Electrical Power System with Environmental sustainability

Electricity Generation, Transmission, Distribution and Utilization With Environmental Sustainability and affordability

By Sammy Chalefac Njukang

Abstract

With A Critical Analysis and research on the Said subject, observation have pulled my attention, that Many have concentrated on the root causes, Some focus more on the consequences and others on the Solution. Generating, transmitting, distributing and utilizing Electricity with Environmental Sustainability and Affordability will tackle the three facets {the problem, the cause and the Solution}.

Looking at the current state of the world globally, Electricity Generation in a greater measure is produced from fusil fuels sources, irrespective of its increase of carbon emission to our atmospheres. Whereas there are abundant natural sources which electricity can be harnessed? It seems to me that attention need to draw now to Governmental Authority, Generating companies, Scientific/engineering communities and to the entire human race on the suffice of the earth about the impacts of such electrical generating sources to Environmental sustainability and affordability.

The contamination of Carbon dioxide in the atmosphere in the past was 250ppm and presently it is estimated at about 411.97 ppm. As per the “US Energy Information Administration” {EIA}, 2008 release; it will reach 450ppm by 2030. The spurt in the growth of Co2 is attributed to growing of fossil fuels –coal, oils and gas. The major consumers of these fossil fuels are electricity and automobiles. Electricity generation top the list.

In this project I will be critically analyze how generating electricity from fusil-fuel had been destructive to our environment and how generating, transmitting and utilizing clean-green renewable electrical energies, smart Grid, promoting IEEE Smart village goals and UNESCO development sustainability Vision number “Seven” can help reduce the effect of Global Warming and improve electricity generation, transmission, distribution and utilization with environmental sustainability, cheap and affordable energy.

Acknowledgement

All thanks to the almighty God {Father, son and Holy Spirit}, Creator of the Heaven and Earth for the reveletional insight and inspirations from the start to the end of this project, I will forever be grateful to you.

It will be impartial for me to underestimate the sacrificial works of my wife and Son {Mrs. Ayimfuet Emelda and Njukang Samuel John}, I am grateful for the many things you let go in this Season to see me concentrate in this destiny changing investment, I pray God continue to shower blessings upon you

And to the Special Vessels that God used to bring to the Earth Realms, my Father and Mother.

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You are family with a difference.

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My Educational Adviser and counselor, Doctor Dr. Edward Lambert, my Academic/ Educational tutor Mrs. Sandra Redriquez, Only God can reward you for your undying Sacrifices for us students around the Globe.

It is a great pleasure and honor to have Spiritual leadership over us, who spent their time praying, counseling and giving us moral and Spiritual teachings. Many thanks to

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I am grateful to the institute of Engineering and technology IET- {**IET Connect**} for their support; I will make the world know that impacts of Engineering to our Communities and World as you desire.

The institute of Electrical and Electronics Engineers IEEE and Royal Academy of Engineering, thanks for making available Engineering resources and Engineering Ethics. Your Standardization for Engineering is unforgettable.

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General Introduction:

The earth is seasonal planet blessed with night and day. Illumination is naturally produced by the Sun for daily activities, whereas in the Moon produces light for the night which is lesser and cannot help illuminating our household. Needing more ways in which residential, commercial and industrial activities can be powered, earthly resources are harnessed to generate electricity. Unfortunately as a result of doing this; some responsibilities are added to our planet {Earth} which could be of a negative or positive impact to our Environs'.

Electricity plays a vital Role in our Communities, Nations and World; despite its importance to humanity and its industries; Generating, transmitting, distributing and utilizing electricity can be of negative impact to our Environment and its client; although they're better ways of Generating green, Environmental friendly electricity at low cost.

The contamination of Carbon dioxide in the atmosphere was 250 ppm. Presently it is estimated at about 411.97 ppm and as per the "US Energy Information Administration" {EIA}, 2008 release; it will reach 450ppm by 2030. The spurt in the growth of Co2 is attributed to growing of fossil fuels –coal, oils and gas. The major consumers of these fossil fuels are electricity and automobiles. Electricity generation top the list.

Amongst the fossil fuels, coal since it is abundant, has been the top favorite of electricity generation because liquid fuels have been under watch. Gas has become a favorite because of higher thermal efficiencies obtained with it. Gas has relatively less harmful emissions; however, unlike coal, oils and gases have volatile prices. They have been a geometric progression in Greenhouse effect {Gases trapped in the atmosphere} as a result Global warming cause by pollutant from Carbon dioxide emission; consequently leading to climate change. New generating methodologies need to be discovered to combat this global challenge.

Description:

When electricity is generated, it needs to be transported for utilization. In-between the generating plants and the utilization point are; the transmission and distribution. Generating of electricity involve the transformation of the natural or unnatural source {such as wind, sun, heat, water, coal, gas} into electrical energy. For example; water can be used to generate hydro-electricity, by harnessing water and store into constructed Dams, and then use its pressure to rotate hydro-turbine connected to the Shaft of the generator to generate electrical current/voltage.

Definition of Useful terminologies:

Transmission: An electrical power transmission is a bulk movement of electrical energy from a generating site such as “power plant”, to an electrical substation. The interconnected line which facilitates this movement is known as transmission.

Figure 1

Sub-station

A Substation is a part of an electrical generation, transmission, and distribution system. Substations transform voltage from high to low, or the reverse. It is between the

Figure 2

Generating station and the consumer; electrical power may flow through several substations at different voltage levels. A substation includes transformers to change

voltage levels between high transmission voltage and low distribution voltages or at the interconnection of two different transmission voltages.

Distribution/ distribution networks

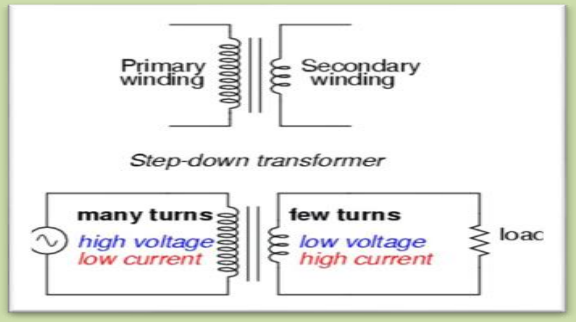
Electrical power distribution is the final stage in the delivery of electric power; it carriers electricity from the transmission system to the individual consumers. And distribution substations connect to the transmission system and lower the transmission voltage to medium voltage ranging between 2KV and 35K

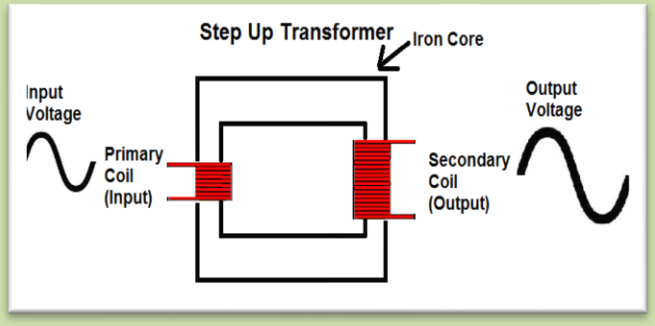
Figure 3

Transformers

A transformer is a static device that transfers electrical energy between two or more circuits. A varying current in one coil of the transformer produces a Varying magnetic flux, which in turn, induces varying Electromotive forces across a second coil wound around the same core. Electrical energy can be transferred between the two coils, without a metallic connection between the two circuits. . faraday's law of induction discovered in 1831 described the induced voltage effect in any coil due to changing magnetic flux encircled the coil. Transformers are used for increasing or decreasing the

Figure 4



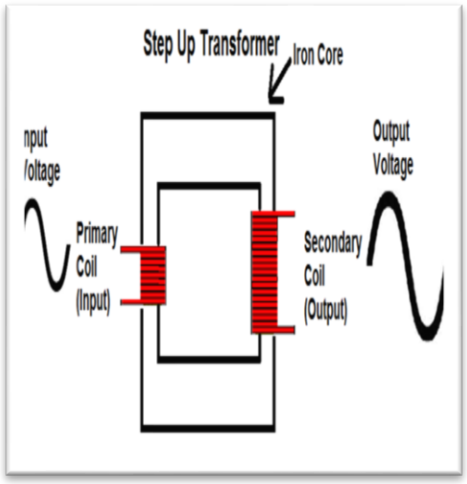


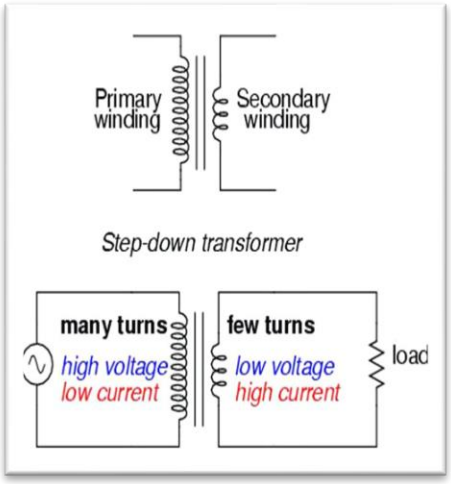
voltage or current of an electrical circuit. There are very important in the transformation of generated electrical energy.

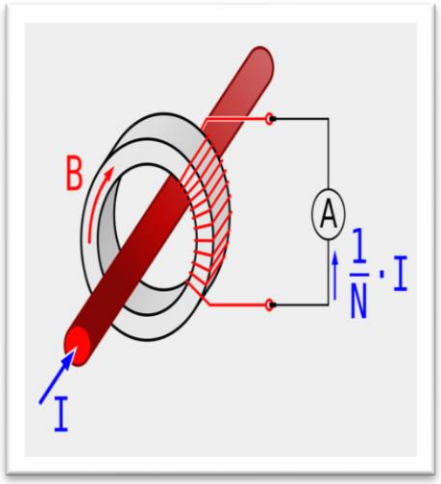
Types of transformers:

Figure 5

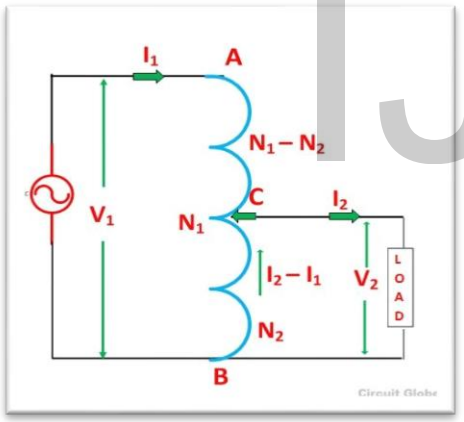
A B C

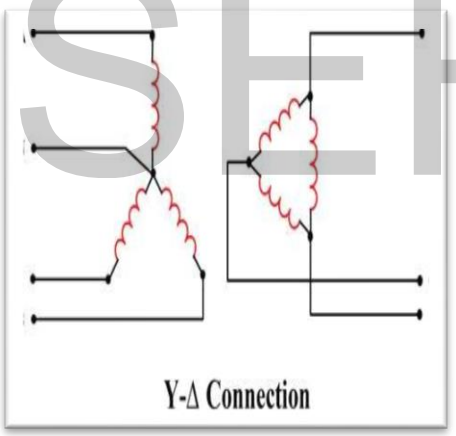


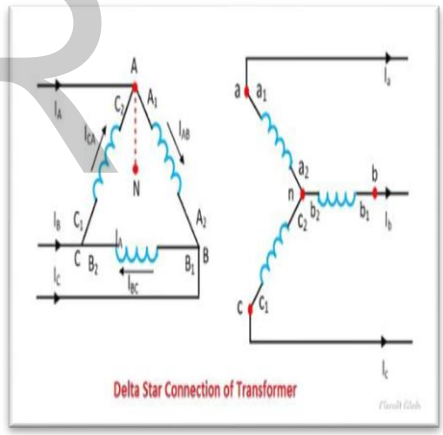




C







D

The difference between distribution lines and utilization lines are;

Basics	Transmission lines	Distribution lines
	Transmission line helps in the movement of electricity from power line to substations.	The distribution line carries electricity from the substation to the to the consumers' end.
Phase	It carried out electricity in three phase supply system.	It requires a single phase supply system for carrying electricity.
Voltage level	Carries electricity at a very high voltage of about 11000 volts.	Caries electricity at a very low and safe level of about 220 v.
Current conductor level	They conduct current at 69 kV or more.	The conduct less than 69 kV.
Thinness	Transmission lines are thick lines.	Distribution lines are thin as compared to transmission line.
Passage	Transmission is usually underground for urban areas and overhead for rural areas.	Most of the distributions line is overhead, except in must urban develop countries.

Figure 6

Demand for Electrical Energy:

The increasing demand and usage of electrical energy are changing and increasing drastically on daily basis around the globe. Duel to this increase in the demand for client's needs, innovation, creative technology went into research and discoveries of new electricity generating methodologies to enhance the satisfactory of these needs from residential, commercial, industrial consumption.

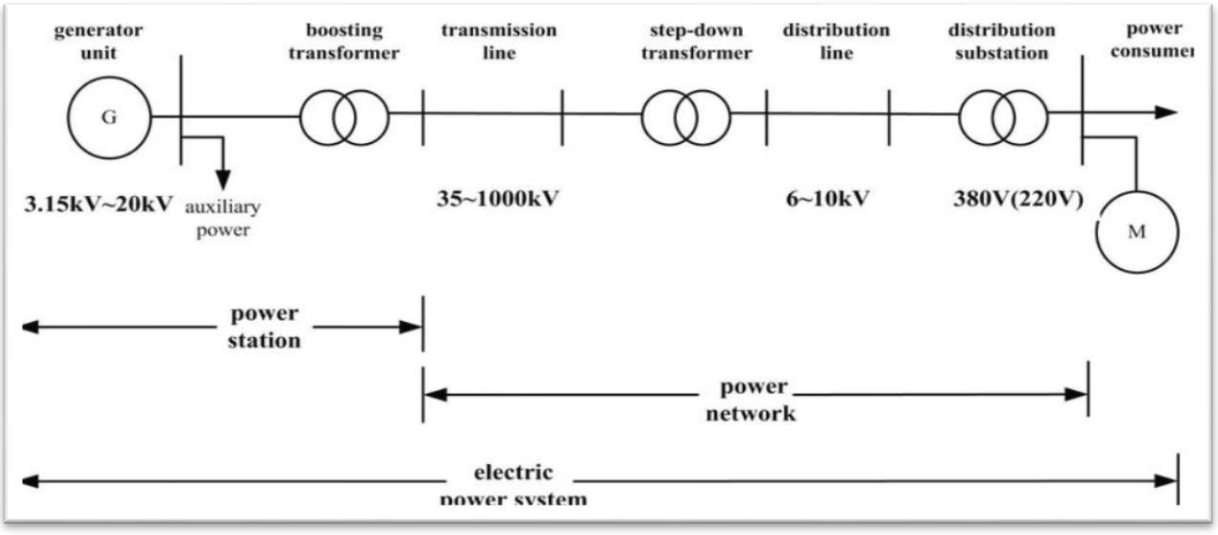


Figure: 7 Line diagram of electrical power system

Transmission starts from the output already generated stepped-upped electrical current/voltage. The step up transformers increases the generated current and the transmission power line {overheats or underground} connect it from the output of transformer to the substation. Then it is transmitted to sub-transmission and step down via step down transformers in the distribution substation to supply the primary distribution for utilization systems {residential and commercial customers}.

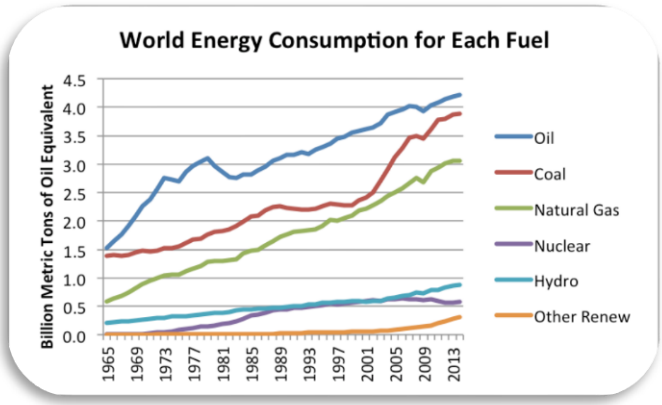
Figure: 8 generating, transmitting, distributing and utilization of electricity

The increasing demand and usage of electrical energy are changing and increasing drastically on daily basis around the globe. Duel to this increase in the demand for client's needs, innovation, creative technology went into research and discoveries of new electricity generating methodologies to enhance the satisfactory of these needs from residential, commercial, industrial consumption.

The increase Demand of Electrical energy

On the attempt to meet up with this demand, more Electrical generating methodologies were instituted; unfortunately in 1965 {after the second world war 2, WW2}, the industrial revolution brought about new technological discoveries which influence generating electrical energy. Most of these generating techniques were focus on harnessing electricity from natural available resources such as Gas, oil, coal and water {EIA} and most of these systematic conversion of gas, oil and coal into electricity involve the discharge of high level pollutant {Co2, N02} into the atmosphere. As a result

of this, the current state of the World have reached the worse peak of Climate change and global Warming, with a lot Gases trapped in the atmosphere and with drastic depletion of the Ozone-layer. If care is not taking now the next generation will be force to face the consequences.



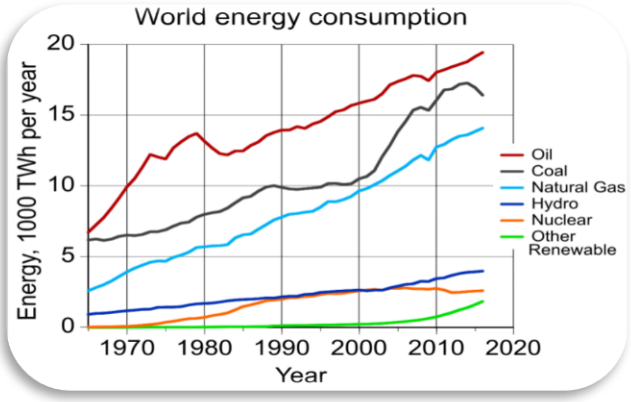


Figure 9
theenergycollective.com

Justification----Thesis Question:

The question is, how can we generate, transmit, distribute, and utilize, Green-clean and Environmental friendly Electricity at low cost?; Knowing that we might not be able to completely eliminate the negative impact already created by other sources such Automobiles, landfill, incineration, waste burning and to name but a few, but we can help reduce the effect. In this project there is an answer;

Objectives:

- Protect Global environmental sustainability.
- Promote clean-green electrical generating energy sources.
- Introduced the smart grid, renewable and system integration to our world.
- Reduce global carbon emission.
- Educating the Global community about the current climatic state of the world.
- Work in line with UNESCO and UN 2030 vision Goal number 7{
  Ensure global universal access to affordable, reliable, sustainable and modern energy for all}.
- Double the global rate of increasing electrical energy efficiency.
- Promote global utilization of renewable energy, Smart Grid and system integration according EIA, IEEE, IET, and Royal academy of engineering.

Action Plan

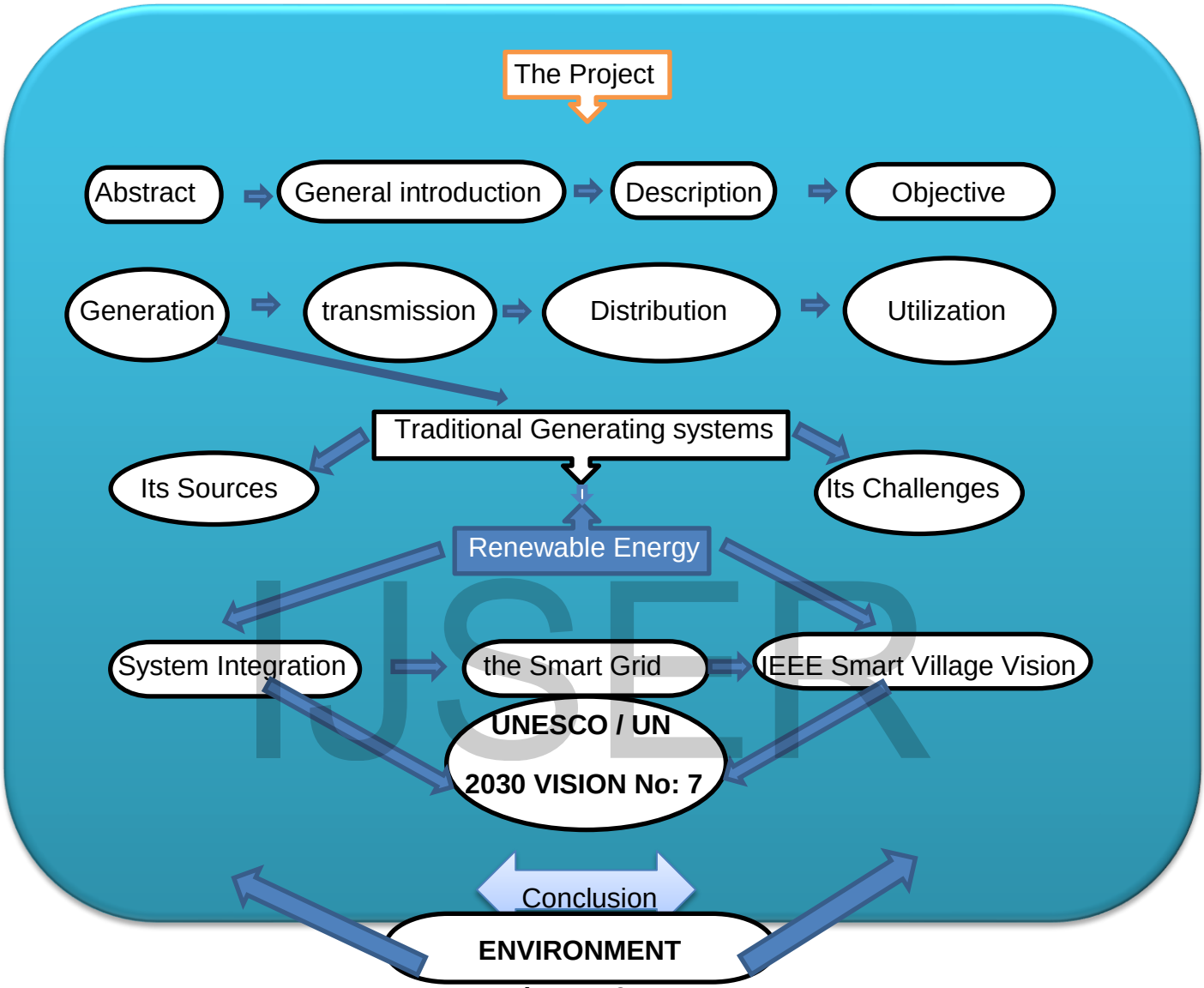


Figure 10

Types of renewable energy:

What is renewable Energy?

Renewable energies implies derived from a source which is automatically replenished or one that is effectively infinites so that it is not depleted because, although the fields may last for generations, their time span is finite and will eventually run out. Coal, gas and oil are not renewable because, although the fields may last for generations. Renewable energies are energy which have less damaging impact to our environment and include the following Solar energy, Wind power, Hydroelectricity, Tidal power, geothermal energy,

5.1.1 Wind power

Winds are due to the fact that the earth's equatorial regions receive more solar radiation than the Polar Regions setting up large-scale convections currents in atmosphere. According to estimations from meteorologists, about 1% of the daily wind energy input is nearly equivalent to the present world daily consumption. This means that global wind resources are very large, but widely distributed.

Wind energy is another alternative source of energy that can be used without producing by-products that are harmful to nature. The fins of the windmill rotate in a vertical plane which is kept vertical to the wind by means of a tail fin and as wind flow crosses the blades of the windmill it is forced to rotate and can be used to generate

Figure 11

electricity. Unlike Solar power harnessing the Wind is highly dependent upon weather and location. The average wind velocity of Earth is around 9m/s, and the power that could be produced when a windmill is facing a wind of 10 mph {that is about 4.5 ms} is about 50 watts. {Electrical and Electronic Principles and Technology page 38,40 by John Bird}

Solar energy:

Solar energy is one of the most resourceful sources of energy for the now and the

Figure12

future. The reason for this is that the total energy received each year from the Sun is around 35000 times the total energy used by man. However, about one-third of this energy is either absorbed by the outer atmosphere or reflected back into space. Solar energy could be used to run cars, power plans and space ships. **Solar panels** on roofs to capture heat in water storage systems. **Photovoltaic cells,** when suitably positioned covert sunlight to electricity.

Hydroelectricity:

Hydroelectricity is achieved by the damming if rivers. As the water stored behind a dam is released at high pressure, its kinetic energy is transferred onto turbines blades

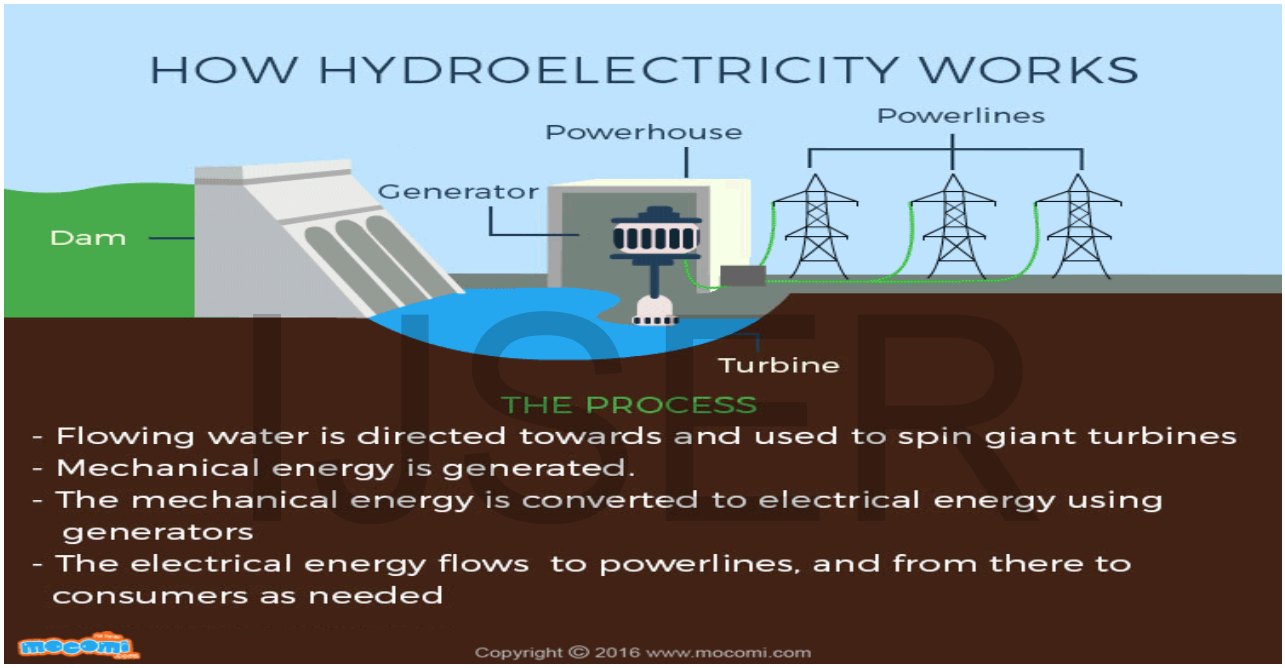


Figure: 13

and used to generate electricity. The generation system has enormous cost and provides power quite cheaply. Hydropower is one of the most cost effective and reliable energy technologies to be considered for providing clean electricity generation. In particular, the key advantages that hydro has over wind, wave and solar power are; High efficiency {70-90%} by far the best of all energy technologies, high capacity factor {typically greater than 50%} compared with 10% for Solar and 30% for Wind A high level of predictability, varying with annual rainfall patterns slow rate of change; hydro output varies only gradually from day to day {not from minutes to minutes}. It is good correction with demand that is output is maximum in winter. It is a long-lasting and robust technology; system can readily be engineered to last for 50 years or more. It is also environmentally benign and favours environmental sustainability.

Tidal power:

Its utilizes the naturalmotion of tides to fill reservoirs which are then slowly discharged through electricity-producing turbines. Tidal power or energy is the form of hydropower that convert the energy obtained from tidal into useful forms of power, mainly electricit. Although not widely used, tidal energy has potential for future electricity generation. Tides are more predictable than the Wind and Sun Sources.

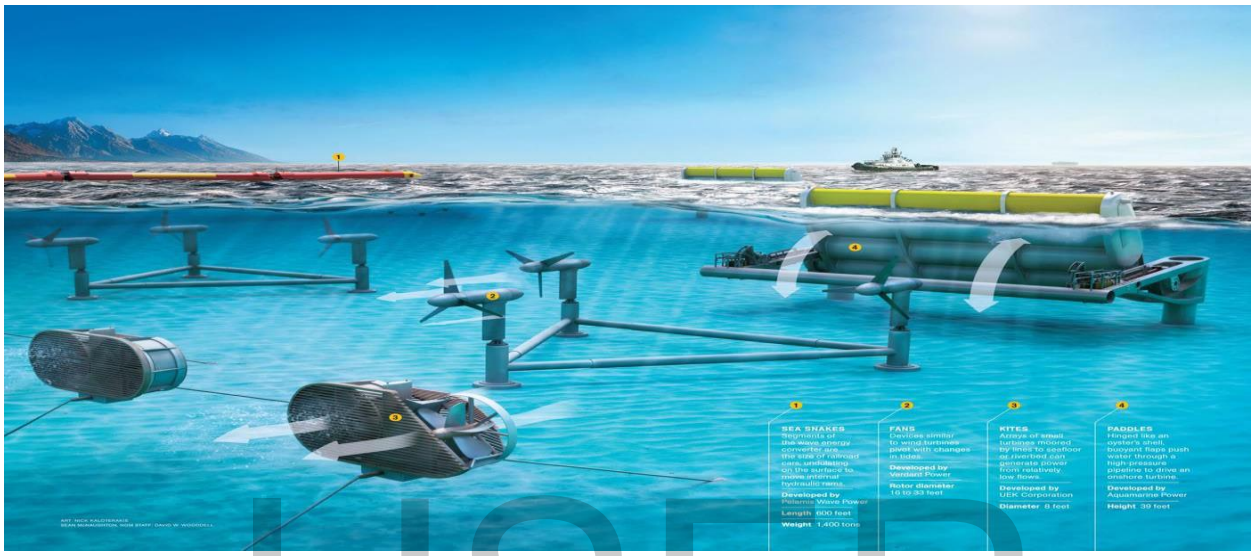


Figure: 14

Geothermal energy:

Geothermal energy is obtained from the internal heat of the planet and can be used to generate steam to run a team turbine which, in turn, generates electricity. The radius of the Earth is about 4000 miles with internal core temperature of around 40°C at the Centre. Drilling three miles from the surface of the Earth, a temperature of 100°C is encountered; this is sufficient to boil water to run a steam-power electric power plant. Although drilling three miles down is possible, it is not easy. Fortunately, however, volcanic features called **geothermal hotpots** are found all around the world. These are which transmit excess internal heat from interior of the outer crust, which can be used to generate electricity.

Figure: 15

General Analysis

Generating electricity had increased geometrically since the industrial revolution, as the need for residential, commercial, and industrial usage arises; the demand needed was lagging behind the supply. As a result this, more generating source are being discovered on daily basis.

The world is facing great environmental challenge cause by electrical generation that releases harmful pollutants to our atmosphere. I will be strategically analyzing three countries; United states, Qatar, Cameroon and the Globe, how theirs electricity is generated, with its impact to environmental sustainability. United States electricity generation being one amongst the world largest electricity generating countries, Qatar being my country of residents-developing nation{Emerging} and Cameroon being my country of birth- an underdeveloped country.

Acceding the UNESCO/UN vision 7, {ensuring global universal access to affordable reliable, sustainable Modern energy for all}. This vision aimed at doubling the global rate of increasing electrical energy efficiency in a green-clean and environmental friendly way. Most of the countries around the globe are adopting this vision for 2030 in harnessing theirs electrical energy.

United States Electrical Energy:

The United States Census Bureau estimated the country's population to be 327,167,434 as of July first, 2018. It's have fifty states with her capital city being Washington D.C. According the **United States** energy information administration {eia}, United States electricity is produced from diverse energy sources and technologies. These sources have change over time and some are used more than others. The three major categories of sources for electrical generation in US are; fossil fuels {Coal, natural gas and petroleum}, Nuclear energy and renewable sources.

Most of this electricity is generated with steam turbines using fossil fuels, nuclear, biomass, geothermal and solar thermal energy. Other major electricity generation technologies are; gas turbine, Hydro turbines, wind turbines and solar photovoltaic.

Steam turbine

nuclear power plant

geothermal power plant

Solar thermal energy

gas turbine

Hydro turbine

Figure 16

United States Electricity Generation statistics

Meanwhile fossil fuels sources remain the largest source of energy for US electricity generation. Natural gas was the largest source of about 32% of US electricity in 2017 and coal was the second largest energy source of US electricity generation in 2017 with about 30% of US electricity generation. Petroleum was less than 1% of US electricity generating in 2017, meanwhile nuclear was one-fifth of United States electricity

generation in 2017. Renewable Energy sources provide nearly 20% of US electricity Generation in 2017, and hydro sources were about 7% of US electricity generation,

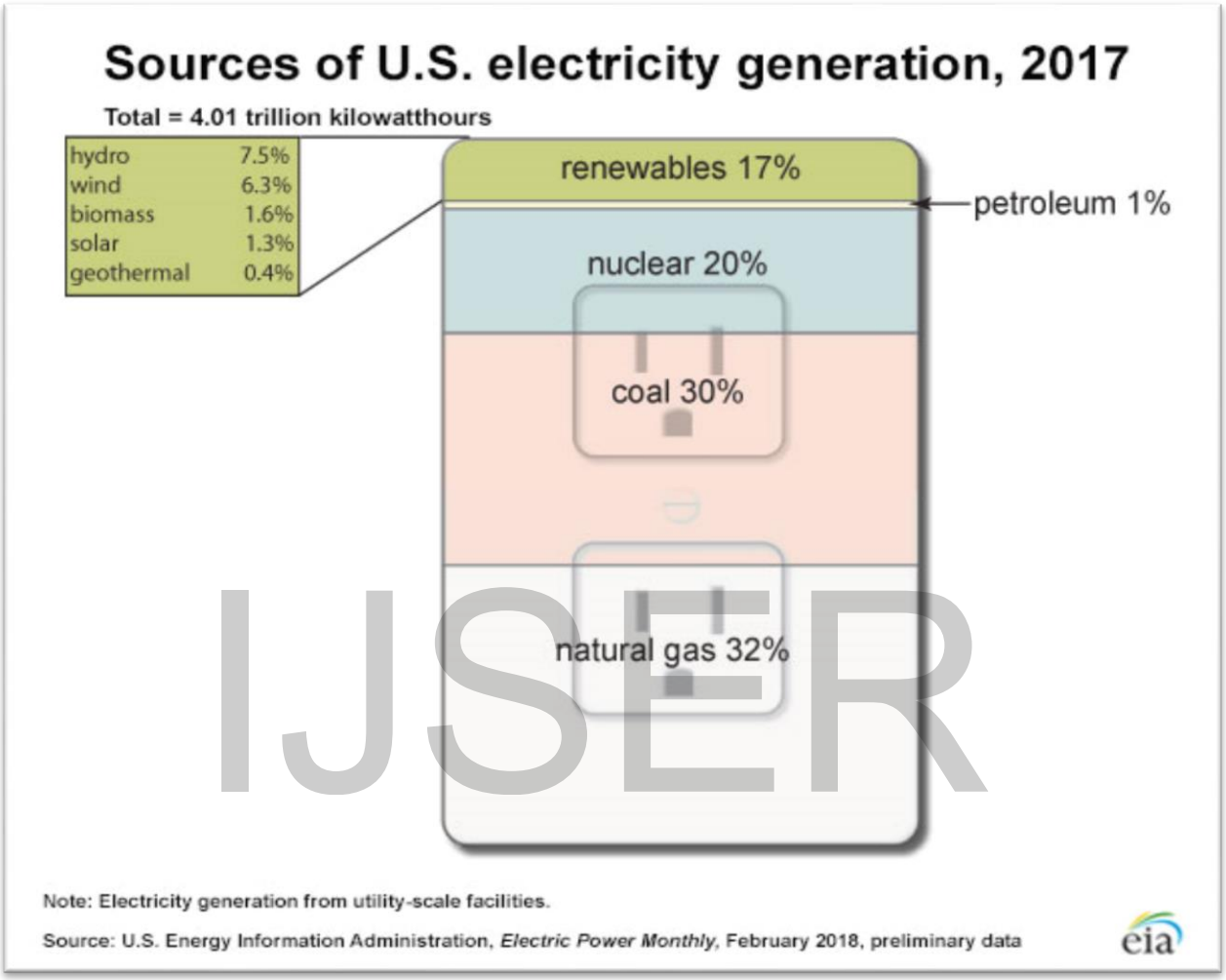


Figure 17

which 44% it's renewable is source by hydro energy sources. Wind energy was about 6% of US total electricity generation and constituted about 37% of its renewable in 2017.

Biomass energy source were 2% of US total electricity generation in 2017, solar energy produces about 1% of US total energy in 2017 and Geothermal power plan produced less than 1% of US total energy. From the above analysis fossil fuels energy sources are dominant and clean renewable energy sources are lagging behind. This is already an indication of a risk to our environment.

Qatar Electrical Energy:

Qatar is located latitude and longitude of {25.2854°**N,** 51.5310°**E**} respectively. It has an Area of about 2.4 million with temperature raging from {12°c to 41.5°c} during coldest and hottest season. Qatar is one of the fast developing countries rated as {first}

Figure 18

of the highest GDP country in the world in 2018, because of its blessed nature of natural gas, petroleum and oil resources. Because of the availability of these oil and natural gas Sources in Qatar, almost about 100% of Qatar electricity generation for past years depends on fossil fuels products.

The total fossil fuels sources electricity generated in Qatar in 2016 was 39.77 billion kilowatt-hours {Bkh} leading to over 63.54% emission of Co2 produced from electricity generation. It was for this reason that the Qatar national strategy in 2011-2014 toward Qatar national vision 2030 for sustainability development under the guidance of the beloved Emir of Qatar "Sheckh Hamad Bin Khalifa Al-Thani, the Kings of Qatar" and Tamim Bin Hamad Al Thani- Heir apparent and head of supreme oversight committee for implementing Qatar national vision 2030, invision renewable energy sources to present opportunity for Qatar to enhance it future energy mix, conserve gas and reduce Carbon emission once this technology become cost effective.

He futherly expantiated that the greatest potential lies Solar energy, but other technologies may play a depending on still-evolving technological and economic paramaters. Seeing the position of Qatar above, it very clear that it is highly expose to heat of higher concentration intensity and it could be of greater advantage for her electical generation if she truely they want to acherve the following 2030 set goals:

- ✓ Improve thermal efficiency in the power production.
- ✓ Advance the adoption of energy-saving technologies.
- ✓ Keep Qatar's green building code implantation on track.
- ✓ Establish a nation-level committee on renewable energy

Cameroon Electrical Energy:

Cameroon is a Sub-Saharan country covering a total surface Area of about 475440km^2. It is located at latitude 600000 N and longitude 1200000 E with part in the central and western Africa. It is population was estimated to be 24.5 million people in 2017 and there are ten regions in Cameroon with Yaoundé being the capital city and Douala being it economical city.

Out of over 14000 localities in Cameroon about 300 are electrified, resulting in a national electrification rate of 22% while the rate of rural electrification is about 3.5 %. Cameroon is one of African state {country} with many natural resources and her waterfalls are located in almost all location in the country because of it mountainous features. Harnessing electricity for the past Years had been mainly from the hydro-source due to the availability of water falls and the position where dams are easily constructed for Hydro- turbines rotation via the water pressure. The water pressure in turn rotate the shift of the generator to generate electrical current/voltage, which is fourthly step up via the help of step-up transformers and transmitted for distributed and then utilized.

Even though hydro- power is term to be a renewable clean energy source it also

Figure 19: overheat and underground transmission

has some environmental degradation challenges; transmitting and distributing could have some impacts to our environment, since it is transported via underground {for Urban} and via overhead for rural centers. Electrical Power lines and other distributing infrastructure also have a footprint{US eia}. Electricity transmission lines and distribution infrastructure that carries electricity from plans to customers also have environmental effects. Most transmission is above the ground on large towers. The towers and power lines obstruct the visual landscape, especially when they pass through undeveloped

areas. Vegetation near power lines may be disturbed and may have to continually manage {cut down} to keep it away from the power lines. These activities can affect native plant populations and wildfire. Power lines can be placed underground, but it is a more expensive option and usually not done outside of urban area and also need to be

clearly allocated and indicated to avoiding accidental electrical hazards by unknown personals activities.

Although these are great potentialities {Energy Sources } available in Cameroon to exploit, yet about 70% are untapped and its electrical energy still suffers lower voltages, blackout, poor maintenance, poor transmission and distribution, thefts, financial losses, and result to higher billing on its clients. Even though the present rate of electricity coverage in Cameroon is 55%, among these, those able to access energy, 88% live in urban areas. Only 17% of those living in rural areas have electricity in their households {us Aid 2015}, which is a clear indication of the decimation between rural and urban areas. The government alone cannot help handle this situation. The solution lines in utilizing the untapped Wind and Solar {renewable energy} available potencies.

Current information

The environment is the surrounding {Air, water, and land} in or on which humans, plans and Animals live in. according to scientific report, the earth fever got worse in 2015, making it the hottest on record ever. The current state of the is breaking records, include; measures for land and ocean temperatures, sea levels and greenhouse gases are rising {according to august 2019 report} from the national oceanic and atmospheric administration {NOAA}. I think the time to call the doctor was years ago ‘’NOAA Climate monitoring chief Deke Arndt reported.

Scientific and Engineering View

The heart of the records is the fact that all three major heat-trapping greenhouse gases are Carbon dioxide, methane, and nitrous oxide- hit records high in 2015 Blunden said

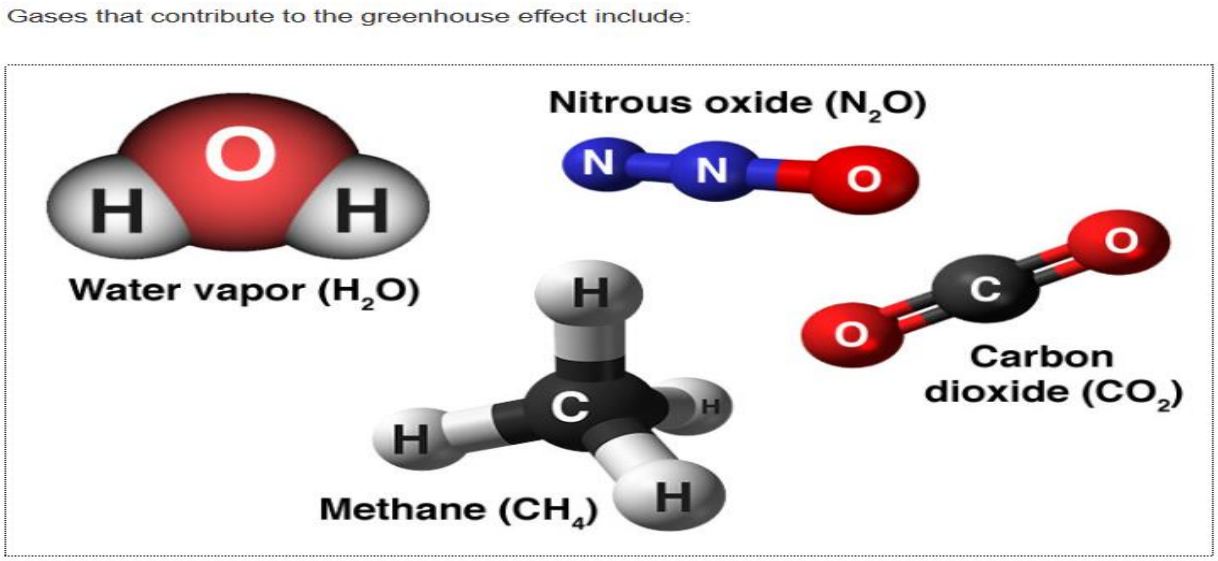


Figure 20

And according to Global climate change the current warming trend is of particular significance because most of it is extremely likely {greater than 95 percent probability}

to the result of human activities since the mid-20th century and proceeding at rate that **is** unprecedented over decades to millennia. The heat trapped nature of Carbon dioxide

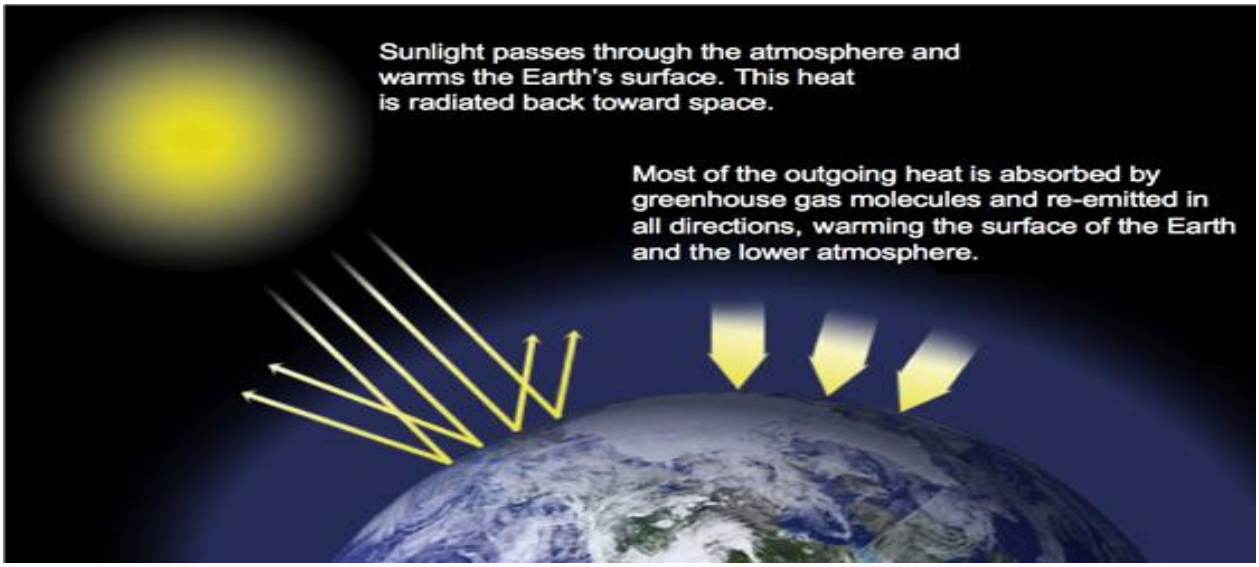


Figure 21

and other gases was demonstrated in the mid-19th century and there is no question that increased level of greenhouse must cause the earth to warm in response.

According to the world Meteorological organization {WMO}, the dramatic sweeping changes in the state of the world is alarming. June 2016 was the 14th month in the row of the record heat for lands and oceans. It is also marks the 35th consecutive month with temperature above 20th century average {David Carlso, Director of the Wmo's}. He also said World global warming is unpredicted and emission and greenhouse effect are increasing.

NASA a global climate change expert company says that there's a blanket around the earth. Most scientists agreed the main cause of the current global warming trend is

Human Expansion of the greenhouse effect-warming that result when the atmosphere traps heat radiating from earth towards space. Certain gages in the atmosphere block escaping long lived gases that remain semi – permanently in the atmosphere and do not respond physically or comically to changes in the temperature are described as forcing climate.

The role of human capacity

In the fifth assessment report of the intergovernmental panel on climate change, a group of 1300 independent scientist expert from countries all over the world under the auspice of the united nation concluded there's a more than 95 percent probability that human activities over the past 50 years have warmed our planet and if care is not taking now it will take increasing drastically. This human activity; electricity generation is at the top of the list.

Electricity plays a vital Role in our Communities, Nations and the World; despite its importance to humanity and its industries, Generating, transmitting, distributing and utilizing electricity can be of negative impact to our Environment and its client; although there are better ways of Generating green and Environmental friendly low cost Electricity. Replacing traditional sources that emit pollutant gases to our atmosphere with renewable energies source has become a global goal of 2030 by many nations like, united states, Qatar and others, incorporating UN/UNESCO Vision 7, IEEE Smart village vision, IET sustainability vision and Royal academy of engineering vision for sustainability and development.

The place of Renewable energy

Up until the mid-1800's, wood supplied was nearly all the nation's energy needs. As more consumers began using coal, petroleum, and natural gas, the United States relies less on wood as an energy source. Today, the use of renewable energy source is increasing especially bio-fuels, solar and wind. In 2018, about 17 percent of the total US energy consumption was from renewable energy sources according to US energy information administration {EIA}.

Figure- 22 Renewable energy

Renewable energy plays an important role in reducing greenhouse gas emission. When renewable energy sources are used; the demand for fossil fuels is reduced. Unlike fossil fuels, non-biomass renewable sources of energy such as hydro-power, geothermal, wind, and solar, do not directly emit greenhouse gases {1}. The consumption of bio-fuels and other non-hydroelectric Renewable energy sources were more than doubled during the last decade mainly because of state and federal government mandates and incentives for renewable energy.

Focusing on the Solar and Wind energy, there are green- clean energy that can be exploited. The Wind is caused by uneven heating of the earth's surface by the Sun. Because the Earth's surface is made up of different types of land and water, it absorbs the Sun's heat at different rates. Wind Energy is low cost renewable energy technology; it is available as a domestic source of energy in many countries worldwide and not redistricted to few countries as in the case of oil. It is energized by naturally flowing wind, thus, it is clean source of energy. It does not pollute the air and cause acid rain or

greenhouse gases. It can also be built on farms or ranches and hence can provide the economy in rural areas using only small fraction of land. Thus it still provides opportunity to the landowners to use their land.

Meanwhile the Solar Energy on the other hand is still a very small portion of energy today whereas the energy release by the sun to the earth surface is enormous {total energy received each year from the sun is around 35000 times the total energy used by man}. Furthermore, the Solar PV industry is growing very fast, sustaining an annual rate of more than 40% for the last decade. Because this fast growth, and decreasing costs and vast technical potential of solar energy is becoming an important alternative for future needs.

The Photovoltaic energy; when a photovoltaic PV cell is expose to the Sun's thermal radiation, it absorbs the thermal energy and covert it directly into DC electrical energy. The size of the cell and the DC voltage and energy and energy it can deliver are small. These plates together form a solar array. These arrays require sizable expose area and reasonable clear skies to exploiting solar energy and converting it into electrical form has been under intense development for a long time. Its advantages are; this energy is free. It consumes no fuel, meaning it releases no pollutants. It is easily and universally available, increase in solar radiation lead to increase in solar array output coincide with the increase in the load demand during the day.

The Smart Grid

Transforming from a centralized producer-controlled network to one that is less centralized and more consumer interactive, change of the industries entire business world and its relationship with all stakeholders, involving and affecting utilities

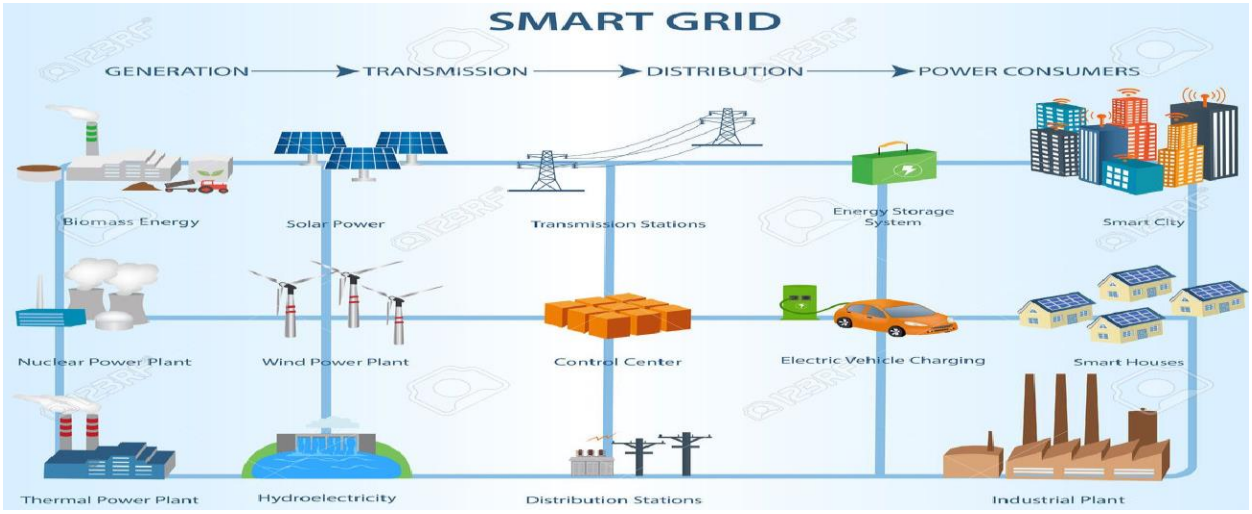


Figure -23 Smart Grid

Regulations, Energy service providers' technology and automation vendors and all consumers of electrical power. The Smart Grid makes this transformation possible by binging innovative philosophies to the utility and electrical grid. Technologies already in place are; advance metering infrastructure, visualization technology, Phasor measurement unit, distribution generation, peak demand, and smart grid versus meter.

Smart Grid Technology

What is the Smart Grid?

- The smart Grid as defined by the national Institute of Standards and Technology {NIST}, USA: is a modernized grid that enables bidirectional flow of energy and uses two way communication and control capabilities that will lead to an array of new functionalities and application.
- According to IEEE, the Smart grid is a large "system of systems", where each functional domain consists of three layers: {i} the energy layer, {ii} the communication layer, and {iii} the IT/Computer layer.
- Layer {ii} and {iii} above are enabling infrastructure that makes the existing power and energy infrastructure Smarter.

Characteristics of modern power System:

- ✓ Wide geographical spread {due to typical large distance between major load centres and conventional sources of energy}.
- ✓ Large numbers of interconnection {due to political, economic, environmental, reliability, and stability issues}.
- ✓ Rapid growth in the demand of electricity {due to increase in population, standard of living, and development}.
- ✓ High penetration of renewable energy sources {intermittency, relay coordination, power quality, system stability}
- ✓ Competitive electricity market {need real time monitoring and strict regulations}.

Smart Grid Transmission domains:

- ✓ Energy-efficient transmission network will carry the power from the bulk generation facilities to the power distribution systems.
- ✓ Communication interface exists between the transmission network and the bulk-generating station, system operator, power market, and the distribution system.
- ✓ The transmission network needs to be monitored in real- time and protected against any potential disturbance.
- ✓ The power flow and voltage on the lines need to be controlled in order to maintain stable and secure operation of the system.
- ✓ An important task of the system operator is to ensure optimal utilization of the transmission network, by minimizing the losses and voltage deviations, and maximizing the reliability of the Supply.

Smart Grid distribution Domains:

- ✓ Substations automation and distribution automation will be the key enablers for the smart distribution system.
- ✓ Increasing use of distributed energy resources {DERs} will be an important feature of future distribution systems.
- ✓ Distribution system operator typically controls the distribution system remotely. Communication infrastructure to exchange information between the substations and the central distribution management system {DMS} therefore should be in place.
- ✓ An important job of the distribution system operator is to control the DERs in a coordinated way to ensure stability and power quality of the distributed system.
- ✓ Information exchange between the distribution system operator and the Customers for better operation of the distribution system is new feature of the Smart distribution systems.

Smart Grid Customer domains:

- ✓ Customer can be classified into three main Categories: Residential, Commercial and industrial.
- ✓ In Smart grids, customers are going to play a very import role, through demand response. By peak-load shaving, valley-filling, and emergency response, customers are going to play an active role in better operation of the distribution system.
- ✓ Building or home automation system will monitor and control power consumption at the consumer premises in an intelligent way.
- ✓ Proper communication infrastructure will be required for the consumers to interact with the operation, distribution system and market.

Smart Grid operation domains:

- ✓ Smart grid operation require communication interface with the bulk generating facilities, transmission systems, substation automation, distribution automation, DMS, Consumers, and the market.
- ✓ Metering, recording, and controlling operations come under the purview if the smart operations.
- ✓ Real-time information exchange with the power market needs to be established in order to implement power trending and scheduling.
- ✓ The operation need to interact with various service providers for ensuring proper functioning of the smart grid.
- ✓ Information exchange with the consumers is the key for the operators to implement the so-called demand management system.

Smart Grid market Domains:

- ✓ Smart grid power market needs to develop, keeping in mind all the objective of the smart grid.
- ✓ The communication infrastructure integrating the bulk generation, transmission, distribution, utilization, market, and service providers is the key to success of the power market in a Smart Grid.
- ✓ Appropriate regulatory policies need to formulate for seamless integration of the various domains, including the storage and DER aggregator into the smart grid market.
- ✓ The pricing information has to made available online short intervals {hours or even minutes}.

Measurement and sensing Enablers:

- ✓ Sensing and measurement system is the backbone of a smart Grid.
- ✓ Smart meters and the associated advanced metering infrastructure {AMI} has to be in place to support monitoring, control, protection, and decision making functions.
- ✓ High-resolution real-time measurements will enable optimal usage of the available resources, avoid congestions, assist market operation, and make demand side management possible.
- ✓ Emerging technologies, such as synchrophosor technology is already being used in modern power systems.
- ✓ Phasor measurement unit {PMUs} can provide timesynchronized measurements from distant locations, and make possible the design of the wide area monitoring, protection and control {WAMPAC} system.

Smart Grid

A Smart grid can be defined as an upgraded electricity grid network enabling two-way information and power exchange between suppliers and consumers, due to the pervasive incorporation of intelligent communication monitoring and management systems. The U.S department of energy {DOE} define smart grid as a system that will incorporate digital technology to improve reliability, efficiency and security of the electric system. According to the international Energy Agency technology roadmap Smart Grid; a smart grid is an electricity network that uses digital and other advance technologies to monitor and manage the transportation of electricity from all generation sources to meet the varying demand of end users. The smart grid will organize various capabilities and needs of the grid operators, generations, end-user and electricity market stakeholders to operate all parts of the system reliability, resilience and stability. Beside the smart grid being able to match with demand.

Wide Area Monitoring and Control

Real-time monitoring and display of power system components and performance, across interconnections and over large geographic areas, help system operation to understand and optimize power system components, behavior and performance. Advance system operation tools avoid blackouts and facilitate the integration of variable renewable energy resources. Monitoring and control technologies along with advanced system analytics including wide area situation awareness {WASA}, wide area monitoring systems {WAMS}, and wide area adaptive protection, control and automation {WAAPCA} generate date to inform decision making, mitigate wide area disturbance, and improve transmission capacity and reliability.

Information Communication Technology Integration

Underlying communication infrastructure, whether using private utility communication networks {radio network, meter mesh networks} or public carriers and networks {internet, cellular, cable or telephone}, support data transmission for deferred and real-time operation, and during outages. Along with communication devices, significant computing, system control software and enterprise resource planning software support the two way exchange of information between stakeholders, and enable more efficient use and management of grid.

Renewable and Distributed Generation

Integration of renewable and distributed energy resources encompassing large scale at the transmission level, medium scale at the distribution level and small scale on commercial or residential building can present challenges for the dispatchability and controllability of these resources and for operation of the electrical system. Energy storage systems, both electrically and thermally based, can alleviate such problems by decoupling of control of generation and demand {in addition to other forms of demand response} to ensure balancing of supply and demand.

Transmission and Enhancement Application

There are a number of technologies and applications for the transmission system. Flexible AC transmissions systems {FACTS} are used to enhance the controllability of transmission networks and maximize power transfer capability. The deployment of this technology on existing lines can improve efficiency and defer the need of additional investment. High voltage DC {HVDC} technologies are used to connect offshore wind and solar farms to large power areas, with decreased system losses and enhanced system controllability, allowing efficient use of energy sources remote from load centers.

Dynamic line rating {DLR}, which uses sensor to identify the current carrying capability of a section of network in real time, can optimize utilization of existing transmission assets, without the risk of causing overloads. High temperature superconductors {HTS} can significantly reduce transmission losses and enable economical fault current limiting with higher performance, though there is debate over the market readiness of the technology.

Distribution Grid Management

Distribution and substation and automation can reduce outage and repair time, maintain voltage level and improve asset management. Advanced distribution automation processes real time information from sensors and meters for fault location, automatic reconfiguration of feeders, voltage and reactive power optimization, or to control distributed generation. Sensor technologies can enable condition and performance based maintenance of network components, optimizing equipment performance and hence effective utilization of assets.

Advance Metering Infrastructure

Advanced metering infrastructure {AMI} involves the deployment of a number of technologies. In addition to advanced or smart meters that enable two – way flow of information, providing customers and utilities with data.

Regulations, Energy service providers' technology and automation vendors and all consumers of electrical power. The Smart Grid makes this transformation possible by binging innovative philosophies to the utility and electrical grid. Technologies already in place are; advance metering infrastructure, visualization technology, Phasor measurement unit, distribution generation, peak demand, and smart grid versus meter.

Renewable energy and the environment

While the nation's transportation emits 20% of all the total carbon-dioxide, electricity generation emits 40%. Clearly presenting an enormous challenge for the electric power industry in term of global climate change. The Smart grid deployment is a key tool in addressing the challenges of climate change; ultimately and significantly reducing greenhouse gases and criteria pollutants such as NOx, SOx. A smarter Grid delivers and uses conservation efficiency thanks to its ability to establish more focused and pervasive consumer participation from a behavioral perspective. There is measurable energy savings when consumers participate in controlling of their utility, which is approximately 6% in the residential sector.

Awareness on the part of consumer to manage peak load by virtue of a feedback mechanism may incite greater attention to consumption patterns and result in savings. Proving that time is everything,

Figure- 24

renewable energy and the environment a smarter grid can capture carbon saving from peak load shifting even if energy is not being saved. When peak load is reduced by means of demand response from many peaking plants and the carbon that emits is kept on the sidelines.

The smart grid's single biggest potential in delivering carbon saving is proving cost effective and increasing plug in hybrid electric vehicles, although the vehicles will be producing the saving rather than the Smart Grid, only Smart Grid technology will allow us to tap this fundamental potentiality. The idle producing capacity of today's grid could supply 73% of the energy needs of today Cars, SUV, pickup trucks and Vans with exiting power plants. Additional benefit includes the potential to displace 52% of net oil imports, or 6.7 million barrels per day, and reduce CO2 emission by 27%. Furthermore, by enabling the sale of electricity over the same infrastructure, the Smart Grid has the potentials to lower electric rates and benefit its consumers.

The Smart Grid functioning can enable the US to shift focus to challenges raging from carbon management to the use of renewable sources of electricity. In the process, it will work towards improving the general health of the United States as well as lessening its dependence on foreign oil. The full exploitation of renewable energy source such as wind and PV Solar is critical to managing our collective carbon footprint.

RENEWABLE ENERGY SWOT ANALYSIS

Strengths	Weaknesses	Opportunities	Threats
Renewable Energy are clean-green and environmentally friendly	They are expensive to harness and transmit to be utilize	It natural resources are easily Seen	It is still in pepper pipeline development by many countries. Need budgeting to actualize it.
They are pollutant free	They are difficult harness larger continue of Electrical energy.	It presents an opportunity for Energy and creates platforms for Employability.	Often influence by the fluctuation in the Climatic situation of it locality.
Reduced	Residential,	Solar and wind	Most of it

electrical generated carbon oxide release to the atmosphere.	commercial and industrial utilities cannot only depend on renewables alone for its supply.	resources are located in most places of the world and Solar can be instilled directly into the rooftop to power the household and it livelihood.	Sources like Wind and Solar are influence by the Season and month of the year.
They help in reducing Greenhouse effect and consequently reduce Global warming/climate change.	Renewable energy metallic products and materials are expensive.		Fusil fuels generating companies are strengthen lost it market and customer since, many will deploy renewables.
Even the less privilege in remote area can benefit from small scale instilled renewable energy to feel the touch light.	Good resources location restrictions		Landscape distortion
Cost competitive with fusil fuels	Cannot produced base load		Market saturation
Zero fuels utilization	Low energy efficiency of {22%}		
Requires little or almost no maintenance cost	Deployment is quite small compared to global potential		
Can provide basic loads and peak loads	Maybe responsible for inadequate		
Cheapest from RET/ unit of electricity			

System integration:

System integration is an engineering process that bring together the components Sub-station into one system {An aggregation of Subsystems cooperating so that the system is able to deliver the overarching functionality} and ensuring that the subsystems function together as a system and in information technology as process of linking together different computing systems and software applications physically or functionality to act as a coordinated whole.

System integration can also be define as a process of creating a complex information system that may include designing or building a customized architecture or application, integrating it with new or existing hardware, packaged and custom software, and communications. Most enterprises rely on external contractor for program management of most or all phases of system development. The external Vendor generally also assumes a high degree of the project risks.

Electricity generation, transmission, distribution, and utilization {the grid} are now being interconnected monitored and managed by advance soft/hard-wares and the current development is intervolving transport, business, and industries, homes and everything that concerned life together. This whole systematic approach is a combination of Smart Grid and System integration. Although these promising development is yet to fully realize to operate to if potency, many countries are already

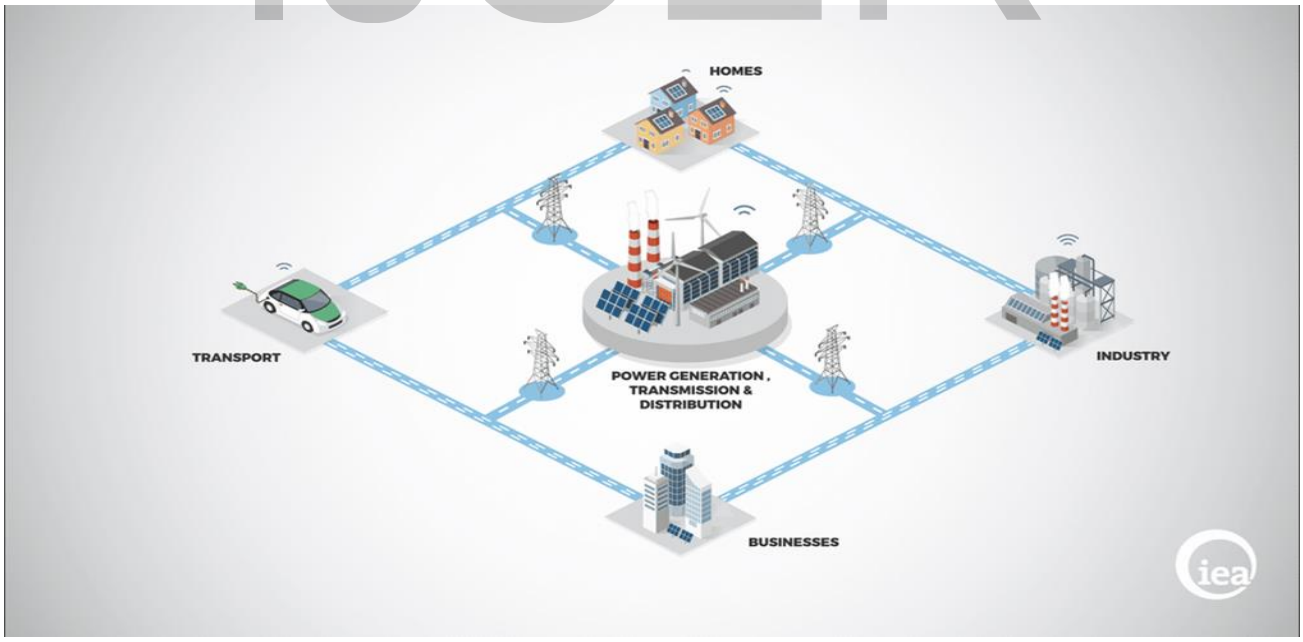


Figure 25

Implementing it into already existing Grid. Here Computer networking {LAN, WAN, VLAN} and topologies play a very vital rule; in the interconnection and exchange of

date. This cannot be achieved alone with the help of computer enterprise advance Software's.

An incorporation of Remote access technology to monitor the grid:

The incorporation of advance Smart meters for bills reading, has made it easier for both the Client's and power Suppliers, this advance meters with internet protocols enable a remote monitoring of the kilowatt-hour by the electrical power utility company and also Facilitate connecting with internet enabled software-apps. This create an awareness to the users on how much consumption they are, thereby given them the choose to unpluck peak load to minimize bills.

Figure 26

Using internet protocol {IP} Visualize Watts-meters:

TeamViewer **Remote desk connection**

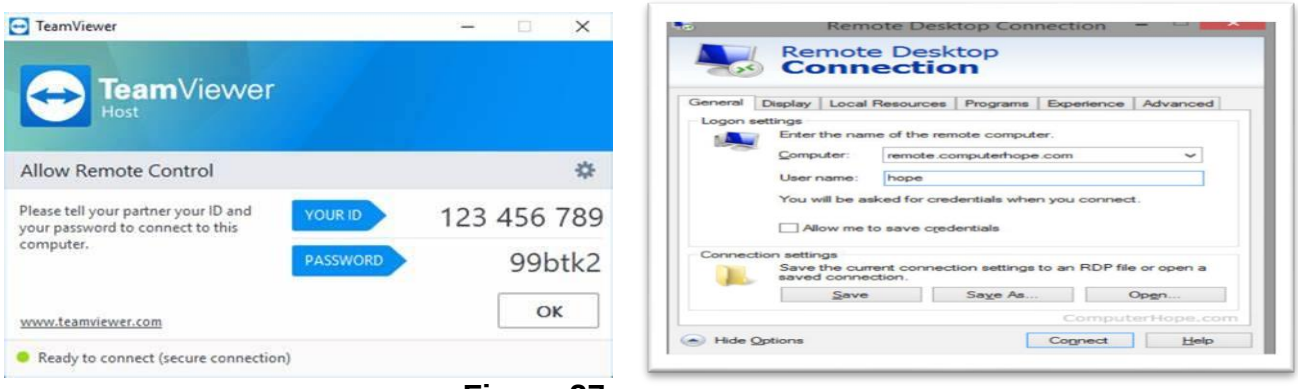


Figure 27

TeamViewer:

Integrating internet software's in the power system Grid to monitor the entire grid facilitates the operations and visualization of actual happenings at the hardware components. The team View is an application used to Monitor, visualizes, supervise and control remotely. It is an internet base remote access that can be of very impact when dealing with Smart meter operation and customer bills registration and collection. It advantages is that; it reduced the burden of going to manually read that smart meter. Thereby reducing the charges of employing many for bills collection and consequentially, affordable by its customers.

Remote desk connection

Unlike Team View, the Remote desk connection is a computer base application use to check the continuity of a device connects on a network. All what it needed is for that device to have an internet protocol {IP} as to it. Once that device is connected to a LAN / VLAN or WAN / VWAN, with the help of the IP, it is possible to connect that device. This application to be very valuable to monitor strategic polices in the Grid. The generating stations, sub-stations, distributing stations and some important part of the power systems can be under CCTV supervision via remote access of remote desk connection. These will prompt System supervision engineer to see and observe parts of the grid from the communication command Centers. Its help in preventing unnecessary blackout, fault, thieves, and maintenance if necessary. This would enhance the efficiency of the overall output to power industrial, commercial, and residential utilities.

IEEE Smart Village vision

IEEE Smart village is a vision of institute of electronics and electrical engineers to promote renewable energy to the entire earth. It is a humanitarian action to reach to the lest privilege in accordance with the UN/UNESCO'S visions. It seeks to Integrating sustainability electricity education and entrepreurial solution to empower off-grid communities. Making the world a place where all people enjoy equal access to electricity and education. It generates opportunities for many and leverage change for themselves and others.

Figure 28 {IEEE Smart Solar design}

The IEEE Smart Village has successful empowered, trained, equipped, engage and sponsor many especially in remote Area to take this action into practices. All over the world IEEE Smart village has sponsor companies such; Africa development promise in Uganda and Rwanda, Solar Soul collective in Khri, Shakti Empowerment Solutions PVT.LD India, Bending Bambo in Vietnam, Madan Medical clinic Papua New Gunea, Shaybis Nigeria LTD Nigeria, RELc Cameroon, igniting Africa, Green village electricity Nigeria and The Maa trust Kenya. All of these companies are sincerely generating renewable energy for the poor and changing lives in the Remote area where people where have no access to electricity, educating and employing local technician in their communities. At the same time promoting environmental sustainability, employability and lower electrical bills, thank to IEEE Smart Village financial support, educational action.

Conclusion

From the above Critical Analogy, it can be clearly seen that implementing clean-Green renewable from {Wind, water, Sun and others} can go a long where in reducing that Carbon emission and others toxics or pollutant, coupling and integrating these clean energies with the Smart Grid to facilitate the smooth running of the entire electrical power systems {From the Generating, transmission, distribution, and utilization systems}. And make electrical energy available for both to poor and the rich while preserving our environment for the future generation to enjoy confortable climatic arenas.

Figure 29 Figure: IEEE Smart Village Solar

The institute of electrical and electronics engineers-IEEE have successfully device a movable smart solar system that can be instilled in most villages and there are in position to support any genuine Environmental-Humanitarian development company that focuses on transforming the state of the world and the betterment of both the society and its people. This smart village IEEE vision had brought about an unchangeable development in most countries especially Africa. I strongly recommend this Smart vision to be a Priority to most Governmental Authorities and Engineering companies. This is not just for Money making but an attempt to reduced carbon Emission and at the same time improving the standard livelihood for the less privilege.

The United States was the second with {6672.4472 $MtCo_2e$} greenhouse emission in 2014 and Qatar was fifty eight with {82.8446 $MtCo_2e$} in 2014. These contributed to global warming. Even though the both state are improving and developing theirs renewable and clean electrical energies; Most of theirs electricity are still relying on fusil-fuel. Qatar stand in the best position duel it is climatic nature to harnessed the world best and large scale solar electrical energy, since Solar panels are more heat dependent to covert the sunlight into electrical Energy. I strongly see that Generating Solar Energy in Qatar could be possible even at all homes.

Cameroon is a country with colder and hot climatic regions, it most common electrical energy is harness from Hydro duel to its blessed natural of natural water falls, even though it potency is yet unexploited and low voltage is order of the day, the Smart Grid is required to properly manage her electrical Energy system. Most of the Remote Areas hardly experience the touch of electricity duel poor management systems. This condition has left many with no option than to steal and tap unauthorized electricity, consequently leaving Generating companies in huge debts. If the Wind turbine Energy could be implemented at the colder regions and Solar panel at hotter regions in any capacity and interconnected in distribution centers, it could go a long way to help reducing the lag of energy in the country.

System integration should be globalizing conception, standardizing and constraining most Governmental Authorities, stake holders, companies and end users. Electrical power systems engineering international organizations such as institute of electrical and electronics engineer, instituted of engineering and technology, Royal academy of engineering should implement structured rules and regulations that ethically constrain any company, organization, government, individual exploiting electrical energy sources with higher capacity of Carbon dioxide emission and those that are found guilty of such contributing and contamination to the environment should be entitle to pay huge penalties. Engineering society should also create platform through which the Global community can be sensitize and educated on the risk of generation, transmitting, distributing and utilizing non green-clean renewable energy and l code “the cost destroying our environment is cheaper than the cost restoring it back to its original state”, but if we think of the future generation then will better be cautious now or never.

If we do nothing, an environmental study shows the U.S Carbon Emissions are expected to rise from 1,700 million tons of Carbon per year today to 20300 million tons of carbon by the year 2030. The same study show that utilities through implementation of energy efficiency programs and use of renewable energy sources could not only displays that growth. But actually have the opportunity to reduce the carbon output to below 1,000 million tons of Carbon by 2030.

If we do nothing about engaging the consumer, we can expect to run out of both choices and time, drastically limiting our ability to meet future energy challenges. If we do nothing the incidence of massive and crippling blackouts will likely increase. If we do nothing, rate will increase drastically to pay not only for electricity but also for increase generation and transmission constraints, higher peaks loads, and the moorages on outdated assets. If we do nothing about the resulting plight of those who can least afford to pay.

Bibliography:

1. Electric Power Generation. By Digambar M. Tagare, 2011 the Institute of Electrical and Electronics Engineers, page. 135.
2. Electric Power Generation. By Digambar M. Tagare, 2011 the Institute of Electrical and Electronics Engineers, Advantages of Solar Energy. Page. 195
3. Electrical power systems by Coursera
4. English for Scientist, technology, engineering mathematics by coursera {Focusing it the earth getting warmer?, by }
5. Electrical power generation.
6. Electrical and electronic principles and technology, John Bird 2013, page 40
7. The Energy system of Cameroon and its impact on the Economy by Henry Yusinyu Bunyui, page 5.
8. Environmental constraints in thermal power generation by Digambar, page 138.
9. US Energy information administration EIA.
10. Institute of electrical and electronics engineers.

11. Electrical power distribution by Turon Conen, third edition page 808.
12. Distributed generator and renewable energy by Turon Conen page 767.
13. Qatar National development strategy 2011-2016, towards Qatar National Vision 2030, page 85 and 236.
14. Transforming our World: the 2030 agenda for sustainable development, page 23
15. {Energy efficiency and renewable-supporting policies in the local level for energy Page 71—by Dr Charalambos Malamatenios }
16. Electrical and Electronic Principles and Technology {page 38,40 by John Bird 3013}

References:

- ✓ The IEEE Village vision: https://smartvillage.ieee.org/ and https://smartvillage.ieee.org/about-ieee-smart-village/
- ✓ The C02: https://www.co2.earth/
- ✓ Associated Press. (2016, August 08). Scientists report that the Earth's fever is rising. (Ed. Newsela Staff). Retrieved from https://share.america.gov/scientists-report-that-earths-fever-is-rising/
- ✓ 3.Schlein, L. (2016, July 21). WMO: Global Warming Happening Faster Than Predicted. Retrieved from http://www.voanews.com/a/who-global-warming-happening-faster-than-predicted/3429127.html
- ✓ NASA. (2017, January 19). A Blanket around the Earth. (Ed. Newsela staff). Retrieved from http://climate.nasa.gov/causes/
- ✓ NASA. (2017, January 19). The consequences of climate change. (Ed. Newsela staff). Retrieved from http://climate.nasa.gov/effects/
- ✓ 11. Berman, J. (2014, May 7). Study: Rising Carbon Dioxide Levels Threaten Human Nutrition. Retrieved from http://www.voanews.com/a/study-rising-carbon-dioxide-levels-threaten-human-nutrition/1909926.ht

- ✓ VOA News. (2015, December 3). African Nations Vulnerable to Effects of Climate Change. Retrieved from http://www.voanews.com/a/african-nations-vulnerable-effects-climate-change/3086573.html

- ✓ Pasricha, Anjana. (2016, August 26). Indian Scientists Design Solar Tree to Save Space for Solar Power Generation. (Ed. Newsela staff). Retrieved from http://www.voanews.com/a/indian-scientists-design-solar-tree-to-save-space-for-solar-power-generation/3481641.html
- ✓ Terhune, L. (2016, Nov 17). Salting away renewable energy for future use. Retrieved from https://share.america.gov/salting-away-renewable-energy-for-future-use/

- ✓ Electricity and the environment: https://www.eia.gov/energyexplained/index.php?page=electricity_environment
- ✓ Qatar is located: https://www.latlong.net/place/doha-qatar-15673.html
- ✓ environment: https://dictionary.cambridge.org/dictionary/english/environment
- ✓ UNESCO Vision 7: https://en.unesco.org/sdgs
- ✓ Cameroon: https://en.wikipedia.org/wiki/Departments_of_Cameroon
- ✓ US Electricity Generation: https://www.eia.gov/tools/faqs/faq.php?id=427&t=3
- ✓ Introduction to electrical power systemshttps://www.coursera.org/learn/electric-power-systems/lecture/pWSOE/introduction-energy-production-distribution-safety
- ✓ Basic electricity: https://www.coursera.org/learn/electric-power-systems/supplement/3prvU/basic-electricity-optional-resources
- ✓ Generation, transmission, distribution: https://www.coursera.org/learn/electric-power-systems/supplement/kLvm5/generation-transmission-distribution-optional-resources
- ✓ System design: https://www.coursera.org/learn/electric-power-systems/supplement/pf1yu/system-design-switching-optional-resources
- ✓ Renewable energy-smart grid: https://www.coursera.org/learn/electric-power-systems/supplement/uoeEg/renewable-energy-smart-grid-technologies-optional-resources
- ✓ https://www.coursera.org/learn/electric-power-systems/supplement/EjoZN/electric-power-systems-key-takeaways
- ✓ Earth fever is rising: https://www.coursera.org/learn/stem/supplement/2PXmu/basic-scientists-annual-physical-of-the-planet-earths-fever-rises
- ✓ How do we know the climate is changing: https://www.coursera.org/learn/stem/supplement/Etq8Z/advanced-climate-change-how-do-we-know
- ✓ Climate change by Yali network: https://yali.state.gov/course-725/#/
- ✓ Global worming: https://www.coursera.org/learn/stem/supplement/jjunt/wmo-global-warming-happening-faster-than-predicted
- ✓ Climate change data: https://www.coursera.org/learn/stem/supplement/FxI1K/5-takeaways-from-the-latest-climate-data
- ✓ Blanket around the earth: https://www.coursera.org/learn/stem/supplement/Gsj8a/advanced-a-blanket-around-the-earth
- ✓ Consequences of climate changes https://www.coursera.org/learn/stem/supplement/aVv6q/advanced-the-consequences-of-climate-change
- ✓ Solar tree to saved space:https://www.coursera.org/learn/stem/supplement/AAOji/advanced-indian-scientists-design-solar-tree-to-save-space-for-solar-power

- ✓ Green energy:https://www.coursera.org/learn/stem/supplement/m9RyZ/blue-energy-could-be-another-way-to-go-green