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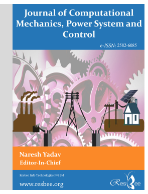

Renewable and Sustainable Energy Status and their Applicability in Electric Vehicle Recharge Stations

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Abstract: Significant progress has been made in the field of renewable and sustainable energy over the past two decades. Sustainability and decarbonization paved the solution for climate change, global warming, pollution, and deforestation. Using environment-friendly energy resources, reliable supply based on demand, and sustainable storage can serve the need for power in various forms. The increase of Electric vehicles (EVs) increases the popularity in the future mode of transport. This paper defines and analyzes the most emergent renewable energy sources. These are either specialized or evolved forms of conventional energy sources, such as hydro, biomass, biofuels, geothermal, wind, and solar, or completely novel technologies. These technologies include marine energy, concentrated solar photovoltaics (CSP), enhanced geothermal energy (EGE), cellulosic ethanol, and artificial photosynthesis. Each emerging renewable source's explanation is followed by its market share, challenges, implications for increased adoption, prospects, and drawbacks. In addition to this, integrated photovoltaics and wind-power electric car charging stations were developed as an application of renewable energy. The optimized design of the electric charging station can provide sufficient electric supply to electric vehicles throughout the day. This paper provides overall research information on emerging renewable resources and establishes a ground for future research in EVs and their vital fields.

Keywords: Renewable energy, sustainable energy, charging stations, electric vehicles, marine energy, and photovoltaics are all viable energy sources.

Nomenclature

Abbreviation	Expansion
GSR	Global Status Report
EVs	Electric Vehicles
GTREI	GLOBAL TRENDS IN RENEWABLE ENERGY INVESTMENT 2020
IEA	International Energy Agency
OES	Ocean Energy Systems
CST	Concentrated Solar Thermal
CSP	Concentrated Solar Power
EGS	Enhanced Geothermal Systems
DP	Degrees of Polymerization
PV	Photovoltaics
CSP	Concentrating Solar Thermal Power
PLEXOS	Production, Losses, and EXpenses Operating System
ANN	Artificial Neural Network
PSO	Particle Swarm Optimization
GA	Genetic Algorithm

1. Introduction

Energy production and consumption are vital for the growth of all countries economically [36]. Currently, most activities require energy. Transport, industry, housing, agriculture, air conditioning, and health are some of the examples. The total number of vehicles worldwide is expected to reach 2 billion by 2035 [33]. The demand for the current use of fossil fuels [1] such as coal, oil, and natural gas was highly increased. Burning of these resources impact on carbon emissions. This causes an increase in greenhouse gas emissions, leading to pollution, climate change, a rise in the earth's temperature, increases health risks for humans, animals, and plants, and increase sea levels. There are many researches, policies, and methods for the reduction of CO_2 worldwide. However, the need for fossil fuels hasn't decreased and they are not renewable. So, Future needs can only be satisfied through the shift to renewable resources. This also helps to reduce the greenhouse gases. Renewable resources are reliable, timely, and cost-effective

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supply [8,9]. This method helps to adopt a sustainable development strategy: one that serves the requirements of the current generation without jeopardizing those of future generations.

The present transport system releases major pollutants into the atmosphere [29]. To reduce air pollution and oil dependence in the transport section, EVs was adopted in recent years. The EVs use fuel cells and batteries to store energy. They are not dependent on fossil fuels. The vehicles won't emit any gases [30]. China's EV sales were on the top since 2009 and reached 2.08 million in 2018 [34]. However, to make EVs stand out in the market, several challenges need to be resolved such as the cost of the battery, grid, and charging methods [31]. It is important to note that the real-world data about EVs was scarce including new technology and policy scenarios [35]. An Electric vehicle spends 2 cents per mile, roughly, while a fuel vehicle spends 12 cents per mile [32]. People can save time in gas stations by owning an electric vehicle by charging the vehicles in the EV charging station or at home. Consequently, this challenge motivated us to seek out concrete energy production and management solutions.

The main objective of the manuscript is

- Analyze various renewable resources based on their market share, challenges, implications for increased adoption, prospects, and drawbacks.
- Implementation of an EV charging station through photovoltaics and wind energy.
- Comparison of Investment vs efficiency for renewable and Non-renewable resources.

In this paper, an overview of the latest renewable resources such as ocean power, wave and tidal energy, concentrated solar power/photovoltaics, EGS, Cellulosic ethanol, and Artificial photosynthesis was discussed based on the process with current technology, future scope, market shares, scope and challenges of each renewable energy sources. It also highlights the implementation of the Electric charging station through solar/photovoltaics and wind energy to provide a sustainable energy source throughout the day for cars and other vehicles. The prospects and the drawbacks were also explained to help the researchers of future development.

The organization of this paper is in this order: Section 2 presents the literature review, and Section 3 portrays renewable and sustainable energy development. The emerging renewable and sustainable energy technologies are explained in section 4. Section 5 covers the implementation of EVs using solar and wind energy. Section 6 provides the advantages and disadvantages, Section 7 showed the result and discussion, Section 8 explains the Comparison of Investment vs efficiency for renewable and Non-renewable resources, Finally, Section 7 concludes the paper with future work.

2. Literature Review

In 2020, Petrusic *et al.* [23] have implemented a multicriteria methodology for scheduling a hybrid electric vehicle charging station. Initially, it monitored the origin of energy and maximize the use of solar power plants. The charging system for EVs was connected to a public distribution network for solar power plants and an energy storage system. The result showed that the vehicle can be charged in different ways depending on the availability of energy from different sources, such as the network, PV panels, and battery.

In 2020, Noman *et al.* [24] have used an interval-based approach to wind energy conversion. Initially, the approach was analyzed using different constraints and criteria, including wind speed averaging time intervals, various turbine manufacturers, and standard high-resolution wind speed datasets. A quasi-continuous wind turbine's output energy was used to measure the EV charging effectiveness. Finally, the Performance of the wind turbine analysis used two years of wind speed data to determine the feasibility of direct wind-to-EV charging.

In 2017, Sakib *et al.* [25] have executed mathematical modeling and simulation using Matlab/Simulink for a microgrid system with natural gas generators and an electric vehicle charging station. Initially, Simulation of the natural gas generators, including excitation systems, off-grid operation, grid-tied operation, and combined heat and power generation. Simulation of the EV charging station, including the electric vehicle charging station levels, DC bus capacitance calculations, EV battery, battery charger, three-phase inverter, and LCL filter. Finally, simulation results were analyzed and verified results were obtained.

In 2013, Foley *et al.* [26] have developed PLEXOS to analyze the impact of electric vehicle charging. Initially, Input data on operational and market constraints from the generation portfolio to dispatch power to meet demand as a series of models. Then developed solutions using deterministic or stochastic programming techniques to minimize an objective function or expected value subject to the cost of electricity dispatch and to several constraints including availability and operational characteristics of generating plants, licensing environmental limits, fuel costs, and operator and transmission constraints. Finally, the results showed that off-peak charging was more beneficial than peak charging.

In 2020, Abas *et al.* [27] have adopted Microbial Fuel Cells for hydrogen production. This method used sunlight to split water molecules into hydrogen and oxygen that can be used as a source of clean and renewable energy. In this process, solar energy is stored in the chemical bonds of the carbohydrates.

In 2019, Sayed *et al.* [37] have introduced an integrated DC microgrid using solar and wind power. Initially, integrating a wind turbine and solar photovoltaic arrays into the DC microgrid. Using DC converters and inverters the power supply load was managed. The additional power was used in the battery and used as needed. The result showed that this method can provide electricity throughout the day.

In 2023, Aboelezz *et al.* [38] have devised a generic electric vehicle battery charging system using a wind turbine. A small vertical-axis wind turbine was used to build an ANN model. It was then inserted into the MATLAB/Simulink software tool to predict the charging performance. An rpm controller was used to achieve the maximum generated power from the wind turbine across the day with various wind speeds. It was then fed into an EV battery charger to implement the constant current constant voltage (CC-CV) charging protocol. The charging current is maintained at a constant value despite the change in the generated power from the wind turbine or the utility grid. The result showed that this application of wind energy to EVs provides sufficient constant power supported by the utility grid.

In 2023, Karmaker *et al.* [39] have integrated solar and biogas for energy production in EVs. It also used PSO, GA, and the GA-PSO algorithm for Optimizing and to get better results. Furthermore, the process was evaluated and the performance was compared with existing flat-rate tariffs. The results showed that the energy costs were reduced by 74.67% compared to existing flat rate tariffs and offer lower charging costs for weekdays and weekends.

2.1 Review

Table 1 portrays the methodology, advantages, and disadvantages of the existing method. We considered eight papers that used a different methodology at various levels. Each method has certain benefits and shortcomings, that were explained in detail.

Table 1: *Review Based on Existing Methods*

Author	Methodology	Advantage	Disadvantage
Petrusic *et al.* [23]	Multicriteria optimization	• Maximized the use of renewable sources. • Flexibility in charging. • Easy to implement.	• Required significant investment in infrastructure, such as solar power plants and energy storage systems.
Noman *et al.* [24]	Interval-based approach	• Cost Effective method. • Reduced greenhouse gas emissions and promote sustainable transportation. • Provided a constant power supply for specific time intervals. • Suitable for urban areas with high demand for EV charging.	• Feasibility depends on several factors. • Required significant investment in wind turbines and other infrastructure.
Sakib *et al.* [25]	Matlab/Simulink	• Reduced the negative impact on the environment and geological aspects. • Meet the demand for the next-generation power system. • Better design and optimization of the system. • Enhancing fuel efficiency.	• Required initial investment and infrastructure development. • Depends on the availability and accessibility of natural gas resources.
Foley *et al.* [26]	PLEXOS	• Minimize the cost of electricity dispatch and to some constraints. • More accurate analysis of the impact of electric vehicle charging under peak and off-peak charging scenarios.	• May not be directly applicable for other electricity markets.
Abas *et al.* [27]	Microbial Fuel Cell	• Developed more efficient and stable water-splitting systems. • A promising technology for generating clean and renewable energy. • Can withstand harsh conditions and resist corrosion.	• Used expensive catalysts. • Need for large areas of land and the requirement for continuous monitoring and maintenance.
Sayed *et al.* [37]	DC microgrid	• Reduced carbon emission • Provide sufficient electricity supply.	• Costly and may require a significant initial investment.
Aboelezz *et al.* [38]	Generic electric vehicle battery charging system and ANN	• Accurate and efficient model. • Achieved the maximum generated power from the wind turbine across the day.	• Required a full prediction of the wind signature. • Required initial investment in wind turbines and charging infrastructure.
Karmaker *et al.* [39]	Fuzzy inference system	• Reduced energy costs • Provided lower charging costs • Establish a sustainable charging infrastructure • Effective energy management system.	• Effectiveness may vary with sizes and locations. • Required initial investment costs.

2.2 Challenges

Some of the issues faced by the EVs are as follows,

In [23][24][25][37][38][39], it is easy to implement. However, it required significant investment in infrastructure, such as solar power plants and energy storage systems. For commercial use, The individual implementation of the project is risky. Solar and geothermal energy production maximizes renewable energy production [23][27]. Consequently, it required large space for the solar panel setup and man-made EGS. Energy production varies with climate and resources [24][25]. For example., On sunny days, the solar energy is maximum in the daytime and if the natural resources are abundant in the particular locality, then the production of the energy was also higher. To store the excess energy the manufacturing units required Storage facilities. However, the storage facilities are complex and located far away from the energy source. In [39], the method provides lower energy costs. Moreover, it depends on resources. Higher resource lowers the price and vice versa. Wind energy, tidal energy, and geothermal energy are the greater source of renewable sustainable energy [24][37][28]. The pollution from various sources such as carbon emissions from transport while transporting machinery and setup, urbanization of nearby areas for want of labor to work in the plant, clearing the areas by removing the habitual inhabitants, noise pollution from turbines, and tidal plants affects birds, fishes, and other living organisms. This reduces the number of EV charging stations.

3. Renewable and Sustainable Energy Development

To get a sustainable energy source, it must meet certain social, environmental, and economic criteria. An overview of established and emergent renewable technologies is explained in Fig. 1,

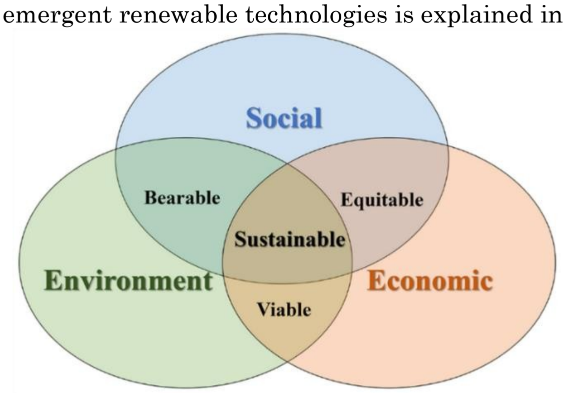

Fig. 1. *Sustainable Development Scheme (Source: Sustainable Development Portal)*

Today, renewable energies are more mature and dependable on the rise and increasingly competitive with conventional energy sources. Bio-energy, Wind power, geothermal power, heat, hydro power, Solar PV, CSP, Solar thermal heating and cooling, and Ocean power are on the right track, and in some cases have surpassed economic limitations. The proportion of renewable energy sources in global final energy consumption is increasing.

In 2014, renewable energy was estimated to account for 23.7% of global final energy consumption [2], and by the end of 2019, it is 27.7% [3]. Fig. 2 depicts the contribution of various renewable energy sources to the world's renewable energy. It has been observed that hydropower accounts for 15.9% of the total 27.3% of renewable energy sources, while wind power, solar PV, and bio-power account for 5.9%, 2.8%, and 2.2% respectively. As shown in Fig. 2, other renewable energy sources such as geothermal, CSP, and ocean power contribute only 0.4%.

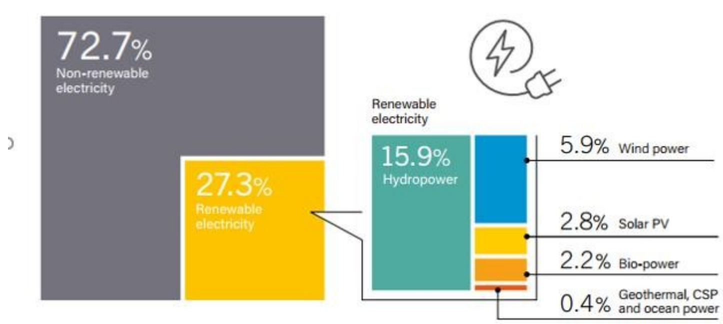

Fig. 2. *Estimated Renewable Energy Share of Global Electricity Production, End 2019 [3]*

According to the GSR, despite gains in energy efficiency and continued growth in EV sand bio-fuels, the transport sector has the lowest share of renewable energy. On the other hand, the renewable power sector has experienced record-high increases in capacity, outpacing net installations in nuclear power and fossil fuel [3].

In 2015, developing economies accounted for the preponderance of global investment in renewable energy capacity for the first time, and continue to do so. In 2019, $54 percent of the world's total of $282.2 billion was represented by the United States. This was the same proportion as in 2018, but it was lower than the 62% share in 2017. It was the highest amount ever invested in renewable energy capacity in other developing countries outside of China and India. [4]

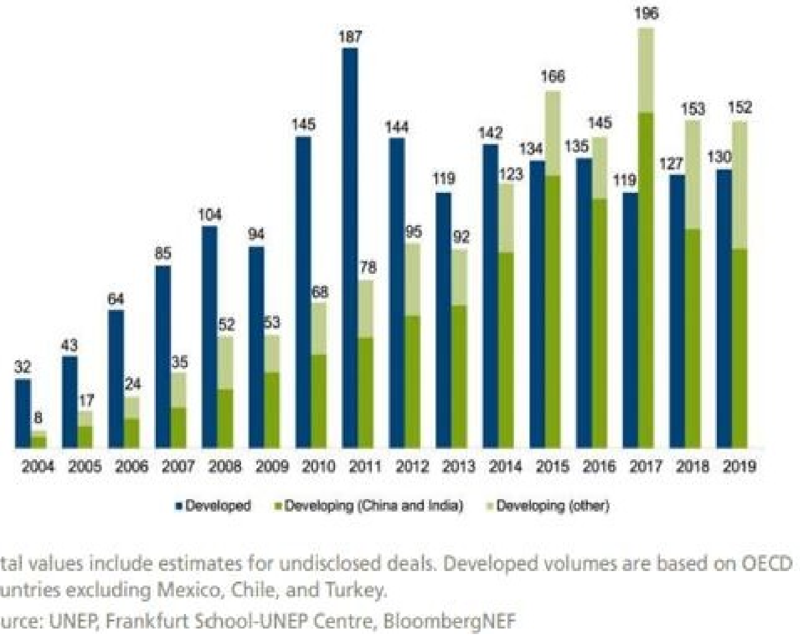

Fig. 3. *Investment in renewable energy capacity, developed vs developing countries, 2004-2019 $BN [4]*

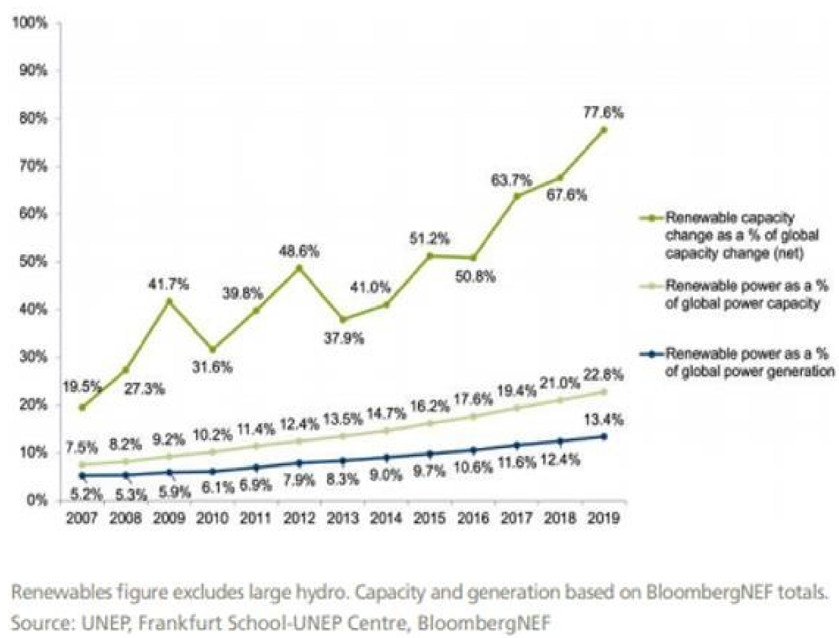

Fig. 4. *Renewable Power Generation and Capacity as a Share of global power, 2007-2019, % [4]*

GTREI is a report published annually by the Frankfurt School under the auspices of the UN Climate and sustainable energy finance group. It examines renewable investment in the context of the entire system of electricity generation [4]. As shown in Fig. 4, the addition of renewable energy generation capacity is progressively altering the global energy composition. The blue line indicates that, excluding large hydro, renewables generated an estimated 13.4% of the world's electricity in 2019, up from 12.4% in 2018 and just 6.2% in 2010. The upper line represents the proportion of last year's net new generating capacity additions that consisted of wind, solar, and other renewable technologies. The performance of investments in renewable energy has been noticeably more impressive in recent years. As depicted in Fig. 4, a record increase of 78% was observed in 2019, setting a new benchmark.

4. Emerging Renewable and Sustainable Energy Technologies

Renewable energy technologies can be classified as both mainstream and emergent. Wind energy, solar energy, biofuel, hydropower, biomass energy, and geothermal energy constitute the mainstream renewable energy sources. Emerging renewable sources include improved geothermal energy, marine energy, solar photovoltaics, cellulosic ethanol, and artificial photosynthesis. In the past decades, a great deal of work has been done and continues to be done on mainstream renewable energy technologies, and in the last decade, several renewable energy technologies have emerged. The sections that follow expand on emergent renewable technologies.

4.1 Ocean Power

Ocean energy is also referred to as marine energy. Although the energy held in these oceans in the form of currents, tides, heat, and waves is sufficient to meet the world's energy needs [5], it represents the smallest portion of the renewable energy market [6].

The ocean power is obtained through the movement of waves. The floating beacon in the water top was used to indicate the ships. As the water surface moves it moves the floating beacon up and down that pulls the cables below. It contains a generator coil that has a magnet. The to-and-fro movement of the magnet creates an electric current that will be transferred through cables.

The global ocean power market size was valued at $0.6 billion in 2021 and is projected to reach $7.8 billion by 2031, growing at a CAGR of 21.4% from 2022 to 2031 [40]. The scope is based on the coastline. The longer the coastline can provide higher power. This method helps the coastline's residents, Islands to generate electricity.

Even though advancements in this sector are sluggish, the ocean power industry has begun shifting towards semi-permanent installations and device arrays. So many regional government policies with varied incentives have been implemented [7]. According to the International Energy Agency, ocean waves produce 20,000 to 80,000 terawatt hours of electricity.

In 2001, The IEA Technology Collaboration Program on OES began with three countries; by 2022, the number of member nations had increased to22[8].

Table 2: *List of OES members of 2022*

Membersin 2022		
Australia	Belgium	Canada
China	Denmark	France
Germany	Ireland	India
Italy	Republic of Korea	Japan
Mexico	Monaco	Netherlands
NewZealand	Portugal	Spain
Singapore	Sweden	European Commission
United Kingdom	United States of America	

4.2 Wave and Tidal Energy

The only source of marine wave energy is the wind. When the water level in the chamber raises and falls, the air from the chamber moves in and out of the turbine which causes the rotation of the turbine. Here the mechanical energy is converted into electrical energy through the generator. Waves can transfer energy with minimal losses, particularly since they can acquire energy from the wind over vast expanses of open ocean. Tidal energy results from the rise and decline of ocean waves as a consequence of the gravitational and rotational forces between the moon, sun, and earth [10]. Tidal energy has been utilized commercially for along time [1]; the principle of this technology is similar to that of power plants as reservoirs, except that the wave masses do not travel downstream, but rather move back and forth in response to the tidal flow [11].

The wave energy converter market size stood at USD 21.08 million in 2022. During 2022–2030, the growth rate of the wave energy converter market will be around 4.70%. Power Generation is the largest application area in the wave energy converter market [41]. The World Energy Council predicts that ocean energy could meet 10% of global electricity demand. Wave energy is a pure source of renewable energy and is obtained from all the water bodies which produce waves. The energy can be produced throughout the year.

However, the wave power reduces significantly when the weather is rough. The large machinery will provide huge noise and affects the habitats of crabs, fishes, and plants nearby. The crucial side effects of this method are huge investments, huge machinery, and labor.

4.3 Concentrated Solar Power/Photovoltaics

Solar energy is one of the finest solutions to meet the world's growing energy demand [12]. The sunlight is trapped in the photovoltaic cells. The semiconductor wafer consists of a positive and negative charge that creates an electric field. When the sunlight energies the field it loosens its electrons and the motion creates the electric current. Utilizing this method, the generation of electricity from solar energy is performed. Annually, approximately four million exajoules (1 EJ = 1018J) of solar energy (1 EJ = 1018J) reach the earth. It is claimed that 5X 104EJ are harvestable [13].

Latitude, climate, geographic variation, and diurnal variation determine the magnitude of the solar flux that enters the Earth's atmosphere [14]. Around 342 Wm^{-2} of solar energy is received by the earth's atmosphere, of which 30% is reflected into space and 70% can be captured [12]. Annually, effective solar energy across the globe ranges from 60 to 250Wm^{-2} [15]. The scope of the solar energy is enormous. In equatorial, tropical, and temperate regions, solar energy is produced by establishing solar plants and also from the rooftops. Consequently, the initial cost of the solar panels is expensive and required sunlight throughout the day.

There are two categories of active solar energy technology: solar thermal technology and photo voltaic technology [16]. Recently, using semiconductors to convert solar energy into electrical energy has become the preferred method [17]. Domestic and commercial applications such as boiling, drying, and heating utilize solar energy [18]. In the industrial sector, however, CST is used to meet such needs, whereas CSP is used to generate electricity [12].

Fig. 5 represents the classification of solar energy technologies.

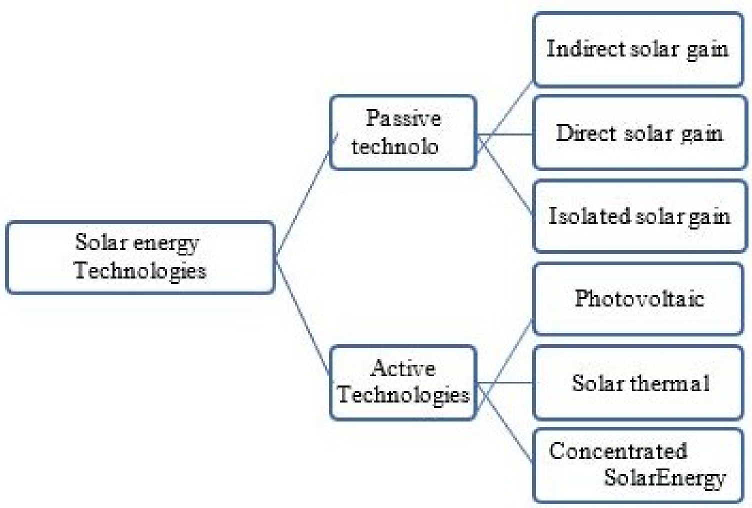

Fig. 5.*Classification of solar energy technologies [12]*

The exorbitant cost of installation is one of this technology's limitations. The national average cost fora 6kW solar panel system for a 1500-square-foot property is $18,500. Solar panel prices per watt can range between $2.50 and $3.50 [19]. In addition, this technology can only be utilized during sunny days; as a result, solar energy is not the most dependable source of energy, especially considering that air pollution at the installation site affects the efficiency of cells [20].

4.4 EGS

Providing constant renewable energy with thermal and geothermal energies is crucial for a solar photo voltaic and wind-only hybrid grid implementation, as batteries are required to store vast amounts of energy.

Geo thermal energy is projected to increase as a result of EGS, in which hydraulic fracturing may generate geo thermal fluid sources in the quantity and quality required in numerous locations where they are naturally unavailable [21]. A man-made setup was created to inject the fluid into the hot rocks to generate electricity. There are three main technologies: Flash stream, dry stream, and binary cycle. The EGS system is created by injecting water at a very high pressure into the thermal reservoir to forma fracture system. The first stage is the injection of water into the fracture system. The second step is to intersect the fracture system and conduct the water to the surface.

The energy required is vast in populated countries. The greenhouse gas emission was high in the polluted areas and populated areas which increases the heat in the underground surface. These are chosen for the production of geothermal energies. From the allied market research report. The global geothermal turbines market size was valued at $67.5 billion in 2021 and is projected to reach $99.5 billion by 2031, growing at a CAGR of 4% from 2022 to 2031.

This energy is limited by the requirement for vast volumes of water for continuous hydraulic fracturing operations. In addition, this technology is complex, hazardous, and costly [22].

4.5 Cellulosic Ethanol

Cellulosic ethanol is produced from sugarcane and maize starch. Initially, the fibers were pre-treated with various technologies to access enzymes. Then they are hydrolyzed into fermented sugar called cellulase. Then further fermented to produce ethanol using yeast [42].

Ethanol is the largest liquid biofuel in terms of volume [23]. As shown in Fig. 6 [24], the United States and Brazil are the largest fuel ethanol producers in the globe.

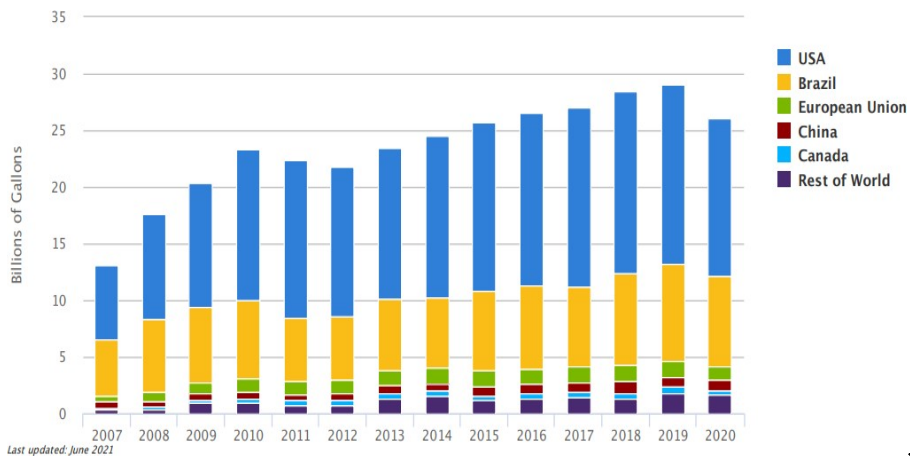

Fig. 6.*Global Ethanol Production by Country or Region [24]*

The U.S. consumers of increased cellulosic ethanol production up to $12.6 billion in 2020. It is equivalent to about 40 percent of the gains in real income that would accrue to the United States from eliminating all restraints on imports [43]. Ligno cellulosic biomass is a sustainable feedstock for the production of fuel ethanol; it is dispersed on the ground and has low mass and energy densities for large volumes and high logistics costs [23].

Cellulose is a homogeneous glucan composed of -1,4 glycosidic bonds with cellobiose as the repeating unit and displaying varying DP [25]. Cellulosic ethanol production is intricate, but according to a study conducted at the University of California, Berkley, this energy has the potential to reduce greenhouse gas emissions by 90%.

To commercialize this technology, researchers in the field of cellulosic ethanol must overcome numerous obstacles, such as the reduction of stages in the cellulosic ethanol formulation by extending process integration [44].

4.6 Artificial Photosynthesis

The sun is the primary source of renewable energy. Artificial photosynthesis is one of the ways it can be used with water. There are three phases. The first stage is light harvesting by chlorophyll, the second is tyrosine, which mediates the mobility of electrons so that they act as a catalyst, and the final step is manganese, which is responsible for sending electrons to chlorophyll [26].

To summarize the concept to f artificial photosynthesis, the electron transport principle is identical to that of natural photosynthesis [26].

This energy had the potential to produce solar fuels in the future in an efficient manner. The catalytic stages for it are its significant contracts. Several laboratory prototypes of systems that use sunlight to divide water into hydrogen have been created, but there are safety concerns regarding the storage and transportation of hydrogen. In addition, AP materials are frequently submerged in water, causing stability issues.

Artificial photosynthesis has a large scope on an industrial scale. It can reverse global warming. It is a clean renewable energy and doesn't create any by-products. The energy produced in the process is stored in solar fuel for later use. This creates opportunities for designing new vehicles with no carbon dioxide emissions. However, It is challenging to find the right transition metal catalyst for each desired reaction, balancing activity, selectivity, and stability.

5. Applications

These renewable energies are used in our daily lives to power residences, structures, and automobiles to create green cities. In our paper, photovoltaics and wind energy will be utilized to simulate a charging station for electric vehicles, as depicted in Fig. 7. Initially, the DC is obtained from the solar panels and the wind turbines. From the solar panel the electrical energy was fed into MPPT where the maximum power from the solar cells was transmitted. The voltage and current was monitored to choose the optimal value. If the voltage various then it can be altered through DC-DC convertor. The DC Microgrid is used to transfer the energy from the source to its EVs. In the receiving end the DC-AC inverter is used to convert the current. The LC filter remove the unwanted noise from the circuit and improve the waveform quality of the electrical signal.

The wind turbine is connected to DC-DC converters where the electric current is monitored through MPPT the charge controller. At the same time, the battery bank charged and discharged from DC microgrid using a bidirectional DC-DC converter.

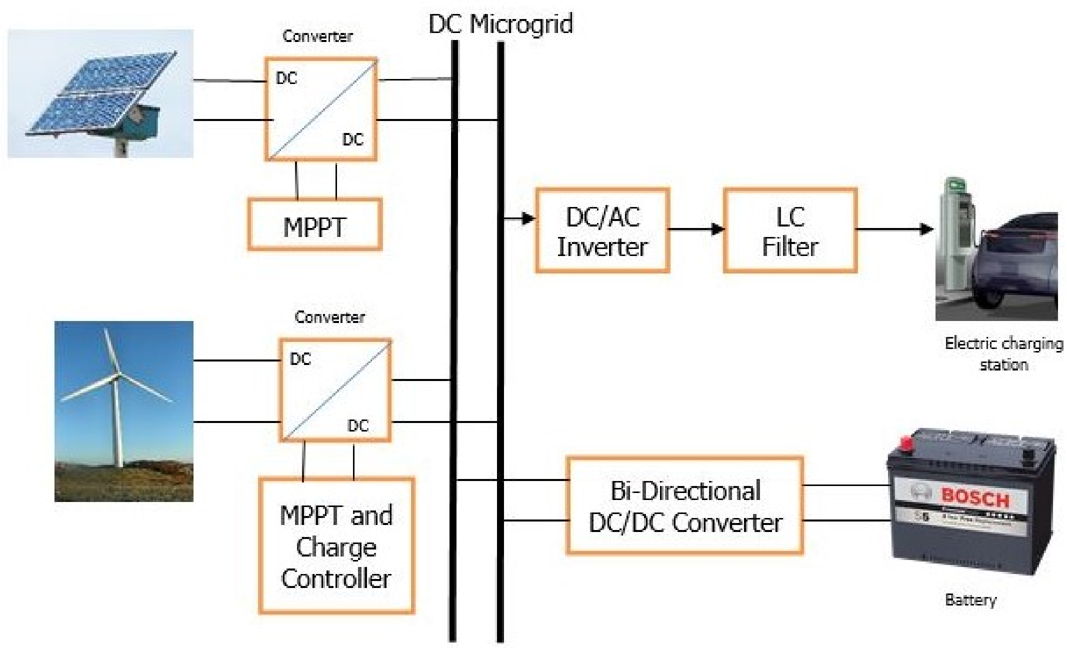

Fig. 7.*Diagram for Charging station using renewable energies*

6. Advantages and Disadvantages of Charging Station

Advantages

- EV Charging stations will reduce carbon footprints and reduce air pollution.
- It helps to change the electric vehicles at own convince.
- Renewable energy such as solar and wind helps to reduce the non-renewable energy in the charging station.
- Reduce greenhouse gases.
- Eco-friendly method

Disadvantage

- It required an initial investment for the setup.
- It takes more time to charge the battery.

7. Result and Discussion

Marine energy, concentrated solar photovoltaics, EGE, cellulosic ethanol, and artificial photosynthesis have been defined, along with their process, scope, markets share, and challenges. It shows that renewable energy was the future of the world. As the non-renewable source of energy is on the edge of existence. Renewable energy was the only scope of many countries. Renewable technologies may cost a lot in the initial investment but they last for a decade. With the combination of all the renewable energy methods, we can get more energy than non-renewable energy in an eco-friendly manner. Each country has to analyze the wealth in renewable energy and invest them for the future development of the nation and people. The initiative must be strengthened with further research in minimizing investment, machinery, and labor. This leads to higher and more efficient energy production. The application using solar and wind help to provide electricity throughout the day. Solar energy covers the day time and wind energy is produced higher in the night time. This provides excellent performance under different operational conditions. The Battery can increase the reliability of the system because it can store excess renewable energy during low-demand periods and can supply during high-demand periods.

8. Comparison of Investment and Efficiency of Non-Renewable Energy and Renewable Energy

Construction for any plant for non-renewable and renewable energy sources required lot of upfront investment, exploration, extraction, infrastructure, labor, machineries, vast area for the construction of the power plant. Apart from the initial investment additionally, there are ongoing cost of mining, refining, fuel procurement and maintenance. In general, the initial investment for any sources is higher and it can be decreased over the years due to the technological advancement and economics of scale. Mostly the sources are free only to obtain the energy we need higher initial percapita and the operational cost are comparatively low.

The efficiency of any source is relatively efficient in terms of energy density and conversion rates. The efficiency depends on technological advancement. There will be higher efficiency while converting the source into electricity. However, the efficiency decreases when in it inherits losses in extraction, transportation and conversion process. The energy density is lower in renewable energy compared to the non-renewable energy. This makes the renewable energy to provide more extensive infrastructure in large areas to provide the same amount of energy from the non-renewable sources.

The cost of any power plant is based on the specific project (Small-scale or Large-scale), resource, location and technological advancement. So, we cannot predict the exert investment of any energy sources. However, approximate investment of power plants are estimated. In ocean power plant, the investment ranges from \$3 Million to \$300 Million. As investment various based on the project, the efficiency of the ocean power plants varies from 20% to 40%. In tidal power plant. Investment various from \$3 million to \$20 million and the efficiency lies between 35% to 45%. In geothermal power plant, the investment ranges from \$2 million to \$5 million and the efficiency ranges from 10% to 20%. In solar power plant, based on the size of the plant the investment varies from \$1000 to \$300 per kilo walt and efficiency is from 20% to 25%. In the cellulosic ethanol, the investment lies on \$200 million to \$500 million and efficiency at 40% to 50%. The artificial photosynthesis power plant is in the early stage of development and the approximate investment are not yet predicted. In the coal power plant, the investment, lies on \$1 million to \$5 million and the efficiency is based on 30% to 40%. In oil power plant, the investment lies from million to billions and the efficiency will be from 25% to 40%. From the natural gas plant, the investment lies from \$0.5 million to \$ 2 million and the efficiency at 50% to 60%. In nuclear power plant, the investment is from \$1Billion to \$10 Billion and the efficiency is above 30%. In the Fig. 8 and Fig. 9, the comparison of the renewable resources such as ocean energy, tidal energy, geothermal energy, solar energy, cellulosic ethanol was compare with the non-renewable energy such as coal, oil, natural gas and nuclear energy. Here the maximum investment and the maximum energy is taken into consideration.

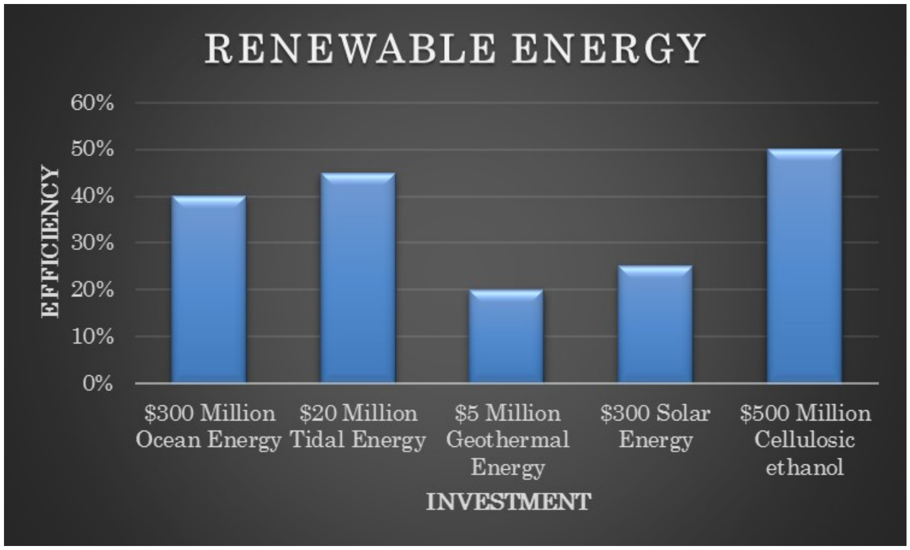

Fig. 8.*Comparison of Investment vs Efficiency for renewable energy*

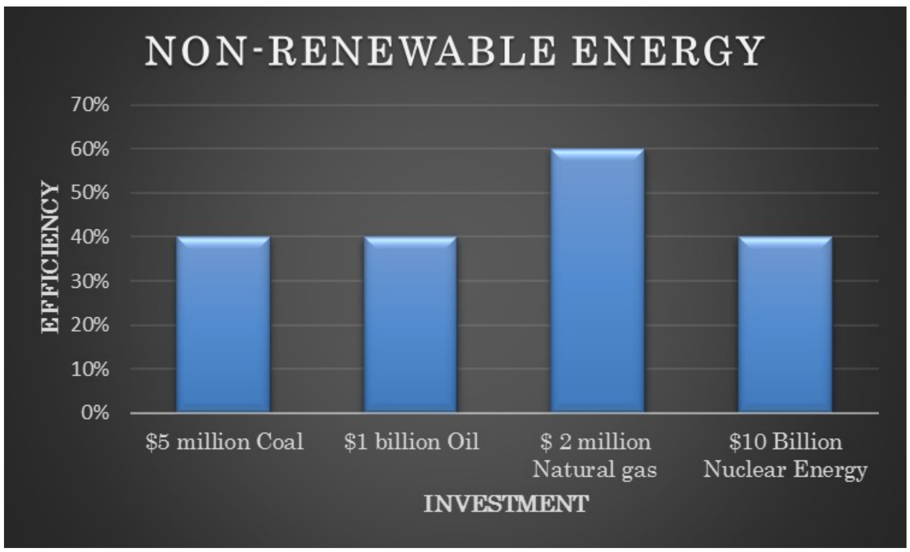

Fig. 9.*Comparison of Investment vs Efficiency for non-renewable energy*

From the graph, Despite the initial high investment, non-renewable energy sources have historically been more cost-effective due to their high energy density and established infrastructure. However, the costs associated with non-renewable energy are not limited to financial considerations. They also include environmental externalities, such as air pollution, greenhouse gas emissions, and their impact on climate change. As renewable energy technologies advance and economies of scale are realized, they are becoming increasingly cost-effective. Solar and wind power costs have decreased significantly in recent years, and they are now competitive or even cheaper than fossil fuels in many regions. Moreover, renewable energy sources have the advantage of being sustainable and have a much lower environmental impact compared to non-renewable sources.

9. Conclusion

The growing population, increasing greenhouse gases, and reduction of non-renewable resources paved the way for new avenues of research in renewable resources. This study aims to understand the emerging renewable energy extraction technologies and their applications. The proposed study is helpful for the effective utilization of renewable resources to reduce greenhouse gases. Many sub-technologies exist within each of the major emergent technologies. It is necessary to support these renewable technologies to purify the planet. In addition to that, while non-renewable energy sources have traditionally required significant investment and have been relatively efficient, renewable energy sources are catching up in terms of cost-effectiveness and efficiency. The ongoing global shift towards renewable energy is driven by factors such as decreasing costs, environmental concerns, and the desire for long-term sustainability.

Due to Morocco's high energy consumption, these renewable energies can be utilized in electric vehicle (EV) recharge stations.

Compliance with Ethical Standards

Conflicts of interest: Authors declared that they have no conflict of interest.

Human participants: The conducted research follows the ethical standards and the authors ensured that they have not conducted any studies with human participants or animals.

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