A Review on Renewable Energy Sources in Environmental Sustainability

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Abstract: -
Security of electric energy is crucial, but in energy-based economies throughout the world, renewable resources are more appealing due to the high cost and scarcity of fossil fuels, as well as the need to minimise greenhouse gas emissions. The potential for renewable energy sources is enormous because they have the potential to, in theory, exponentially exceed global energy demand. As a result, these sources will make up a sizeable portion of the future global energy portfolio, which is largely focused on expanding its supply of renewable energy sources. The utilisation of renewable energy resources now, technological advancements to enhance their usage, their prospects for the future, and their implementation are all covered in this essay. The report also illustrates the significance of power electronics and smart grid innovations that can enable the appropriate.
Renewable energy sources are regarded as clean energy sources since they generate little secondary waste, have little influence on the environment, and can be sustained for the foreseeable future in light of societal, economic, and environmental demands. The sun is where all energy come from. Solar energy mostly manifests as heat and light. The environment transforms and absorbs heat and sunlight in a variety of ways. Some of these transitions lead to the flow of renewable energy sources like wind and biomass.
Keywords:- Renewable resources, Environmental Problems, Energy.

1. Introduction: -

Oil, coal, and natural gas-based conventional energy sources have shown to be very effective economic growth drivers. However, the global primary energy consumption increased by 1.8% in 2012 [1] due to the fast depletion of traditional energy sources and rising energy demand. Many connected groups have promoted vigorous research for more effective, environmentally friendly power plants using cutting-edge technology due to particular environmental challenges. Both clean fuel technologies and novel energy are being studied and researched as environmental protection concerns rise. In fact, costs associated with social and environmental issues, the price of fossil fuels, and the price of renewable energy are all trending in the opposite directions, and the economic and policy frameworks required to support the wide adoption of sustainable markets for renewable energy systems are rapidly changing. It is obvious that the new renewable energy regime will account for the majority of the energy sector's future development. So, switching to renewable energy can help us achieve the twin objectives of lowering greenhouse gas emissions, which will reduce the effects of extreme weather and climate change in the future, and assuring dependable, prompt, and cost-effective energy delivery. Our energy security may benefit greatly from investing in renewable energy.
Renewable energy sources come from nature and are constantly replenished. They can be derived from the sun directly (such as thermal, photochemical, and photoelectric energy) or indirectly (such as wind, hydropower, and photosynthetic energy stored in biomass). They can also come from other environmental processes and natural movements (such as geothermal and tidal energy). Energy sources generated from fossil fuels, waste from those fuels, and waste from inorganic sources are not considered to be renewable energy sources [2]. An overview of renewable energy sources is shown in Fig. 1 [3,4]. Utilizable energy forms, such as electricity, heat, and fuels, are produced from these renewable energy sources.

2. Description of Renewable Energy Sources: -

The paper's objective is to provide a summary of the many forms of renewable energy resources, their existing and potential future states, their share in various end-use applications, and their advantages, growth, investment, and deployment. The discussion will also cover smart grid and power electronics as enabling technologies for various renewable energy sources.

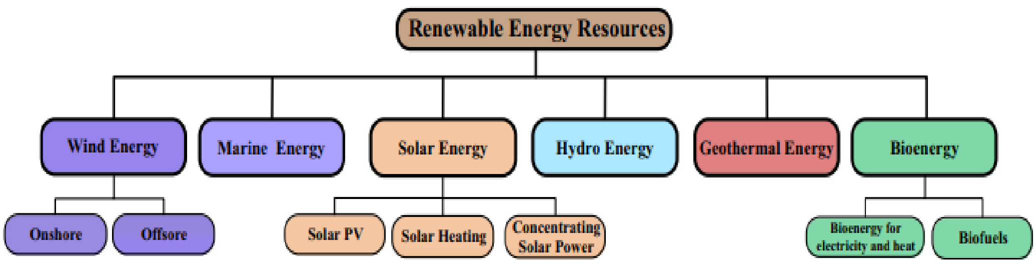

Fig.1. Renewable Energy Resources

2.1 Biomass: -

Biomass for bioenergy can be derived directly from the land, such as from crops grown specifically for energy, or from residues left over after crops are processed for food or other uses [8–10]. Although biomass energy is sustainable and renewable, it has several traits in common with fossil fuels. Although biomass may be burnt directly to provide energy, it can also be used as a feedstock to create a variety of liquid or gas fuels (biofuels). Transportable and storage-capable biofuels enable on-demand generation of heat and electricity, which is crucial in an energy mix heavily reliant on erratic sources like wind. The significant role that biomass is anticipated to play in future energy scenarios can be attributed to these commonalities [11]. Therefore, creating biorefinery and biotransformation technologies to turn biomass feedstock into clean energy fuels is a recently developed concept. Fig. 4 [12] depicts the interconversion of different biomass and energy forms in the carbon cycle. Processes that use thermochemical and biochemical conversion can turn biomass feedstock into biofuels. As shown in Fig. 2, these procedures include combustion, pyrolysis, gasification, and anaerobic digestion.

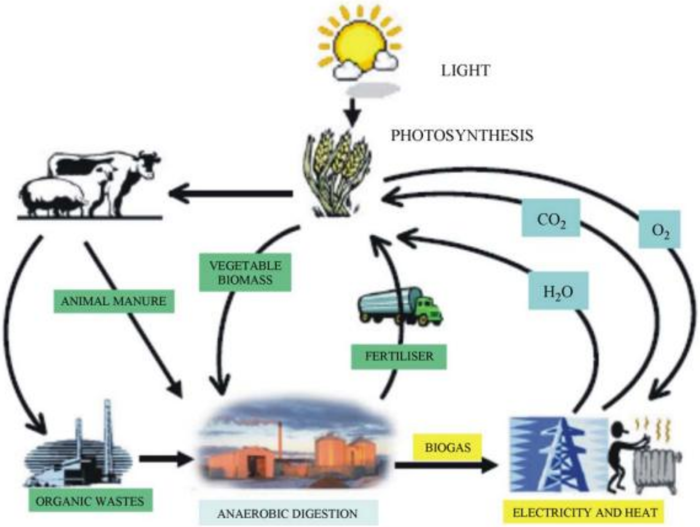

Fig.2. Schematic Representation of the Sustainable Cycle of Anaerobic Co-Digestion Of Animal Manure And Organic Wastes

2.2 **Solar Energy:**

Additionally, as shown in Fig.3.[13], the use of biomass-derived fuels would significantly lessen present energy security and trade balance difficulties and promote socio-economic improvements for many countries. Biomass-to-energy systems face major obstacles in contrast to their advantages. Low energy density of biomass fuels makes their gathering and delivery prohibitively expensive. Although it is technically possible to produce power from biomass, the cost of electricity is rarely enough to cover the cost of the biomass fuel. The usage of inputs such as land, water, crops, and fossil fuels, all of which have opportunity costs, is extensive for bioenergy fuels

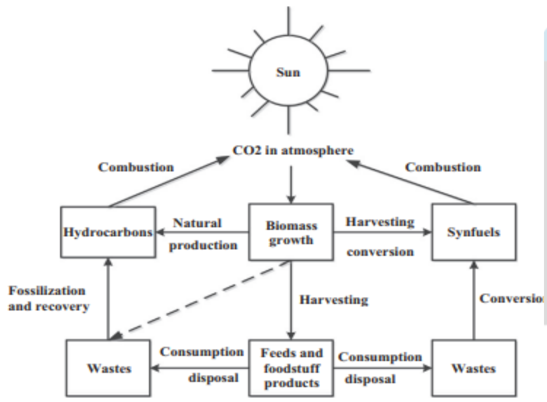

Fig.3. Main Features of the Biomass Energy Technology

Because traditional energy sources are limited and quickly running out, electrical energy serves as the foundation for all developmental initiatives in both developed and developing countries [46]. The best use of resources, the impact of pollution emissions on the environment, and the usage of conventional energy supplies are all issues that have grown in importance over the past several decades [47].

Traditionally, photovoltaic cells are used to convert direct solar energy to electricity, taking use of the photovoltaic (PV) effect. The photovoltaic (PV) effect depends on photon interactions with energies greater than or equivalent to the bandgap of the PV materials. By stacking semiconductors with various band-gap widths, some losses resulting from band-gap restrictions are prevented. [48]. Without any pollutants, noise, or vibration, PV modules produce power straight from light. While sunlight is free, the cost of producing electricity is quite expensive, although costs are beginning to decline. Low energy density describes solar energy. PV modules need a lot of surface area even if they only produce a little energy [49].

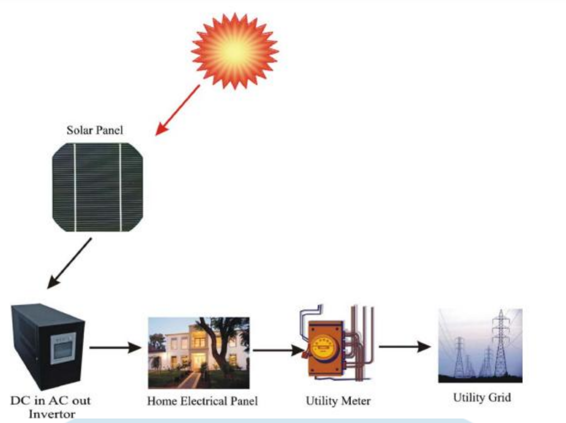

Fig.4. Grid Connected Photovoltaic System.

2.3 **Wind Energy: -**

Wind energy is one of the renewable energy sources used to generate electricity, and it is expanding quickly. Hydroelectricity is its closest competitor in terms of installed capacity. One of the most promising nations in the world for the development of wind power is India [54]. Increased installed wind energy capacity is anticipated to be crucial in reducing climate change. However, the effects of climate change also affect wind energy. The wind energy sector will most likely profit from some changes brought on by climate change, while other changes may have a detrimental effect for wind energy advancements. These "gains and losses" will depend on the location in question [55]. Small power requirements in remote locations may make wind power practicable, but for greatest flexibility, it should be used in combination with other power generating techniques to assure continuity [56]. Studies on the potential for wind energy demonstrate the wealth of the world's wind resources. According to estimates, there is a global market for 26,000 TWh/yr of wind energy, albeit only 9000 TWh/yr may really be used [57]. Today, a mature, competitive, and essentially pollution-free technology called wind energy is employed extensively throughout most of the world to provide power [58]. Through the use of wind turbines, wind technology transforms the energy present in the wind into electrical or mechanical power [59]. As shown in Fig. 5, the purpose of a wind turbine is to transform the wind's velocity into rotational energy that may be utilised to power a generator. Wind turbines use aerodynamically shaped blades to catch wind energy and transform it into rotational mechanical power. Airfoils are used by wind turbine blades to provide mechanical power [60].

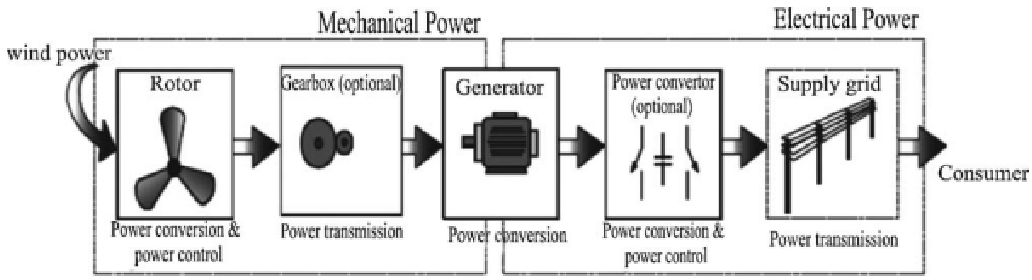

Fig. 5. Conversion From Wind Power to Electrical Power in A Wind Turbine.

2.4. **Smart Grid Enables Renewables: -**

Global electric power networks are faced with a variety of difficulties, including ageing infrastructure, rising demand, incorporating more renewable energy sources, enhancing supply security, and reducing carbon emissions. Smart grid technologies provide strategies to address these issues as well as provide a cleaner, more cost-effective, sustainable, and energy-efficient electricity source. The smart grid's evolving nature is seen in Fig. 6. Bidirectional energy and communication flows are made possible by the electrical grid infrastructure's use of smart grid tools and technology.

Improved effectiveness, dependability, interoperability, and security may result from these additional capabilities [62]. Although renewable energy sources may be utilised to generate electricity in isolated or standalone systems, their advantages are greatly increased when they are incorporated into the electric utility system. Higher degrees and rates of penetration can be accommodated with increased usage of smart grid enabling technologies. However, the amount of energy produced from renewable sources varies (not dispatchable, intermittent and uncertain). The system faces several issues as a result of the varying generation schedules of renewable energy sources.

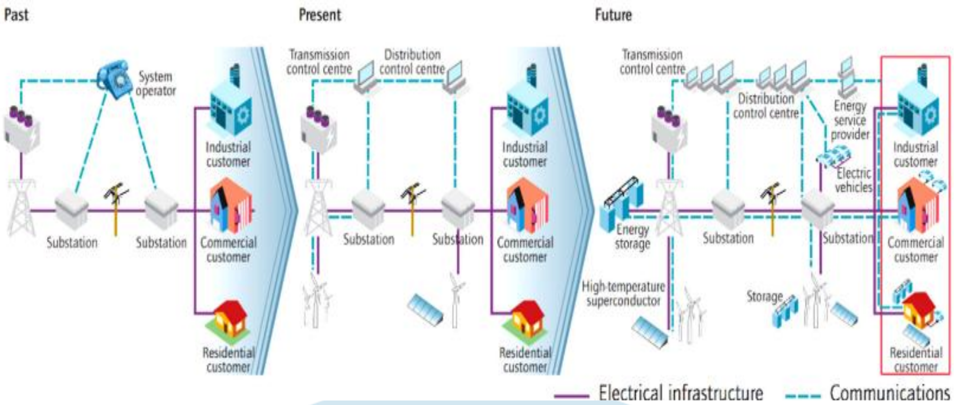

Fig.6. Smarter Electricity Systems [62]

Conclusion

Traditional power generation based on fossil fuels is typically seen to be unsustainable over the long run due to the scarcity of non-depletable resources and environmental issues brought on by the emissions. As a result, several efforts are being undertaken globally to increase the proportion of renewable energy sources in the energy mix. The potential of renewable energy sources, which are creative ways to generate power, is immense since they could, in theory, provide all of the world's energy needs. The advantages, growth, investment, and deployment of the major renewable energy resources are all discussed in this article, along with their current state and prediction for the future. Additionally, an illustration is provided of the function of power electronics converters as enabling technology for utilising various renewable energy sources. Additionally, incorporating renewable energy sources into a smart grid system would assist to successfully satisfy rising demand for electric energy while taking all obstacles into consideration.

References:

[1] BP Statistical Review of World Energy, ⟨bp.com/statisticalreview⟩; June 2013 [accessed on 13/8/2013].
[2] ⟨http://www.treia.org⟩ [accessed on 6/6/2013].
[3] Brown A, müller S, Dobrotková Z. Renewable energy: markets and prospects by technology. Int Energy Agency Inf Paper 2011.
[4] Bull SR. Renewable energy today and tomorrow. Proc IEEE 2001;89(8).
[5] RE-thinking 2050, ⟨www.erec.org⟩ [accessed on 02/9/2013].
[6] Deploying Renewables 2011, ⟨www.iae.org⟩ [accessed on 15/8/2013].
[7] World Energy Outlook 2012, ⟨www.iae.org⟩ [accessed on 15/8/2013].
[8] Srirangan K, Akawi L, Moo-Young M, Chou CP. Towards sustainable production of clean energy carriers from biomass resources. Appl Energy 2012;100:172–86 (December).
[9] Sriram N , Shahidehpour M. Renewable biomass energy. In: IEEE power engineering society general meeting, vol. 1; 12–16 June 2005. p. 612–617.
[10] Reddy BY, Srinivas T. Biomass based energy systems to meet the growing energy demand with reduced global warming: role of energy and exergy analyses. In: International conference on energy efficient technologies for sustainability (ICEETS); 10–12 April 2013. p. 18–23.
[11] Hall DO, Scrase JI. Will biomass be the environmentally friendly fuel of the future? Biomass Bioenergy 1998;15(4/5):357–67.
[12] Klass DL. Biomass for renewable energy and fuels, Encyclopedia of energy, vol.1, p. 193–212.
[13] Ruiz JA, Juárez MC, Morales MP, Muñoz P, Mendívil MA. Biomass gasification for electricity generation: review of current technology barriers. Renewable Sustainable Energy Rev 2013;18:174–83.
[14] Biomass for Power Generation, June 2012, ⟨www.irena.org⟩, [accessed on 19/6/ 2013].
[15] Hammons TJ. Geothermal power generation worldwide. In: 2003 IEEE Bologna power tech conference proceedings; 23–26 June 2003.
[16] Fridleifsson IB. Geothermal energy for the benefit of the people, Renewable Sustainable Energy Rev, 5, 299–312.
[17] Yan Q, Wang A, Wang G, Yu W, Chen Q. Resource evaluation of global geothermal energy and the development obstacles. In: 2010 International conference on advances in energy engineering; 19–20 June 2010. p. 115–119.
[18] Sheth S , Shahidehpour M. Geothermal energy in power systems. In: IEEE power engineering society general meeting, vol. 2; 10–10 June 2004. p. 1972–1977.
[19] Geothermal: international marker overview report; May 2010, ⟨www.GEO-energy.org⟩.
[20] ⟨http://www.endeavorscorp.com⟩, [accessed on 10/6/2013].
[21] Renewable Energy Sources and Climate Change Mitigation, ⟨www.cambridge.org⟩; 2012.
[22] Statistical Review of World Energy 2013, www.bp.com, [accessed on 19/8/2013].
[23] British petroleum statistical review of world energy. British Petroleum,London, UK; 2010. p. 50.
[24] Wang Q, Yang T. Sustainable hydropower development: international perspective and challenges for China. In: 2011 International conference on multimedia technology (ICMT); 26–28 July 2011. p. 5564–5567.
[25] Hydropower and the environment: present context and guidelines for future action; May 2000, IEA Hydropower Agreement, ⟨http://www.ieahydro.org/reports/HyA3S5V2.pdf⟩.

[26] Bhuyan GS. World-wide Status for Harnessing Ocean Renewable Resources. In: 2010 IEEE power and energy society general meeting; 25–29 July 2010.
[27] Aly HHH , El-Hawary ME. State of the art for tidal currents electric energy resources. In: 24th Canadian conference on electrical and computer engineering (CCECE); 8–11 May 2011.
[28] Ben Elghali SE, Benbouzid MEH, Charpentier JF. Marine tidal current electric power generation technology: state of the art and current status. In: IEEE international electric machines & drives conference, 2007. IEMDC '07; 3–5 May 2007 p. 1407–1412.
[29] Ocean renewable energies, 2011, ⟨www.ifpenergiesnouvelles.com⟩, [accessed on 20/6/2013].
[30] Ocean Energy Roadmap, ⟨www.seai.ie⟩, [accessed on 20/8/2013].
[31] Byrne J, Kurdgelashvili L, Mathai MV, Kumar A, Yu J, Zhang X, Tian J, Rickerson W. World solar energy review: technology, markets and policies. (May). Center for Energy and Environmental Policy, University of Delaware; 2010.
[32] Bhuiyan A, Sugita K, Hashimoto, Yamamoto A. InGaN solar cells: present state of the art and important challenges. IEEE J Photovoltaics 2012;2(3):276 (293,).
[33] Marks ND, Summers TJ, Betz RE. Photovoltaic power systems: a review of topologies, converters and controls. In: 22nd Australasian universities power engineering conference (AUPEC); 26–29 Sept. 2012. p. 1–6.
[34] Brankera K, Pathaka MJM, Pearcea JM. A review of solar photovoltaic levelized cost of electricity. Renewable Sustainable Energy Rev 2011;15:4470–82.
[35] Sheikh N, Kocaoglu Dundar F. A comprehensive assessment of solar photovoltaic technologies: literature review. In: Proceedings of the technology management in the energy smart world, PICMET; 2011.
[36] Global Market Outlook for Photovoltaics Until 2016, May 2012, European photovoltaic industry association, ⟨www.epia.org⟩.
[37] Technology Roadmap: Solar photovoltaic energy, ⟨www.iea.org⟩, [accessed on 2/9/2013].
[38] Sioshansi R, Denholm P. The value of concentrating solar power and thermal energy storage. IEEE Trans Sustainable Energy 2010;1(3):173–83.
[39] Machinda GT, Chowdhury SP, Chowdhury S, Kibaara S, Arscott R. Concentrating solar thermal power technologies: a review. In: Annual IEEE India conference (INDICON); 16–18 Dec. 2011.
[40] REN21, Renewables 2013: global status report, ⟨www.ren21.net⟩, [accessed on 25/6/2013].
[41] Kaygusuz K. Wind power for a clean and sustainable energy future. Energy Sources Part B 2009;4(1):122–32.
[42] Islam MR, Mekhilef S, Saidur R. Progress and recent trends of wind energy technology. Renewable Sustainable Energy Rev 2013;21:456–68.
[43] Eltamaly AM. Design and implementation of wind energy system in Saudi Arabia. Renewable Energy 2013;60:42–52.
[44] Nguyen TH, Prinz A, Friis T, Nossum R, Tyapin I. A framework for data integration of offshore wind farms. Renewable Energy 2013;60:150–61.
[45] Global tracking framework, ⟨www.worldbank.org/se4all⟩, [accessed on 24/6/ 2013].
[47] Deploying renewables: best and future policy practice, 2011, ⟨www.iea.org⟩, [accessed on 27/6/2013].
[48] Doner J. Barriers to adoption of renewable energy technology. Illinois State University. Institute for Regulatory Policy Studies; 2007 (May).
[49] Wiuff A, Sandholt K , Marcus-Møller C. Renewable energy technology deployment: barriers, challenges and opportunities, EA energy analyses for the IEA RETD implementing agreement; May 2006.
[50] Bose BK. Global energy scenario and impact of power electronics in 21st century. IEEE Trans Ind Electron 2013;60(7):2638–51.
[51] Bose BK. Global warming: energy, environmental pollution, and the impact of power electronics. IEEE Ind Electron Mag 2010;4(1):6–17.
[52] Chakraborty A. Advancements in power electronics and drives in interface with growing renewable energy resources. Renewable Sustainable Energy Rev 2011;15:1816–27.
[53] Steimer PK. Power electronics, a key technology for energy efficiency and renewables. In: IEEE Energy 2030 conference; 2008. ENERGY 2008.
[54] Blaabjerg F, Iov F, Kerekes T, Teodorescu R. Trends in power electronics and control of renewable energy systems. In: 14th International power electronics and motion control conference; EPE-PEMC 2010.
[55] Blaabjerg F, Chen Z, Kjaer SB. Power electronics as efficient interface of renewable energy sources. In: Fourth international power electronics and motion control conference, IPEMC 2004; 14–16 Aug. 2004. p. 1731–1739.
[56] Blaabjerg F , Ma Ke. Future on power electronics for wind turbine systems, IEEE J Emerg Sel Top Power Electron.
[57] Blaabjerg F, Liserre M, Ma K. Power electronics converters for wind turbine systems. IEEE Trans Ind Appl 2012;48(2):708 (719,).
[58] Choi UM, Lee KB, Blaabjerg F. Power electronics for renewable energy systems: wind turbine and photovoltaic systems. In: 2012 International conference on renewable energy research and applications (ICRERA); 11–14 Nov. 2012.
[59] Marks ND, Summers TJ , Betz RE. Photovoltaic power systems: a review of topologies, converters and controls. In: 22nd Australasian universities power engineering conference (AUPEC); 2012. O. Ellabban et al. / Renewable and Sustainable Energy Reviews 39 (2014) 748–764 763
[60] Ferreira P, Trindade M, Martins JS , Afonso JL. Interfaces for renewable energy sources with electric power systems. In: Environment 2010: situation and perspectives for the European Union. Porto, Portugal; 6–10 May 2003.
[61] Afzal A, Kumar H, Sharma VK. Hybrid renewable energy systems for energy security using optimization technique. In: 2011 International conference and utility exhibition on power and energy systems: issues & prospects for Asia (ICUE); 28–30 Sept. 2011.

[62] Technology Roadmap: Smart Grids, April 2011, IEA, www.iea.org, [accessed on 1/04/2014].
[63] Shafiullah GM, Oo AMT, Jarvis D, Ali ABMS, Wolfs P. Potential challenges: integrating renewable energy with the smart grid. In: 20th Australasian universities power engineering conference (AUPEC); 5–8 Dec. 2010.
[64] Mohamed A, Mohammed O , Roig G. Efficient integration of renewable energy to smart grid power systems. In: Tenth LACCEI Latin American and Caribbean conference (LACCEI); July 23–27, 2012.