Critical Review and Survey of Renewable Energy Source for Powering Computer Laboratory in Tertiary Institutions

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ABSTRACT

This report presents the result of review and survey of renewable energy source for purpose of powering Computer laboratory in higher institutions of learning in Nigeria. The study gives critical description of energy, renewable energy, it benefits and limitation, and types of renewable energy source. The review and survey of the renewable energy source shows that Nigeria has potential of taping from energy source for purpose of diversify economy especially in educational system. The energy industry needs to partner with institutions of learning towards using the renewable energy source to diversify economy in all ramifications. Many types of renewable energy resources-such as wind and solar energy-are constantly replenished and will never run out. Sunlight, or solar energy and can be used directly for powering computer labs in the higher institutions of learning to promote teaching and learning.

Keywords*:* Biomass, renewable energy, Computer Lab, wind energy, solar energy, Photovoltaic System

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1. BACKGROUND OF THE STUDY

Renewable energy uses energy sources that are continually replenished by nature, the sun, the wind, water, the Earth's heat, and plants. Renewable energy technologies turn these fuels into usable forms of energy most often electricity, but also heat, chemicals, or mechanical power. Popular perception of renewable energy in Nigeria tends to focus on solar and occasionally wind power. Renewables have a relatively short history in Nigeria, especially in the public view. However, renewable energy from hydropower has actually been at the core of Nigeria's grid electricity production since the 1960s. Until very recently, the Kanji and Jebba Dams (1300MW) accounted for around 50 per cent of Nigeria's stable power sources, only recently being overtaken by gas power stations whose role continues to be constrained by the poor state of the national grid and unstable gas supplies.

Renewable energy should never be considered in isolation. Progress in the field goes hand in hand with improved energy efficiency, which has been vital in driving down costs and making new applications feasible. Compared with the existing costs of power in Nigeria (mainly generators), there is a very strong case for quite radical interventions. This is also in contrast with other developing countries which have a more stable grid electricity supply (Chris Newsom, 2012). Energy is a scalar physical quantity that describes the amount of work that can be performed by a force, an attribute of objects and systems that is subject to a conservation law. Different forms of energy include kinetic, potential, thermal, gravitational, sound, light, elastic, and electromagnetic energy which are named after a related force. Any form of energy can be transformed into another form, but the total energy always remains the same.

This principle, the conservation of energy, was first postulated in the early 19th century, and applies to any isolated system. There are two types of energy: Primary energy and Secondary energy i.e., energy found in nature that has not been subjected to any conversion or transformation process. It is the energy contained in raw fuels and any other forms of energy received by a system as input to the system. The concept is used especially in energy statistics in the course of compilation of energy balances. Primary energy includes non -renewable energy and renewable energy. Primary energies are transformed in energy conversion processes to more convenient forms of energy, such as electrical energy, refined fuels, or synthetic fuels such as hydrogen fuel. Secondary energy is an energy which has been transformed from one energy to another. Electricity is the most common example, being transformed from such primary sources as coal, oil, natural gas, and wind (Solar energy, 2015). The focus of this paper is to give critical description of energy, renewable energy, it benefits and limitation, types of renewable energy source, and it areas of applications.

2. RENEWABLE ENERGY

Renewable energy is an energy that cannot be exhausted as it is constantly renewed. It is generated from natural resources such as sunlight, wind, rain, tides and geothermal heat. (Bhubaneswari P. et al, 2011), 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. 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. 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.

2.1 Benefits, Limitations and Sources of Renewable Energy

Benefit of Renewable Energy

Renewable energy is eco-friendly: It is a clean source of energy, meaning, it has low or zero carbon and greenhouse emission. Fossil fuels emit high levels of greenhouse gas and carbon dioxide, which are greatly responsible for global warming, climate change, and degradation of air quality. (Booth D. E. 1998) Fossil fuels also contribute to sulfur emission to the atmosphere leading to acid rains. Acid rains can cause damage to buildings. Solar and wind power are considered eco-friendly because they emit zero toxic gases to the environment. The use of renewable energy dramatically reduces the dependence on fossil fuel as a source of energy, hence, cutting back on air pollution.

It's a renewable resource: This implies that they do not deplete over a lifetime and there is zero possibility that they will run out (sustainable source of energy). Sources of energy like fossil fuels (oil, gas, and coal) are considered limited resources and there is strong possibility that they will run out in the future. Renewable energy can help developing countries from over-reliance on fossil fuels. Powerful winds, heat emanating from beneath the earth, sunshine and moving water can guarantee a huge and steady energy supply to a nation for many years.

It is a reliable source of energy: In the previous few decades, the use of fossil fuel has sharply increased. This over-reliance on fossil fuels has led to our security being threatened. Fossils fuels are prone to trade disputes, political instabilities, spike in energy prices and unnecessary wars. These variables affect a lot more than a nation's energy policies; they can significantly drain a country's economy. Although most argue that solar and wind energy are unreliable, a solid infrastructure puts this argument to rest. If solar and wind plants are distributed over a large geographical location,

there can be minimal electricity generation interruption because weather disruptions in one location cannot be the same in other locations.

Leads to job creation: Since the inception of renewable energy, new and stable jobs have been added to most world economies. For, instance, in Germany and UK, many jobs have already been created thanks to their relentless efforts to develop and encourage the use of renewable forms of energy. Experts project that with the ongoing rigorous campaigns to embrace renewable energy, thousands of stable jobs will be created.

Empowering people in the rural area: Renewable energy generation mainly takes place in remote settings. This means that local towns would get a fair share of power generated, ultimately, catalyzing the regeneration of those depressed areas both socially and economically. Electrification of those areas will open up untapped opportunities for development through the advancement of greenhouses using geothermal power, district heating of towns and communities through hot water generated by the energy exploitation of forestry and agricultural biomass.

2.2 Limitations of Renewable Energy

The electricity generation capacity is still not large enough: There are still challenges to generation of large quantities of power in renewable energy technology compared to traditional forms of energy generation like fossil fuel. Fossil fuel still produces large quantities of electricity today, by far. (Booth D. E. 1998) This, essentially, means that it can't be solely relied upon to power the whole nation. This means that either we need to set up more such facilities to match up with the growing demand or look out for ways to reduce our energy consumption. This phenomenon indicates that a balance of different energy sources will still prevail for some years to come.

Renewable energy can be unreliable: Renewable energy technologies totally depend on the weather (for e.g.: sun and wind) to be able to harness any energy. In case atmospheric conditions are not good enough, renewable energy technologies would lack the ability to generate any electricity. This might instigate campaigns by the authorities to reduce energy usage in order to serve the population for a longer period.

Low efficiency level: Renewable energy technologies are still significantly new to the market, meaning, they still lack the much-needed efficiency. This poses forecast problems and investors may shy away from investing their money for fear of not getting returns pretty quick.

Requires a huge upfront capital: Setting up renewable energy generation facilities requires a huge financial outlay. Installation of wind turbine, solar panels, and hydroelectricity plants are relatively expensive. These plants require upfront investments to build, have high maintenance expenses and require careful planning and implementation. Also, the electricity generated needs to be delivered to towns and cities, which means additional cost of installing power lines.

3. RENEWABLE ENERGY SOURCES

Sunlight: The **Sun** is the star at the center of the Solar System. It is a nearly perfect sphere of hot plasma, with internal convective motion that generates a magnetic field via a dynamo process. It is by far the most important source of energy for life on Earth. The sun is the star that dominates our solar system. (Denholm P. et al, (2007), The amount of energy emitted by the sun as radiation is quite constant. This energy output is generated deep within the sun. As a star the sun is made up of 71% hydrogen, 27% helium, and 2% other elements. At the center of the sun the density is 150 times that of water and the temperature is almost 16,000,000 Kelvin, which causes the nuclei of individual hydrogen atoms to undergo nuclear fusion (in other words they join together).

The result of this is that two hydrogen nuclei combine to make one helium nucleus, and energy is released in the form of radiation. Vast numbers of such fusions occur every second, generating energy beyond our imagination. The energy produced moves out towards the solar surface by radiation and then by convection through the turbulent mixing of gases on the sun's surface. The sun has produced energy for many millions of years and will do so for many millions more. It is estimated that there is enough hydrogen still in the sun's core to last another 4.5 billion years. Solar energy as we refer to it is the solar radiation (light and heat) that reaches the earth. Every day the sun radiates enormous amounts of heat and light energy. The planet and the atmosphere absorb some of this energy with the remainder being reflected back out into space. Sunlight contains a surprisingly large amount of energy. On average, even after passing through hundreds of kilometers of air on a clear day, solar radiation reaches Earth with enough energy in a single square meter to run a mid-size desktop computer.

Wind: Wind is the motion of air masses produced by the irregular heating of the earth's surface by sun. These differences consequently create forces that push air masses around for balancing the global temperature or, on a much smaller scale, the temperature between land and sea or between mountains. Wind is caused by differences in the atmospheric pressure. When a difference in atmospheric pressure exists, air moves from the higher to the lower pressure area, resulting in winds of various speeds. On a rotating planet, air will also be deflected by the Coriolis effect, except exactly on the equator. Globally, the two major driving factors of large-scale wind patterns (the atmospheric circulation) are the differential heating between the equator and the poles (difference in absorption of solar energy leading to buoyancy forces) and the rotation of the planet.

Outside the tropics and aloft from frictional effects of the surface, the large-scale winds tend to approach geostrophic balance. Near the Earth's surface, friction causes the wind to be slower than it would be otherwise. Surface friction also causes winds to blow more inward into low pressure areas. A new, controversial theory suggests atmospheric gradients are caused by forest induced water condensation resulting in a positive feedback cycle of forests drawing moist air from the coastline. Winds defined by an equilibrium of physical forces are used in the decomposition and analysis of wind profiles. They are useful for simplifying the atmospheric equations of motion and for making qualitative arguments about the horizontal and vertical distribution of winds.

Rain: Rain is liquid water in the form of droplets that have condensed from atmospheric water vapor and then precipitated that is, become heavy enough to fall under gravity. Each raindrop has an impact energy that is highly dependent on the size of the drop; from a small drizzle drop that has 2 micro joules on impact, to a downpour size drop that carries 1 mill joule of impact energy. A piezoelectric material might be able to capture that energy. Piezoelectric materials generate an electrical potential when acted on by an outside physical force- say a raindrop. The opposite is conveniently true as well, an electrical charge will change the materials shape, which is how many speakers turn electric signals into vibrations we can hear.

Tides: Tides are the rise and fall of sea levels caused by the combined effects of the gravitational forces exerted by the Moon and the Sun and the rotation of the Earth. The times and amplitude of tides at any given locale are influenced by the alignment of the Sun and Moon, by the pattern of tides in the deep ocean, by the amphidromic systems of the oceans, and the shape of the coastline and near-shore bathymetry. Some shorelines experience a semi-diurnal tide two nearly equal high and low tides each day. Other locations experience a diurnal tide only one high and low tide each day. A "mixed tide" two uneven tides a day, or one high and one low is also possible. Tides vary on timescales ranging from hours to years due to a number of factors. To make accurate records, tide gauges at fixed stations measure water level over time. Gauges ignore variations caused by waves with periods shorter than minutes. These data are compared to the reference (or datum) level usually called mean sea level. While tides are usually the largest source of short-term sea-level fluctuations, sea levels are also subject to forces such as wind and barometric pressure changes, resulting in storm surges, especially in shallow seas and near coasts. Tidal phenomena are not limited to the oceans, but can occur in other systems whenever a gravitational field that varies in time and space is present. For example, the solid part of the Earth is affected by tides, though this is not as easily seen as the water tidal movements.

Geothermal Heat: The term Geothermal originates from two Greek words 'GEO' and 'THERM'. The Greek word 'geo' means the earth while the word 'therm' means heat from the earth. Geothermal energy is an energy derived from the heat of the earth. The earth's center is a distance of approximately 4000 miles and is so hot that it is molten. Temperature are understood to be at least 5000 degrees centigrade. Heat from the center of the earth conducts outwards and heats up the outer layer of rock called mantle. When this type of rock melts and becomes molten it is called magma. Magma can reach just below the earth's surface. Rain water sometimes seeps down through geological fault lines and cracks becoming super-heated by the hot rocks below. Some of this super-heated water rises back to the surface of the earth where it emerges as hot springs or even geysers. Sometimes the hot water becomes trapped below the surface as a geothermal reservoir.

4. TYPES OF RENEWABLE ENERGY

There are five types of renewable energy: Solar energy; Wind energy; Geothermal energy; Tidal energy; Biomass.

Solar Energy: Solar energy is the energy produced by sun through the process of thermonuclear fusion. The process converts about 650 Mega tons of hydrogen to helium per second. The process creates heat and electromagnetic radiations (radiation is the process of heat transfer from source to the target directly). (Thongpron J. et al, 2006), The heat remains in sun and is instrumental in maintaining the thermonuclear reaction. The electromagnetic radiation stream's out in all directions and some energy is lost by Scattering Absorption Cloud cover Reflection Climate The solar energy irradiation at the site is a major factor in selection of the implementation of the project. The solar cells which are also called photovoltaic (PV) cells are p-n junction diodes with large areas and the junction positioned close to the top surface.

The cell converts sun light into direct current electricity. It is an important source of renewable energy and its technologies are broadly characterized as either passive solar or active solar depending on how they capture and distribute solar energy or convert it into solar power. Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air.

Photovoltaic System: The Solar-generated electricity is called Photovoltaic. (Olajide and Oni, 2009), Photovoltaic is a solar cell that convert sunlight to D.C electricity. These solar cells in PV module are made from semiconductor materials. When light energy strikes the cell, electrons are emitted. The electrical conductor attached to the positive and negative scales of the material allow the electrons to be captured in the form of a D.C current. The generated electricity can be used to power a load or can be stored in a battery. There are two ways of connecting photovoltaic power system and they are the grid-connection photovoltaic power system and standalone photovoltaic power system.

- **Grid – Connection Photovoltaic Power System:** A grid connected photovoltaic power system is an electricity generating solar PV system that is connected to the utility grid. A grid connected photovoltaic system consist of solar panels, one or several inverters, a power conditioning unit and a grid connection equipment. They range from small residential and commercial rooftop systems to large utility scale solar power stations. A grid connected system rarely includes an integrated battery solution, as they are still very expensive. When conditions are right, the grid connected photovoltaic system supplies the excess power beyond consumption by the connected load to the utility grid (Elhodelby, 2011). A grid connect system is one that works in with the local utility grid so that when your solar panels produce more solar energy than your house is using the surplus power is fed into the grid. With grid connect solar power system, when your house requires more power than what your solar power is producing then the balance of the electricity is supplied by the utility grid. For example, if the electrical load in your house is consuming 20amps of power and your solar power is only generating 12amps then you would be drawing 8amps from the grid because with a grid connect system you do not store power you generate during the day. (Solar reviews, 2012)
- **Standalone Photovoltaic Power System:** A standalone power system is an off the grid electrical system for locations that are not fitted with electricity distribution system. (Wikipedia, 2016) It includes one or more methods of electricity generation, energy storage and regulations. With standalone solar system the solar panels are not connected to a grid but instead are used to charge a bank of batteries. These batteries store the power produced by the solar panels and then your electrical loads draw their electricity from these batteries. Standalone solar power systems have been used for a long time in areas where no public grid is available

Wind Energy: Wind energy is an energy extracted from the wind, passing through a machine known as the windmill. Electrical energy can be generated from the wind energy. This is done by using the energy from wind to run a windmill, which in turn drives a generator to produce electricity. The windmill in this case is usually called a wind turbine. (Iheonu E.E., et al 2002) This turbine transforms the kinetic energy in the wind into mechanical energy, in which a generator converts it to electrical power. Wind energy has become the least expensive renewable energy technology in existence. The greatest advantages of electricity generation from wind are that, it is renewable, eco-friendly and needs less maintenance. Wind is available in abundance, possibly everywhere in the world and it will not get depleted with use. The power in the wind is directly proportional to the area of the wind turbine swept by the wind and also to the cube of the velocity of the wind.

Wind Turbine

A wind turbine is a machine for converting the kinetic energy in wind into mechanical energy. (Charters W.W.S. 1985) Wind turbines can be separated into two basic types based on the axis about which the turbine rotates. Turbines that rotate around a horizontal axis are more common. Vertical-axis turbines are less frequently used. Wind turbines can also be classified by the location in which they are used as Onshore, Offshore, and aerial wind turbines. Wind turbines, like aircraft propeller blades, turn in the moving air and power an electric generator that supplies an electric current. Simply stated, a wind turbine is the opposite of a fan. Instead of using electricity to make wind, like a fan, wind turbines use wind to make electricity. The wind turns the blades, which spin a shaft, which connects to a generator and generates electricity.

Types of Wind Turbine Design

- **Horizontal Axis Turbine (HAWT):-** Horizontal-axis wind turbines get their name from the fact that their axis of rotation is horizontal. They have the main rotor shaft and electrical generator at the top of a tower, and are pointed into the wind. The variability of wind distribution and speed brings up the requirement of a gear system connected to the rotor and the generator. The gear system enables a constant speed of rotation to the generator thus enabling constant frequency generation. Turbine blades are made in order to prevent the blades from being pushed into the tower by high winds.
- **Vertical-axis wind turbines (VAWT**): VAWT have the main rotor shaft arranged vertically as the plane of rotation is vertical. Blades are also vertical in this arrangement. The biggest advantage of VAWTs is they don't require a raw control mechanism to be pointed into the wind. Thus these are useful at sites where wind direction is random or at places where there is presence of large obstacles like trees, houses etc. Also VAWTs don't require a tower structure and can be placed nearby a ground enabling access to electrical components. Some drawbacks are the low efficiency of wind production and the fact that large drag is created for rotating the blades in a vertical axis.

Geothermal Energy: Geothermal energy is the heat from the Earth, it's clean and sustainable. (Renewable Energy World, 2012) Resources of geothermal energy range from the shallow ground to hot water and hot rock found a few miles beneath the Earth's surface, and down even deeper to the extremely high temperatures of molten rock called magma. Almost everywhere, the shallow ground or upper 10 feet of the Earth's surface maintains a nearly constant temperature between 50° and 60°F (10° and 16°C). Geothermal heat pumps can tap into this resource to heat and cool buildings. A geothermal heat pump system consists of a heat pump, an air delivery system (ductwork), and a heat exchanger-a system of pipes buried in the shallow ground near the building. In the winter, the heat pump removes heat from the heat exchanger and pumps it into the indoor air delivery system. In the summer, the process is reversed, and the heat pump moves heat from the indoor air into the heat exchanger. The heat removed from the indoor air during the summer can also be used to provide a free source of hot water.

Tidal Energy: This is the movement of the water at the coastal front in kinetic energy that can be converted into electrical energy. (Renewable Energy World, 2012). The energy spread out along the thousands of km of coasts, in favorable location, the energy density can average 65 MW/mile of coastline an amount which can lead to economical wave generated Electricity. The cheapest method to draw tidal power is that the oscillating water columns use the force of waves entering a fixed device to generate Electricity. The waves entering the anchored compress air in a vertical pipe. This compressed air can be used to simply derive a turbine generator producing Electricity. The main problem of wave power plants is cyclone and severe storms.

Biomass: Biomass is the most important source for energy productions supplied by agriculture. (N. Khaleefah and S. Jabir, 2012) Biomass energy refers to fuels made from plants and animal wastes. The Biomass resource is, organic matter in which the energy of sunlight is stored in chemical bonds. When the bonds between carbon, hydrogen and oxygen molecules are broken by digestion, combustion (or) decomposition these substances release stored energy. Biomass energy is generated when organic matter is converted to energy. In alcohol fermentation, the starch in organic matter is converted to sugar by heating. This sugar is then fermented and finally ethanol is produced and then blended with another fuel. An aerobic digestion converts biomass, especially waste product such as municipal solid waste and market waste. In this process, the facultative bacteria breakdown the organic material in the absence of oxygen and produce methane and carbon dioxide. Bioconversion is a non-polluting, environmentally feasible and cost effective process. The effluent and digester residues are rich in nitrogen and phosphorus, which can be recycled back to the soil as a fertilizer.

By using this method, we can derive 70% of the energy. The biomass is mixed with water and stored in an airtight tank. The organic wastes (Municipal Solid Waste) are collected separately and dried natural method and shredded to the maximum particle size of 2 – 4 mm. This will be stored in a plastic container at room temperature and will be characterized and used during all anaerobic digestion treatment. Domestic sewage can be collected before disposal and used in all anaerobic digestion experiment for diluting the feedstock to achieve the required total solids concentration for the present investigation.

5. RENEWABLE ENERGY SOURCES APPLICATION IN COMPUTER LABORATORY

The Aleutia computer classroom system shown in Fig 1 is one of the area of application of renewable energy source in educational system (Jeremy Weate n.d).

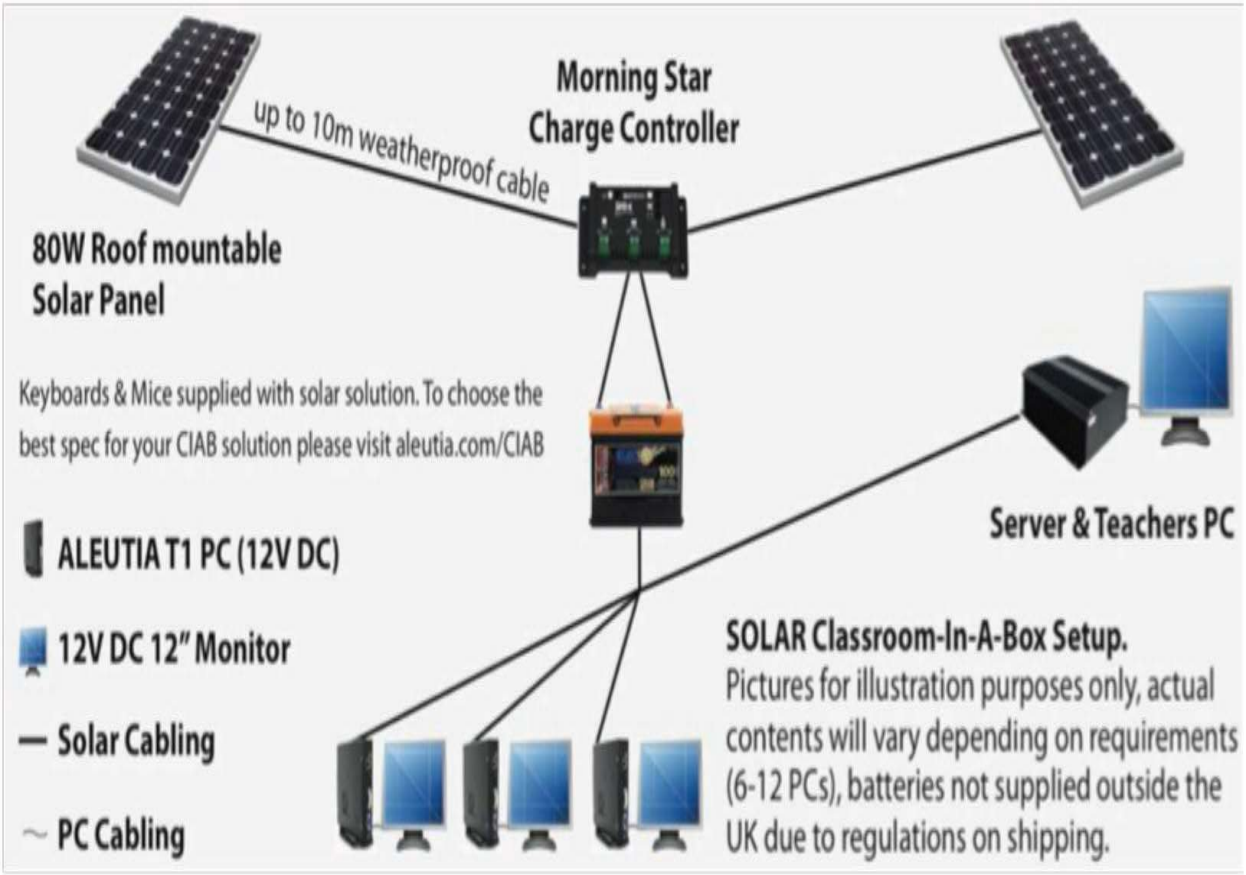

Fig. 1: Aleutia computer classroom system

6. CONCLUSSION

We have given critical description of renewable energy, it benefits, limitation, and types of renewable energy source. The review and survey of the renewable energy source shows that Nigeria has potential of taping from renewable energy source for purpose of diversify economy especially in educational system. Renewables energy can be used electricity supply in computer laboratories of institutions of learning at cheaper rate. There is a wide range of renewable energy technologies suitable for implementation in developing countries like Nigeria for a whole variety of different applications. Renewable energy can contribute to grid-connected generation but also has a large scope for off-grid applications and can be very suitable for remote and rural applications in developing countries.

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