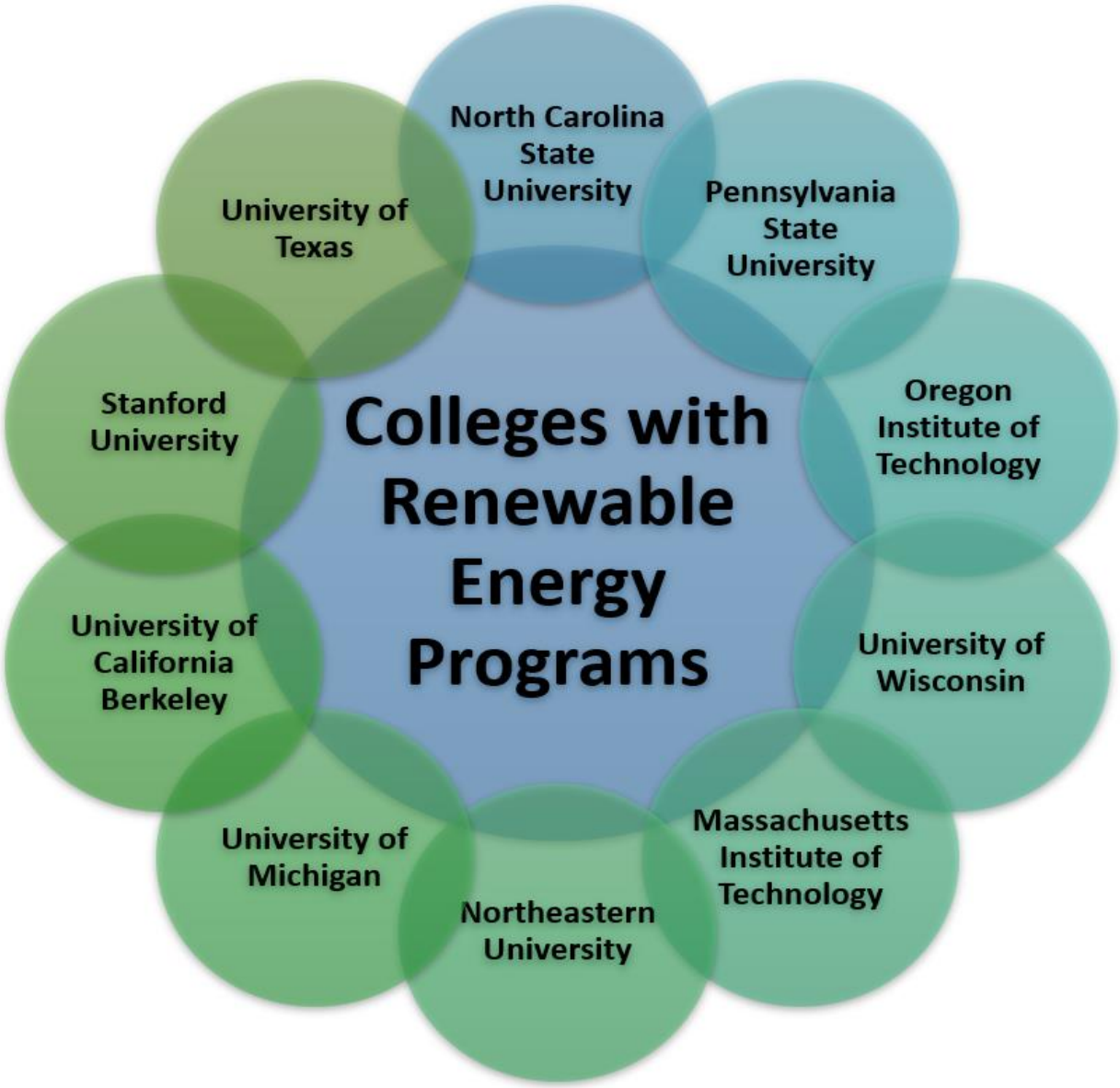

Figure 3. Top 10 colleges with solar and renewable energy programs [9].