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Challenges and Way Forward of Renewables in Developing Energy Economy: Today and Tomorrow

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ABSTRACT

With the rapid increase in population growth, the rate of utilization of fossil fuels in developing nations is becoming a serious source of danger to both humans and the environment because of its emission of Greenhouse Gas emission (GHGE) and pollution to the environment. This paper aim to investigate and analyse the challenges faced by developing nations in utilizing the available abundant renewable energy that are present almost round the clock. These range from high initial acquisition and installation cost, non or little presence of government policies towards utilization, poor stakeholders interest on renewable energy utilization promotion or implementation of renewable energy sources, power consumer/individual awareness of its benefits both to lives and the environment, myth and belief by some heliolatry worshippers, untrained/inadequate man power, poor or inadequate research renewable energy institutes, falsifications as well as importation of substandard products, very poor data mapping of renewable energy potentials among others. The way out of these challenges were also discussed as the major interest it to preserve greenhouse gas emission and achieve the overall industrialization goal of any nation through utilization of all available clean energy sources. This in turn will solve the problem of high unemployment and improve the overall per capital income. This will be a step in the right direction in ensuring that the gap is gradually getting bridged between the developed and the developing nations.

Keywords: *Ghge, Renewable Energy Source, Developing Nation, Non Renewable Sources.*

INTRODUCTION

Renewable energy sources is defined as clean energy sources obtained naturally and are constantly replenished or renewed while re is (are) energy obtained from these various sources. RE sources include solar, wind hydro, tidal, geothermal and biomass. Non-Renewable energy sources are energy sources that cannot be replenished (renewed) with the following examples; natural gas, coal, metal ores earth minerals, oil etc. the world energy usage makes up of more than 75% of non-renewable energy source which has greatly depleted the ecosystem (ozone layer) with china and United State of America (USA) as the largest consumption of this form of energy. It is pertinent to know the level of energy consumption and utilization in the world. Three major institutions have so far being periodically recording and publishing energy data all over the world. These institutions include international energy agency (IEA), United States information administration (EIA), and the European environment agency (EEA).Recent studies have also shown that RE utilization has considerably reduces carbon emission. Studies According to report from International Energy Agency (IEA 2019), it is expected that Renewable Energy (RE) capacity will expand to about 50% between the period of 2019-2024 with the fastest growth rate of hydro, solar and wind type of RE. IEA report also investigated that 26% of the world energy consumption is based on RE and it is projected to attain 30% by 2024 [1-2]. About one-fourth of the electricity produced globally is from renewable energy source as at 2017and it is expected to rise by 1.3% in 2017[3-7].Most developing nations have abundance of RE, however harnessing this energy for its maximum utilization still pose a very big challenge and this has affected their overall growth rate in terms of industrialization and development.

Well over 70% of the entire population world population is from developing countries found within the region of Latin America, Africa and Asia, yet socio-economic activities in these zones are not too impressive especially in sub-Sahara Africa. It staggers my logical acumen that with the enormous untapped abundance of

available renewable energy especially, the government and all other stake holders are either not interested in the development of renewable energy technologies or are adamant about the whole process, otherwise the flow of investment and development level would have been very high. GHGE has contributed immensely to the overall global warming. it is thus worthy of note that various types of renewable energy exist and its utilization in terms of availability and economics is peculiar from one individual country to the other. There is need to carry out proper feasibility studies and data mapping before embarking on any form of utilization .This will ensure that a viable option of renewable energy utilization is guaranteed according to H.H. Goh et al in 2014 [22]. Investigating the cases of developing economies in terms of renewable energy utilization, there is a 14% projection that consumption of energy will increase between 2017-2035.

Review of Relevant Literatures

Channing Arndt et al in 2019 [7] informed that there is a gradual paradigm shift in the utilization of energy systems of renewable and non-renewable types. it was further stated that there is a decline in the cost of generation of renewable energy since 2007 particularly solar and wind with standard policies to control greenhouse emissions. In an attempt to address the challenges posed by the utilization of non-renewable energy sources by both developing and developed nations, Nicole Vandaele and Wendell Porter in 2015[8] used United State of America (USA) as a developed nation and Kenya, Morocco as well as South Africa as developing nation to carry out this study. This was achieved through the effective exploration of the current and future energy state affairs of these study areas. A framework was eventually developed that will guarantee 1005 utilization of renewable energy per year until 2040. If this framework is implemented, the danger posed by consuming non-renewable energy sources will be a thing of the past. Evaluation of the impact of low cost emission reductions through renewable energy(RE) and energy efficiency (EE) projects and initiatives was investigated [9]. The researchers analysed both RE and EE projects totalling about 273. 197 are RE, 62 are EE while 14 are both RE and EE. The analysed sample of RE project contribute approximately 0.084Gtco$_2$, EE projects contribute 0.113 Gtco$_2$ while RE and EE projects contribute 0.059 Gtco$_2$ to the total emission reductions. It was concluded that reduction in GHG emission resulting from all internationally supported RE and EE projects in developing countries that were implemented between 2005 and 2016 could be 0.6Gtco2 per year up to 2020. M. Indra al Irsyad *et al* in 2017[10] posited that developing nations should be very careful in adopting various analytical tool, models and techniques formulated by developed nations in solving their renewable energy challenges. This is because the conditions, constraints as well as the criteria used for the formulation in developed countries are obviously different from developing nations. The researchers further stated some lapses upon review of technical papers of some developing nations that used these developed models and suggested potential improvement to these analytical tools of renewable energy models that can be adopted by developing nations. Katherine Bronstein in 2020 [11] in her investigation identified the good, bad and ugly aspect of renewable energy utilization in developing countries and further reiterated that most of the components and technologies used in the manufacture of these facilities used for RE are highly toxic to both humans and the environment. These include Lead, Polyvinyl Fluoride, Copper bye products, Tin, Lithium, Silicon Tetrachloride etc. The current happening with End of Line (EOL) various approaches adopted by various countries in handling projected quantity of renewable energy waste, the role of developing agencies on management and investment of renewable energy and how can a developing nation promote a circular economy EOL were also discussed. Dieter Holn.D. Arch in 2019 [12] established a rationale on why government should formulate and promote policies to favour the utilization of renewable of renewable energy as well as investigated the enormous benefits inherent in the utilization of renewable energy resources. The researcher further stated that most developing nations are blessed with fossil fuels that are being currently utilized to its fullest, but more blessed with very large quantity of unmapped renewable energy resources that needs to be put to use. The researcher further posited that renewable energy productivity target should be established and academics, entrepreneurs and investors should be involved either directly or indirectly and the government should also make laws and policies favourable to all stakeholders. Assessment of Renewable Energy Sources in Developing Countries, Challenges and Opportunities for a Sustainable Development Agenda was carried out by Jorge Fernando and Sergio Ricardo Siani in 2016 [13]. The study compares database as well as climate change drivers of some Latin American countries with the main purpose of

verifying similarities as well as differences and formulating possible strategies and government policies issues and barriers that favours renewable energy generation using the multivariate analysis approach. The following factors determined include: Greenhouse gas emission, use of alternative source of energy as well as nuclear energy sources, combustible renewables and waste, fossil fuel energy consumption, ocean health index etc. it was however concluded that the best positioned countries with high economic performance are those countries whose policies are tightly connected to sustainability of the renewables. Nadia Singh *et al* in 2019 [14] investigated the relationships between production/utilization of renewable energy, its economic growth and the differential impact on both developed and developing economies using the Fully Modified Ordinary Least Square (FMOLS) regression model. This is demonstrated on a sample of 20 developed and developing countries between 1995-2016.It was found that these impact yield better and favourable results compared to those from the developed nations. Echiegu in 2015 [15] investigated ways of Enhancing Capacity for Renewable Energy Application in Developing Countries and suggested that there should be absolute restructuring of energy sector in some developing countries. These could range from fossil fuel utilization, review of policies that will be favourable to renewable energy utilization, making the sector more competitive among others. Donastorg *et al* in 2017 [16] critically reviewed ways of financing renewable energy products in developing countries with emphasis on Risk and Return on Investment (ROI) of the business. The study compared the current funding mechanisms by government and other stake holders and the modern support mechanisms. This range from borrowing (loan from financial institutions such as banks) and equity capital. The latter involves sales of shares and has better ROI because of its high level of risk involved. Loans are applied to Renewable energy source utilization to conventional and tested established technologies while equity is applied to recent and modern innovative technology. Amir and Morteza in 2018 [17] accessed the potentials of solar energy in developing countries with the aim of reducing energy related emission (Green House Gas-GHG) as well as indoor air pollution especially in rural remote areas where grid connections is not accessible. The researcher further informed that utilization of solar PV as source of energy can reduce 69-100 million tonnes of co_2, 68,000-99,000 tonnes of No_X and 126,000-184,000 tonnes of so_2.

Factors militating against the widespread use of solar energy were also discussed. Dolf Gielen in 2019 [18] established the roles of renewable energy in global energy transformations by exploring both technical and economic characteristics of accelerated transition of energy up to 2050 using data sets of renewable energy. Developed nations such as the Europeans have raised her target from 27% in 2014 to 32% in 2018 while India set her target at 174GW by 2020 [19, 20]. It was investigated that GHGE in Europe decreased by 22% (World bank statistics: 2018). Moreso, in an attempt to stabilize and reduce GHGE using cost effectiveness strategies, the introduction and application of Carbon Capture Utilization (CCU) favoured the use of both renewables and nuclear sources with very low emission of GHGE. Table 1.0 show shares of the energy sources as investigated by International Energy Agency (IEA) .The essence is to stabilize GHGE up to a value of 450ppm co_2.

Table1.0. *IEA stabilisation concept. Share of the energy sources. Source: IEA, World Energy Outlook 2017/2018*

	2015	Current Policies		New Policies in billion tonnes		Sustainable Dev.	
		2025	2040	2025	2040	2025	2040
Coal	5,357	5,711	6,813	5,383	5,441	4,350	2,281
Oil	6,336	7,003	7,957	6,791	6,991	6,191	4,509
Natural gas	4,439	5,166	6,863	5,056	6,337	4,934	4,889
Nuclear	983	1,147	1,359	1,150	1,387	1,230	4,904
Hydro	504	590	734	593	734	616	859
Biomass	1,979	2,246	2,531	2,271	2,644	1,960	2,149
Other renewables	363	684	1,354	737	1,747	926	3,046
	19,960	**22,546**	**27,611**	**21,983**	**28,051**	**20,209**	19,593

CHALLENGES OF RENEWABLE ENERGY SOURCES (RES) IN DEVELOPING COUNTRIES

High Initial Cost of Acquisition and Installation

The high initial acquisition cost when compared to utilizing the conventional sources from power utility companies has resulted to a serious setback in the use of Renewable Energy Sources (RES) as an alternative to power generation in developing countries. Cost of acquiring renewable energy system increases as the power system capacities increases whether mini, micro and

macro. It should be worthy of note that acquiring and installing RES for power generation is beyond the reach of an average individual in terms of his/her income. One –fourth of the world population resulting to well over 1.6 billion people live without access to electricity. Three hundred and thirty three (333) million Africans live below poverty line of one dollar per day and in every minute that passes by, there is every likelihood that three Africans are likely to fall within this poverty bracket. Moreso, cost of acquiring the least rated capacity of renewable energy is far above the minimum wage as earned in most developing nations.

Government Policies/Will towards Enhancing and Promoting Development of Renewable Energy Sources

The demand for electricity is rising at what could be at least 2.5kW per person using Nigeria as an example of the most populous developing nation. If at a conservative figure of 180 million population, then what is required is about 450GW of electricity to effectively service the energy demand, thus the need for government policies to favour the utilization of RES. Unfortunately, there are no effective policies that favour the utilization of RES and as such have discouraged the investment of individuals, corporate organisations and companies towards investing in this sector for power generation. There is also little or no serious commitment by the government towards mitigating environmental pollution via utilization of fossil fuels. There should be favourable government policies on power generation for RES that will be different from the conventional fossil fuel generating sources. These policies should favour reduction or total exemption in tax payment, tariff plan, low interest loans, subsidies in RES utilization, custom duty waivers, tax rebate to encourage people to own solar powered plants, government sponsored programs on RES, etc.

Lack of Adequate User Awareness

RES penetration is yet to reach the critical stage of mass awareness creation to enable greater number of the populace to buy into the concept and then see it as a must have though it is still at its infant stage. Starting from basic education down to nursery, primary, secondary and tertiary institutions, there is very poor awareness of RES utilization by individuals. Serious enlightenment on discouraging the use of fossil fuels due to its negative impact on the overall ecosystem and the immediate environment in terms of pollution and health implication should be the new narrative and transferred to future generations. RES awareness should also cut across individuals, corporate organisations, companies, business owners, decision makers, owners of business and personnel involved in the business of RES technology and its utilization and the public.

Insecurity and Fear of Unknown Affecting Foreign Investment

Policy inconsistencies, poor governance, insecurity, kidnap, insurgency, political apathy, human rights violation, hostage taking etc has negatively affected the attraction of foreign investors to developing nations. These have resulted to a very big threat to the overall development of the developing nations socially, politically, economically and infra structurally. Foreign partners are highly reluctant and discouraged to neither invest a pennyn or even give credit supports and facilities because of the very high level of insecurity and volatility.

Myth and Believe of Some Heliolatry Worshippers

Some people still belief that the sun is the link between them and their life and as such, the sun is seen as their God of wisdom, justice, beneficiary and spiritual bond. This has resulted to the sun been revered and prayers and supplications rendered to it. Some heliolatry worshippers revere the sun and as a result see it as very wrong to tap and convert the solar energy into electricity utilization. Same ideology also goes for the wind and hydro.

Lack of Trained Manpower in Renewable Energy

One of the major challenges of RES development in developing countries is the lack of skilled/ trained man power. RES technology is evolving very fast, however skilled and trained manpower to match this pace of development is obviously lacking. The shortage of manpower and competency level has resulted to poor or no consideration of solar insolation, panel efficiency, and specific consideration of geospatial angle of installation of the panels among others. Further research has showed that most RES programs are not too satisfactory in their course content, such that the RES industries do not find their relevance in tackling challenges (be it practical or otherwise).This has resulted in making some of the RES industries to either hire skilled personnel or do in-house trainings through experts from developed nations. This in turn is very expensive for the company to also handle but they have no choice.

Poor Research Facilities from Government and Private Bodies

From International Renewable Energy Agency records (IREA), RES is expected to provide above 85% of global energy by 2050. In order to meet this projection, most developed countries and industries alike have all established state of the art research institute and learning centres equipped with all required skilled man power. Germany with the highest percentage of renewable energy utilization is 12.72%, United Kingdom (UK) is the second with 11.92%, followed by Spain (10.17%), Italy (9.08%) and Brazil (7.35%).These countries have all reduced to a very large extent the dependency level on conventional fossil fuel source of power generation to achieve a better ecosystem. When compared to developing countries, the high dependency on fossil fuel has still not built the renewable energy industry. There is hardly any renewable energy industry that produces the required facilities and equipment either in part or in whole built in these developing countries not to imagine the research into some of the issues concerning RES technology.

Importation of Falsified and Substandard RES Products

Falsified and substandard equipment are imported into some developing countries mostly through the importers that though have the financial strength to import but lack the pre-requisite knowledge of renewable energy technology. There have been reported cases where some renewable energy products shipped into the developing countries are fake and fail to perform as designed. This has resulted to poor procurement of equipment and facility quality. More so some importers indulge in sharp practices with manufacturing companies and smuggled them into the countries. Among which range from deliberately importing facilities whose ratings are below its stated ratings yet make consumers pay for itto compromising /bribing constituted authorities that would have checked and corrected these criminal acts. When experts install these facilities, its performance output become less effective. This has actually destroyed the gradually built confidence about renewable energy utilization in most developing nations.

Poor Mapping Data of RES Potentials in Comparison with the Environment

Although most developing nations are blessed with abundance of renewable energy potentials such as wind, solar, hydro, biomass, etc., the level of utilization is extremely poor. Most developing countries want to harness these RES because of their peculiar characteristics of cleanness and cheapness of energy and also in terms of running cost though initial cost of installation is high. However, there is lack of available data to enable the government, policy makes, RES companies, public and other stake holders to understand fully these potentials and their exact locations and availability. Some nations such as Lesotho, New Guinea, Vietnam, Nigeria, Zambia Madagascar etc have developed programs on mapping which is still in their initial phase, it is expected to address more serious issues relating to RES mapping currently and in the near future. The mapping is expected to also tackle matters such as validation of existing data and capacity building as well as creation and standardisation of a comprehensive data base, carrying out geospatial output on both solar and wind and generation of global information of wind, solar and tidal data.

THE WAY FORWARD

Job Creation

The corona virus epidemic has actually brought global economy to a standstill. All attempts are now in place by all responsible and focus centred government to create as many jobs as possible. For this singular fact that renewable energy utilization is at its infant stage, it will create enormous jobs for people and this will be a kind of stimulus and recovery package to people either on short term or long term employment basis. These could come in various stages ranging from planning, execution, construction; maintenance etc. it is estimated that the dwindling unemployment that has risen to one (1) in every eight (8) can be tackled effectively and efficiently.

Establishment of Favourable Government Policies on Renewable Energy Development

Policies should be channelled by government towards the limitation to global warming to a bearable limit of 1.5^{o}c and ensuring that adequate move is put in place to encourage 100 percent use of renewable energy in the country while still ensuring that fossil fuels are phased out and converted to synthetic/hydrogen fuels for the sole purpose of power generation in the near future. The policies should also ensure that carbon emission is always within the world's carbon standard budget. There should be greenhouse emission reduction and maximize

positive synergies among companies and establishment of more renewable energy agencies to promote the set RES task.

Raising Awareness on Renewable Energy Utilization and its Health Challenge

This awareness on utilization of renewable energy sources will enhance our overall healthy well-being, economy and general atmosphere. The awareness should imbibe in Individuals the negative and adverse effect of global warming on both humans and other living things (wildlife and plants alike). It should be recalled that the two most important components that the utilization of conventional energy sources affects are air and water. If when contaminated, it become very hazardous to lives. Whereas utilization of renewable energy sources will not lead to any of these contaminations.

Rewriting the Narrative of Some Heliolatry Worshippers

Changing a person's personal belief and conviction on certain issues especially when it is attached to his/her religion is quite a herculean task that is almost impossible. However, consistent and clear focused enlightenment on the need to see the overall relevance of rewriting the narrative with respect to utilization of renewable energy should be the new order as creative teachers should be able to adapt to any form of change.

Grants and Credit Facilities to RE Companies to Power Rural Areas

Electrification of rural areas through available renewable energy sources should be made as priority by the government most especially as these areas are usually not connected to the grid network. There should be favourable formulation of rural electrification policies by government that will be accepted by other stake holders (such as banks, investors, marketers, industry owners etc.), such that access to grants and credit facilities will be easy. More so, the government and other relevant stake holders should ensure that individual household should be able to afford the least home based products that are produced from renewable energy sources.

Establishment of Renewable Energy Bundling Scheme by Government

There should be policies established by the government on bundling of renewable energy source with other conventional generating sources (i.e. hybrid generation of renewables and the conventional energy source of generation). Moreso these hybrid source should be stated such that of the 100% power generation, renewables should contribute like 30% while the conventional sources will be 70% and this will be regulated from time to time in other to achieve the overall goal of reducing the emission of greenhouse gas and air pollution. This will increase penetration of energy from renewable sources and ensure better capacity utilization. Also the tariff under this bundling scheme should be reduced for renewable energy source compared to that for the conventional power generating sources.

Introduction of Renewable Energy Courses in All Curriculums of Studies Starting from Nursery/ Primary Level to Higher Institutions

There should be deliberate attempt by the government to introduce renewable energy courses into all curriculums to boost the level of awareness. This is already obtainable in developed nations and if we must bridge the gap, developing nations should start doing it. Imagine a child from kindergarten already knows the health and environmental effect conventional energy sources will have.

Conclusion

Renewable energy is actually the way to go but it however have its obvious challenges ranging from very high initial cost of acquisition and installation, government policies towards its full utilization, poor individual/customer awareness as to its relevance and enormous advantages, lack of experts as well as trained man power in the installation and purchase of the right and appropriate equipment/facilities, poor and inadequate research/research institutes on renewable energy resources as a subject matter, falsification and importation of substandard products, poor mapping data. Other challenges include fear on the part of investors (private, local or foreign) because of the high level unrest, general belief of some heliolatry worshippers who believes that tapping electricity from these various clean renewable sources is absolutely unacceptable and punishable as these are seen as their gods. There should be deliberate act of switching from the conventional energy utilization source for power generation that causes to much greenhouse emission to the renewable energy sources.

There will be continuous rise in the near future on utilization of renewable energy sources and the gradual phasing out of non-renewable energy sources utilization with the sole aim of reducing greenhouse gas and overall carbon emission.

RECOMMENDATION

- There should be deliberate attempt by the government through her educational agencies in developing nations to ensure that there is overall review of academic curriculum on RES applications from basic, nursery, primary, secondary and tertiary institutions. This will involve incorporating basic/modern concepts of RES in their course outline at all levels.
- Qualified personnel should be involved and encouraged to transfer acquired knowledge to individuals, corporate organisations, companies, business owners, decision makers, owners of business and personnel involved in the business of res technology and its utilization and the public.
- The government should encourage individuals and every stake holders via establishment of acts, laws and policies that will favour the utilization of renewable energy.
- The global energy transition to meet the set objective of limiting the average temperature surface not to rise below 2^{o}c should be deployed.

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REFERENCES

[1] IEA, IEA Finds CO_2 Emissions Flat for Third Straight Year Even as Global Economy Grew in 2019. OECD/IEA, Paris, 2019. https://www.iea.org/newsroom/ news/2019/march/iea-finds-co2-emissions-flat-for-third-straight-year-even-asglobal-economy-grew.html

[2] IEA, the Role of Energy Efficiency in the Clean Energy Transition, OECD/IEA, Paris, 2018. https://www.iea.org/newsroom

[3] IRENA, The Power to Change: Solar and Wind Cost Reduction Potential to 2025, IRENA, Abu Dhabi, 2016 http://www.irena.org/menu/?mnu=Subcat& PriMenuID=36&CatID=141&SubcatID=2733.

[4] IRENA, Renewable Capacity Statistics, IRENA, Abu Dhabi, 2017 http://www.irena. org/menu/index.aspx?mnu=Subcat&PriMenuID=36&CatID=141&SubcatID= 3831.

[5] IEA, IEA Finds CO2 Emissions Flat for Third Straight Year Even as Global Economy Grew in 2016. 17 March, OECD/IEA, Paris, 2017 https://www.iea.org/newsroom/ news/2017/march/iea-finds-co2-emissions-flat-for-third-straight-year-even-asglobal-economy-grew.html.

[6] IEA, The Role of Energy Efficiency in the Clean Energy Transition, OECD/IEA, Paris, 2018.

[7] Channing Arndt., Doug Arent., Faaiqa Hartley, Bruno Merven and Alam Hossain Mondal (2019). Faster Than You Think: Renewable Energy and Developing Countries. Annual Review of Resource Economics. www.annualreviews.org 149-168

[8] Nicole Vandaele., Wendell Porter (Summer 2015). Renewable Energy in Developing and Developed Nations: Outlooks to 2040 University of Florida Journal of Undergraduate Research Volume 15, Issue 3,1-7

[9] Yale Hsu, Carlin Rosengarten, Amy Weinfurter, Yihao Xic (2017).renewable energy and energy efficiency in developing countries: contributions to reducing global emissions the gigaton coalition, third report 2017,Norway .6-90.

[10] M. Indra al Irsyad, Anthony Basco Halog, Rabindra Nepal and Deddy P. Koesrindartoto (2017). Selecting Tools for Renewable energy Analysis in Developing Countries: An expanded Review. Frontiers in energy research volume 5,article 34.Pp 1-12

[11] Katherine Bronstein (2020). The Good, Bad, and Ugly about Renewable Energy in Developing Countries. RTI international research centres, United States of America (USA) © 2020 RTI International. https://www.rti.org/insights/renewable-energy-developing-countries.

[12] Dieter Holm.D.Arch (2019). Renewable energy future for the developing world. White paper to international solar energy society (ISES). http //:whitepaper.ises.org

[13] Jorge Tenório Fernando, Sergio Ricardo Siani (2016), Renewable Energy Sources in Developing Countries: Challenges and Opportunities for a Sustainable Development Agenda. RISUS - Journal on Innovation and Sustainability Volume 7, número 1, p. 64-71.

[14] Nadia Singh., Richard Nyuur and Ben Richmond. Renewable Energy Development as a Driver of Economic Growth: Evidence from Multivariate Panel Data Analysis (2019). *Sustainability* journal of MPDI, *11*(8), 2418; https://doi.org/10.3390/su11082418.

[15] Emmanuel A. Echiegu. Enhancing the Capacity for Renewable Energy Application in Developing Countries. Journal of Fundamentals of Renewable Energy Journal and Applications. (2015), 6:1 DOI: 10.4172/2090-4541.1000e1 04.

[16] Donastorg A, Renukappa S and Suresh S. Financing Renewable Energy Projects in Developing Countries: A Critical Review. 2nd International Conference on Green Energy

Technology (ICGET 2017) IOP Publishing IOP Conf. Series: Earth and Environmental Science 83 (2017) 0 doi: 10.1088/1755-1315/83/1/012 012.

[17] Amir Shahsavari, Morteza Akbari (2018). Potential of solar energy in developing countries for reducing energy-related emissions. Renewable and Sustainable Energy Reviews Volume 90, July 2018, Pages 275-291.

[18] Dolf Gielen., Francisco Boshell., Deger Saygin, Morgan D. Bazilian., Nicholas Wagner. Ricardo Gorini. The role of renewable energy in the global energy transformation. Elsevier energy strategy reviews 24 (2019) 38-50. https: //doi.org/10.1016/j.esr.2019.01.006.

[19] European Commission. Renewable Energy. Moving towards a Low Carbon Economy. European Commission: Brussels. https://ec.europa.eu/ energy/en/topics/ renewable-energy.

[20] MNRE. Tentative State-wise break-up of Renewable Power target to be achieved by the year 2022 so that cumulative achievement is 175,000 MW. Delhi: MNRE (n.d.). https://mnre .gov.in/file-manager/UserFiles/Tentative-State-wise-break-up-ofRenewable-Power-by-2022. pdf

[21] www.statista.com- Accessed August 25th 2020

[22] www.vgb.org (VGB power tech facts and figures: electricity generation 2019/2020). Accessed August 25th 2020.

[23] Renewable energy project: Project management, challenges and risk H.H. Goh., S.W. Lee., Q.S. Chua., K.C. Goh. , B.C. Kok., K.T.K. Teo http: //dx.doi.org/10.1016/j.rser.2014.07.078.Renewable and Sustainable Energy Reviews Volume 38, 2014, Pages917-932.

[24] International Energy Outlook; US Energy Information Agency: Washington, DC, USA, 2019.

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