



**Focusing TVET Practices Towards Sustainable Renewable Energy: A Viable Energy Source for Sustainable Economic Recovery in Nigeria**

By

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**Abstract**

*Energy has been the key to sustainable economic development and recovery worldwide. This is because it is a key driver to developmental activities and several domestic and industrial machine operations requires energy to power them. The way energy is sourced, produced and used creates a lot of issues; certain sources of energy pollute the environment and human life while other sources clean the environment. The paper gave a conceptual overview that calls for the need on focusing Technical and Vocational Education and Training (TVET) practices towards sustainable renewable energy: a viable energy source for sustainable economic recovery in Nigeria. The paper gave a conceptual clarification on basic terms like energy, renewable energy and non renewable energy, types and uses of renewable energy sources and their benefits to human existence. It also unveiled how TVET practices could be focus towards sustainable renewable energy as a viable energy source for sustainable economic recovery in Nigeria. From the literature reviewed it was concluded that focusing TVET practices towards sustainable renewable energy is a viable energy source for sustainable economic recovery in Nigeria.*

**Keywords:** Technical and Vocational Education and Training (TVET), Energy, Renewable Energy, Sustainable Renewable Energy, Economic Recovery.

**Introduction**

Energy has been a vital factor for economic development world wide. This is because it is a key driver to developmental activities and several machine operations requires energy. Energy can simply be referred to as the capacity for doing work. The capacity for doing work are inherent properties of energy sources. Some of the common energy carriers or sources are coal, petroleum, natural gas, nuclear fuels, biomass, and electricity among others (Lora, 2018). Among all these, the most widely used energy sources are the hydrocarbon compounds or fossil fuels which account for more than 80% of global primary energy consumption.

Despite the fact that energy has been the key to economic development worldwide, Taylor (2018) revealed that two major drawbacks have emerged in the way it is sourced, produced and used. First, the overall energy system has been very inefficient. Secondly, major environmental and social problems, both local and global have been associated with the energy system. Climate change and environmental externalities associated with energy consumption have become a major international issue. For instance, fossil energies provide about 67% of the energy needed to produce electricity which is a

veritable and the most terminal form of energy for transmission and distribution for industrial production processes. Energy usage has become an important concern in the past years and there has been growth awareness and an increase in taking personal responsibilities in preventing environmental pollution by minimizing energy waste and creating alternative energy sources through renewable energy.

Renewable energy often called clean energy refers to energy that is collected from renewable resources or from resources which are naturally replenished on a human timescale, such as sunlight, wind, rain, tides, waves, and geothermal heat (Chelsea, 2018). According to Chelsea (2018), renewable energy flows involve natural phenomena such as sunlight, wind, tides, plant growth, and geothermal heat. Renewable energy is derived from natural processes that are replenished constantly. In its various forms, it derives directly from the sun, or from heat generated deep within the earth. Included in the definition is electricity and heat generated from solar, wind, ocean, hydropower, biomass, geothermal resources, and bio-fuels and hydrogen derived from renewable resources.

Renewable energy resources and significant opportunities for energy efficiency exist over wide geographical areas, in contrast to other energy sources, which are concentrated in a limited number of countries. Rapid deployment of renewable energy and energy efficiency, and technological diversification of energy sources, would result in significant energy security and economic benefits (Jocelyn, 2018). It would also reduce environmental pollution such as air pollution caused by burning of fossil fuels and improve public health, reduce premature mortalities due to pollution and save associated health costs that amount to several hundred billion dollars annually only in the United States. According to Jocelyn (2018), renewable energy sources, that derive their energy from the sun, either directly or indirectly, such as hydro and wind, are expected to be capable of supplying humanity energy for almost another 1 billion years, at which point the predicted increase in heat from the sun is expected to make the surface of the earth too hot for liquid water to exist.

According to Lora (2018), renewable energy often provides energy in three important areas and as such renewable energy often displaces conventional fuels in these three major areas: electricity/power generation, hot water/space heating and transportation.

**Electricity/Power generation:** Lora (2018) revealed that by 2040, renewable energy is projected to equal coal and natural gas electricity generation. Several jurisdictions, including Denmark, Germany, the state of South Australia and some US states have achieved high integration of variable renewable

or renewable energy sources. For example, in 2015 wind power met 42% of electricity demand in Denmark, 23.2% in Portugal and 15.5% in Uruguay. Interconnectors enable countries to balance electricity systems by allowing the import and export of renewable energy. Innovative hybrid systems have emerged between countries and regions.

**Water / Space Heating:** Solar water heating makes an important contribution to renewable heat in many countries, most notably in China, which now has 70% of the global total heating rate. Most of these systems are installed on multi-family apartment buildings and meet a portion of the hot water needs of an estimated 50–60 million households in China. Worldwide, total installed solar water heating systems meet a portion of the water heating needs of over 70 million households. The use of biomass for heating continues to grow as well. In Sweden, national use of biomass energy has surpassed that of oil. Direct geothermal for heating is also growing rapidly (Lora, 2018). The newest addition to Heating is from Geothermal Heat Pumps which provide both heating and cooling, and also flatten the electric demand curve and are thus an increasing national priority.

**Transportation:** Isaiah (2018) revealed that most modern buses are fueled by biodiesel or bio ethanol. Bio ethanol is an alcohol made by fermentation, mostly from carbohydrates produced in sugar or starch crops such as corn, sugarcane, or sweet sorghum. Cellulosic biomass, derived from non-food sources such as trees and grasses is also being developed as a feedstock for ethanol production. Ethanol can be used as a fuel for vehicles in its pure form, but it is usually used as a gasoline additive to increase octane and improve vehicle emissions. Bio ethanol is widely used in the USA and in Brazil. Biodiesel can be used as a fuel for vehicles in its pure form, but it is usually used as a diesel additive to reduce levels of particulates, carbon monoxide, and hydrocarbons from diesel-powered vehicles. Biodiesel is produced from oils or fats using transesterification and is the most common bio fuel in Europe.

Some other motor vehicles or solar vehicles are fueled by solar energy. A solar vehicle is an electric vehicle powered completely or significantly by direct solar energy. Usually, photovoltaic (PV) cells contained in solar panels convert the sun's energy directly into electric energy. The term "solar vehicle" usually implies that solar energy is used to power all or part of a vehicle's propulsion. Solar power may be also used to provide power for communications or controls or other auxiliary functions. Solar vehicles are not sold as practical day-to-day transportation devices at present, but are primarily demonstration vehicles and engineering exercises, often sponsored by government agencies. However, indirectly solar-charged vehicles are widespread and solar boats are available commercially.

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Literature evidence showed that renewable power is booming, as innovation brings down costs and starts to deliver on the promise of a clean energy future. For instance American solar and wind generation are breaking records and being integrated into the national electricity grid without compromising reliability (Kristin, 2018).

This means that renewable or renewable energy sources are increasingly displacing the conventional fossil fuels (dirty energy) in the power sector, offering the benefit of lower emissions of carbon and other types of pollution (Lora, 2018). But not all sources of energy marketed as “renewable” are beneficial to the environment. For instance biomass and large hydroelectric dams create difficult tradeoffs when considering the impact on wildlife, climate change, and other issues. Although there impact is minimal compared to the widely used convention hydrocarbon (fossil) fuels often called dirty energy due to the danger associated to its usage in terms or environmental pollution.

As the importance of renewable energy use continues to grow, a key goal will be to focus Technical Vocational Education and Training (TVET) practices towards sustainable renewable energy as a viable energy source for sustainable economic recovery in Nigeria. This implies redesigning, reviewing and channeling TVET curriculum and modular activities to capture and dwell more on each aspect of renewable energy sources, production and utilization to achieve sustainable economic recovery in Nigeria.

#### **Difference Between Renewable Energy and Non Renewable Energy**

Renewable energy, often referred to as clean energy, comes from natural sources or processes that are constantly replenished (Lora, 2018). For example, sunlight or wind keep shining and blowing, even if their availability depends on time and weather. While renewable energy is often thought of as a new technology, harnessing nature’s power has long been used for heating, transportation, lighting, and more. Wind has powered boats to sail the seas and windmills to grind grain. The sun has provided warmth during the day and helped kindle fires to last into the evening. But over the past 500 years or so, humans increasingly turned to cheaper, dirtier energy sources such as coal and hydrocarbon gas. Now that we have increasingly innovative and less-expensive ways to capture and retain wind and solar energy, renewable power sources are becoming more important, accounting for more than one-eighth of U.S. generation (Lora, 2018). The expansion in renewables is also happening at scales large and small, from rooftop solar panels on homes that can sell power back to the grid to giant offshore wind farms. Even some entire rural communities rely on renewable energy for heating and lighting.

While Nonrenewable energy or dirty energy includes fossil fuels such as oil, gas, and coal. Nonrenewable sources of energy are only available in limited amounts and take a long time to replenish (Helder, 2015). When we pump gas at the station, we're using a finite resource refined from crude oil that has been around since prehistoric times. Nonrenewable energy sources are also typically found in specific parts of the world, making them more plentiful in some nations than others. By contrast, every country has access to sunshine and wind. Prioritizing nonrenewable energy can also improve national security by reducing a country's reliance on exports from fossil fuel-rich nations. Many nonrenewable energy sources can endanger the environment or human health. For example, oil drilling might require strip-mining Canada's boreal forest, the technology associated with cracking can cause earthquakes and water pollution, and coal power plants foul the air. To top it off, all these activities contribute to global warming (Helder, 2015).

### **Types of Renewable Energy Sources**

**Solar Energy:** Humans have been harnessing solar energy for thousands of years—to grow crops, stay warm, and dry foods. According to the National Renewable Energy Laboratory, “more energy from the sun falls on the earth in one hour than is used by everyone in the world in one year. Today, we use the sun's rays in many ways: to heat homes and businesses, to warm water, or power devices.

Solar, or photovoltaic (PV), cells are made from silicon or other materials that transform sunlight directly into electricity. Distributed solar systems generate electricity locally for homes and businesses, either through rooftop panels or community projects that power entire neighborhoods (David, Kuang-Hax & Min-Hsien, 2007). Solar farms can generate power for thousands of homes, using mirrors to concentrate sunlight across acres of solar cells. Floating solar farms or “floatovoltaics” can be an effective use of wastewater facilities and bodies of water that are not ecologically sensitive.

Solar supplies a little more than 1 percent of U.S. electricity generation. But nearly a third of all new generating capacity came from solar in 2017, second only to natural gas (David, Kuang-Hax, & Min-Hsien, 2007). Solar energy systems do not produce air pollutants or greenhouse gases, and as long as they are responsibly sited, most solar panels have few environmental impacts beyond the manufacturing process.

**Wind Energy:** We have come a long way from old-fashioned wind mills. Today, turbines as tall as skyscrapers—with turbines nearly as wide in diameter stand at attention around the world. Wind energy turns a turbine's blades, which according to Lora (2018), feeds an electric generator and

produces electricity. Wind, which accounts for a little more than 6 percent of U.S. generation, has become the cheapest energy source in many parts of the country. Top wind power states include California, Texas, Oklahoma, Kansas, and Iowa, though turbines can be placed anywhere with high wind speeds such as hilltops and open plains or even offshore in open water.

### **Other Renewable Alternative Energy Sources**

**Hydroelectric Power:** Hydropower is the largest renewable energy source for electricity in the United States, though wind energy is soon expected to take over the lead. Hydropower relies on water. Typically fast-moving water in a large river or rapidly descending water from a high point and converts the force of that water into electricity by spinning a generator's turbine blades. Nationally and internationally, large hydroelectric plants or mega-dams are often considered to be nonrenewable energy (Olayinka, 2013). Mega-dams divert and reduce natural flows, restricting access for animal and human populations that rely on rivers. Small hydroelectric plants (an installed capacity about 40 megawatts), carefully managed, do not tend to cause as much environmental damage, as they divert only a fraction of flow.

**Biomass Energy :** Biomass is organic material that comes from plants and animals, and includes crops, waste wood, and trees. When biomass is burned, the chemical energy is released as heat and can generate electricity with a steam turbine. Biomass is often mistakenly described as a clean, renewable fuel and a greener alternative to coal and other fossil fuels for producing electricity. However, recent science shows that many forms of biomass especially from forest produce higher carbon emissions than fossil fuels (Nag, 2004). There are also negative consequences for biodiversity. Still, some forms of biomass energy could serve as a low-carbon option under the right circumstances. For example, sawdust and chips from sawmills that would otherwise quickly decompose and release carbon can be a low-carbon energy source.

**Geothermal Energy:** If you have ever relaxed in a hot spring, you've used geothermal energy. The earth's core is about as hot as the sun's surface, due to the slow decay of radioactive particles in rocks at the center of the planet. Drilling deep wells brings very hot underground water to the surface as a hydrothermal resource, which is then pumped through a turbine to create electricity (Lora , 2018). Geothermal plants typically have low emissions if they pump the steam and water they use back into the reservoir. There are ways to create geothermal plants where there are not underground reservoirs, but there are concerns that they may increase the risk of an earthquake in areas already considered geological hot spots.



**Ocean:** Tidal and wave energy is still in a developmental phase, but the ocean will always be ruled by the moon's gravity, which makes harnessing its power an attractive option. Some tidal energy approaches may harm wildlife, such as tidal barrages, which work much like dams and are located in an ocean bay or lagoon (Eleri, 2005). Like tidal power, wave power relies on dam-like structures or ocean floor–anchored devices on or just below the water's surface.

### **Renewable Energy in the Home for Domestic Uses**

**Solar Power:** At a smaller scale, we can harness the sun's rays to power the whole house whether through PV cell panels or passive solar home design. Passive solar homes are designed to welcome in the sun through south-facing windows and then retain the warmth through concrete, bricks, tiles, and other materials that store heat (Nagesha, 2008). Some solar-powered homes generate more than enough electricity, allowing the homeowner to sell excess power back to the grid. Batteries are also an economically attractive way to store excess solar energy so that it can be used at night. Scientists are hard at work on new advances that blend form and function, such as solar skylights and roof shingles.

**Geothermal Heat Pumps:** Geothermal technology is a new take on a recognizable process—the coils at the back of your fridge are a mini heat pump, removing heat from the interior to keep foods fresh and cool. In a home, geothermal or geo exchange pumps use the constant temperature of the earth (a few feet below the surface) to cool homes in summer and warm houses in winter, and even to heat water (Lora, 2018). Geothermal systems can be initially expensive to install but typically pay off within ten years. They are also quieter, have fewer maintenance issues, and last longer than traditional air conditioners.

**Small Wind Systems:** A backyard wind farm, Boats, ranchers, and even cell phone companies use small wind turbines regularly (Kristin, 2018). Dealers now help to site, install, and maintain wind turbines for homeowners, although some energy experts enthusiasts are installing turbines themselves. Depending on your electricity needs, wind speeds, and zoning rules in your area, a wind turbine may reduce your reliance on the electrical grid.

### **Focusing Technical and Vocational and Training (TVET) practices towards sustainable renewable energy**

Technical Vocational Education and Training (TVET) according to the Federal Republic of Nigeria (FRN, 2013) in her National Policy on Education, is an aspect of the educational process involving, in addition to general education, the study of technologies and related sciences and the acquisition of practical skills, attitudes, understanding and knowledge relating to occupations in various sectors of



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economic and social life. TVET provides trained manpower in the applied sciences, technology and business particularly at craft, advanced craft and technical levels; provide the technical knowledge and vocational skills necessary for agricultural, commercial and economic development; and give training as well as impart the necessary skills to individuals who shall be self-reliant economically (FRN, 2013). Institutions in Nigeria running TVET programmes include Universities, Polytechnics and Colleges of Technology, Monotechnics, Technical Colleges, Vocational Schools and Vocational Training centres among others. Technical colleges are regarded as one of the principal TVET institutions in Nigeria for the training of craftsmen and women.

Recently, TVET is considered by the International Labour Organization (ILO) (2010) as a potent tool for sustainable economic recovery in Nigeria because research findings revealed that many developed countries of the world have recognized the great importance attached to TVET programmes and have therefore accorded it the attention it deserves. ILO (2010) have regarded TVET as the basis for industrial, technological and economic advancement. They saw TVET as a means to job creation, poverty reduction, a tool for technological and economic development. Several countries that have experienced technological and economic breakthrough in the world today are those that have placed great emphasis on TVET and have invested substantially on TVET through proper planning and reasonable TVET implementation policy. For example, the Dutch school system provided compulsory technical education for one-third of its pupils between the ages of 14 and 16 years. According to ILO (2010) review, the Dutch provided Technical training centers in secondary or high schools offering technical training for lifelong trade together with general academic studies. India, Asia and several developed countries have invested heavily in TVET and the benefits are very glaring with a great impact on their technological and economic development.

While the United States of America in recognition of the importance of TVET, established public technical secondary schools that introduced extensive public instruction in vocational agriculture associated skill-based courses. In the past decade, the developed countries have shifted emphasis to information and communication technology driven TVET. These countries that have developed their TVET programmes have been described as being secured economically. In addition, through TVET they have also been able to produce innovative and productive alternative energy sources for sustainable economic development which is a major driver of sustainable economic recovery and growth. Through researches in to alternative energy sources, TVET has transformed underdeveloped

countries into developed countries where there are varieties of alternative energy sources that enhance growth and sustainable economic recovery.

The term Sustainable Economic Recovery (SER) refers to a continual process of strengthening the economy of a nation after a period of recession or depression (Onyenekenwa, 2010). Sustainable Economic Recovery (SER) can also be referred to as a continual process that is geared towards restoring positive economic development and growth in a nation that has experienced economic recession or depression (Paul, 2017). A sustainable economic recovery occurs when an economy continues to strengthen progressively after a period of recession. SER brings about economic expansion and an economic expansion increases the demand for both capital and consumer goods. During SER, companies invest in more production facilities in anticipation of taking advantage of increase in sales and profit. SER also allows banks to lend capital for expansion at low interest rate. Strong demand pushes the need for more workers in industries which bring about an increase in employment levels. Sustainable economic recovery according to Onyenekenwa (2010) leads to the development of a nation whose economy has five notable characteristics such as: participation, equity, growth, stability as well as sustainability.

**By participation,** people are able to participate fully in economic life and have greater say over their future. People are able to access and participate in markets as workers, consumers and business owners. Transparency around and common knowledge of rules and norms allow people to start a business, find a job or engage in markets. Technology is more widely distributed and promotes greater individual and community well-being especially at grassroot level.

**Through equity,** more opportunities are available to enable upward mobility for more people. All segments of society, especially poor or socially disadvantaged groups are able to take advantage of these opportunities. Inequality is declining rather than increasing. People have equal access to a more solid economic foundation, including equal access to adequate public goods, services and infrastructure, such as public transit, education, clean air and water.

**Through growth,** an economy is increasingly producing enough goods and services to enable broad gains in well-being and greater opportunity. Good job and work opportunities are growing and incomes are increasing especially for the poor. Economic systems are transforming for the betterment of all especially poor and excluded communities. Economic growth and transformation is not only

captured by aggregate measures of economic output (such as GDP) but must include and be measured by other outcomes that capture overall well-being such as availability and adequacy.

**By stability**, individuals, communities, businesses and governments have a sufficient degree of confidence in their future and an increased ability to predict the outcome of their economic decisions. Individuals, households, communities and enterprises are secured enough to invest in their future. Economic systems are increasingly resilient to shocks and stresses especially to disruptions with a disproportionate impact on poor or vulnerable communities.

**Through sustainability**, economic and social wealth is sustained over time, thus maintaining inter-generational well-being. Economic and social wealth is the social worth of the entire set of assets that contribute to human well-being and preservation of natural resources. In the case of natural resources, human use must preserve or restore nature's ability to produce the ecosystem of goods and services that contribute to human well-being. Decision-making must thus incorporate the long-term costs and benefits, and not merely the short-term gains of human use of our full asset base or natural resources such as alternative energy sources.

### **Conclusion**

The review showed that energy usage has become an important concern in the past years and there has been growth awareness and an increase in taking personal responsibilities in preventing environmental pollution by minimizing energy waste and creating alternative energy sources. Energy has been the key to economic development worldwide, but in the way it is sourced, produced and used, two major drawbacks have emerged. First, the overall energy system has been very inefficient. And secondly, major environmental and social problems, both local and global, have been associated with the energy system. Climate change and environmental externalities associated with energy consumption have become a major international issue. It has been observed that among the various sectors contributing to Green House Gas (GHG) emissions, industrial sector contribution was significant; thus mitigating GHG emissions from the sector offers one of the best ways of confronting the climate change problem. Energy efficiency is a major key in this regard. An estimated 10-30% reduction can be achieved at little or no cost by improving efficiency of energy use in the industry through alternative energy sources such as renewable energy.

Although Nigeria is relatively endowed with abundant fossil fuels and other renewable energy sources, the energy situation in the country is yet to be structured and managed in such a way as to ensure sustainable energy development and economic recovery. It is therefore paramount to explore

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“Technical Vocational Education and Training (TVET) and Alternative Energy Sources for Sustainable Economic Recovery in Nigeria.

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**CITATION AND PUBLICATION DETAILS**

Okwori, R.O., Abutu, F. , Hassan, A.M., Mohammed, B.M, and Kareem, W. B.. (2018). Focusing TVET Practices Towards Sustainable Renewable Energy: A Viable Energy Source for Sustainable Economic Recovery in Nigeria. In A.S. Bappah, .M. Mafwalai, S.A. Adebayo, R. Ager & P.S. Williams (Eds) *Technical Vocational Education and Training (TVET) and Alternative Energy Sources for Sustainable Economic Recovery in Nigeria*. Proceedings of the 31<sup>st</sup> Annual National Conference of Technology Education Practitioners Association of Nigeria (TEPAN), held at Yusuf Maitama Sule University, Kano. 15<sup>th</sup> - 18<sup>th</sup> October , 2018. 43 -50. Lagos: Technology Education Practitioners Association of Nigeria (TEPAN).

**Publisher:** Technology Education Practitioners Association of Nigeria (TEPAN).

**Date Issued:** 16<sup>th</sup> October, 2018.

**Series/Report No:** 31<sup>st</sup> Annual National Conference of TEPAN, 2018. p 43 -50.

**Identifiers:** ISBN: 978-978-967-443-5.

**Sponsors: The Authors.**

**Publication Collection Category :** Conference Paper.

**Website:** [www.tepan.org](http://www.tepan.org) or [www.natt.org](http://www.natt.org)