

# Global Status of Solar Energy: Review and Opportunities

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**Abstract** - The world is progressively moving toward its environmentally friendly power benefit. Sustainable power on the planet slowly expands its establishment limit. Inexhaustible electric energy request has been developed by a normal 30% per annum in the recent years against view of quickly declining expenses and costs. By mid-2010, the approach focuses on environmentally friendly power at the public level existed in at any rate 85 nations around the world, including each of the 27 European Union part states. Many public targets are for portions of power creation, commonly 5–30 percent, yet range from two percent to 90 percent. By mid-2010, more than 66% of the 85 nations with existing public targets were focusing on 2020 or the past in some way. Non-industrial nations can balance their CO<sub>2</sub> production by 2025 and lessen subsequently, while simultaneously expanding energy usage because of financial development. The Organization for Economic Co-operation and Development nations will have the option to diminish their outflows by up to 90% by 2050. With this backdrop, this paper provides an insight review based on recent trends in renewable energy like photovoltaic PV, Concentrating Solar Thermal Power and Solar thermal heating and cooling.

**Key Words:** Solar panels (PV), Concentrating solar thermal power (CSP), Solar thermal heating and cooling, Solar cell, Policy Framework.

## 1. INTRODUCTION

Solar energy is one of the most promising energy sources. It's because of their great output efficiency. Another significant point that needs to consider is that it can be used in various areas depending on our needs. It has a lot of potential for use in poor countries. It is because these are mainly found in places around the equator, where it receives lots of sun light. India, for example, receives 5000 trillion kWh of solar power reception per year. By doing this, this not only cutting greenhouse gas emissions but also safeguard the earth's ecology by producing energy from renewable sources. Solar energy can be converted into electrical energy using various technologies, including photovoltaic (PV) panels, concentrated solar thermal power (CSP), and concentrating photo voltaic (CVT).[1].

In the year 2019, environmentally friendly power once more enlisted as another effective year, delivering the force limit exceeding 200 Gigawatt (GW) contrasted with a year ago capacity limit, which has made it the most noteworthy ever[2].

The power age is the area were the portions of renewable continued flourishing owing to its popularity and accessibility of resources. While different areas like heating, cooling, transport did not have that sort of effect because of the absence of strategies and advancements not satisfying the requests. In 2018, the assessed use of sustainable power was 11% of TFEC, while it was 9.6% of TFEC in 2013. The most elevated offer was accounted around 26.4% just for electrical use, but end uses were just 17% of TFEC in 2017[3].

Legislatures of various nations have concocted their atmosphere destinations and approaches. The atmosphere crisis will be announced across twenty-eight countries, the point is to advance the usage of sustainable power framework on customary premise and get adjusted to it. Some nations avoided using coal, while some spent for coal-fired power plants. The financial uphold continued expanding for non renewable energy sources based activities after an arrangement were hit with Paris in 2015, that accounted USD 2.7 trillion from 2016 to 2019. While the CO<sub>2</sub> outflows were leveled out in 2019, however the significant concern is an Earth-wide temperature boost far and wide and it was referenced in the Paris understanding that it ought to be under 1.5°C yet presently it remains at 2°C. Presently, renewable innovation taking other types of thoughts where we can use to extricate useful energy. Energy from these is perfect and don't influence climate at the hour of extraction-Generating energy that creates no ozone depleting substance outflows from petroleum derivatives and diminishes a few kinds of air contamination. Sustainable power age from biomass can prompt a wide scope of an unnatural weather change[4].

It is clearly indicated that solar energy is considered to be emerging energy sources. In general, utilisation of advanced sustainable power framework on customary basis advisable.

## 2. OVER ALL TREND OF RENEWAL TECHNOLOGY IN DIFFERENT COUNTRIES

### 2.1. Solar Panels (photovoltaic PV)

The sun oriented PV market expanded 12% in 2019 to a record of 115 GW (direct current), for an aggregate of 627 GW [5]. A decade finished with solid interest in the United States, Europe and developing business sectors around the globe, more than compensating for a kind decrease in China. Excluding China, the worldwide market developed around 44%. Many governments have implemented laws for the solar industry to develop distributed PV. Germany, being the

world's biggest PV producer, has nearly a quarter of the world's total PV-installed capacity. Additionally, subsidies and policies are one of the key driving forces behind the global shift to solar energy generation. Governments, to policies and subsidies, are employing the second strategy. It is governed by three rules. To begin with, traditional entities are competing directly with large-scale PV enterprises. Second, PV owners have a specific agent that trades power on their behalf in a specified area. Finally, the formation of a decentralized secondary market, via which transactions can be made between the secondary market and distributed PV firms. The PV industry can grow to a larger market share using this strategy [6].

The continent most likely to be affected by climate change is Africa. As a result, they're beginning to place a higher value on renewable energy. South Africa intends to create 8.4 GW of renewable electricity from solar energy by 2030. Egypt wants to create 700 megawatts by 2027, and Nigeria has agreed to follow similar. Now we're in Colombia, a South American country. Photovoltaic solar energy generation is still in its infancy in this country. It is mostly due to a lack of government initiatives as well as photovoltaic energy investors. Photovoltaic energy generating accounts for only about 3% of Colombia's overall energy generation, which totals 5.28 MW. In addition, to photovoltaic energy production is primarily limited to the capital region of Bogota[7].

Building Integrated Photovoltaic Systems (BIPS) is one of the fastest expanding segments of the photovoltaic industry (BIPV). These are capable of producing both power and hot air for space heating. They provide a variety of advantages, including the ability to shelter residents from the weather elements and noise, as well as providing thermal insulation and structural support. Building Integrated Photovoltaic is a rapidly expanding market that is now expanding at a rate of 30% per year. Currently, this sort of system is estimated to have an installed capacity of roughly 8000 MW[8].

China kept on overwhelming the world market just as assembling, impacting both. In many nations, the need actually exists for help plans for sun-oriented PV, just as for sufficient administrative structures and approaches overseeing lattice associations. All things being equal, interest in simply serious huge scope frameworks is developing rapidly, with various undertakings under development. Corporate buying extended extensively in 2019, and self-utilization (progressively with battery stockpiling) was a significant driver for new appropriated frameworks in a few nations, including Australia and Germany. The business kept on confronting tenacious rivalry that, combined with strategy notions and vulnerability, provoked merciless offers at certain bartering and brought about meager edges for certain designers and makers, adding to continuous solidification. Simultaneously, rivalry drove declining costs, opening new business sectors, while the weight of lower costs and desires for rising worldwide interest energized extended and more effective assembling, the passage of new organizations into the area and continuous quest for development. During the year, sun powered PV represented around 10.7% of complete age in Honduras and significant offers likewise in Chile (8.1%),

Greece (8.3%), Italy (8.6%), Germany (8.2%)[5], and somewhere else. By the end of the year, enough limits were in activity worldwide to create an expected 2.8% of worldwide power generation. Photovoltaic frameworks are calm and outwardly inconspicuous thus, it can use on vacationer and normal propensities where it can't upsets the creatures. It likewise produces clean energy and keeps clean surroundings. Around 20% of the worldwide populace lives in 70 nations flaunting astounding conditions for sun oriented PV[6].

## 2.2 Working of Solar cell (Photovoltaic cell)

Indonesian development in solar energy- Indonesia is a tropical country in the equator, so the potential for sunlight-based energy is sufficiently high with the normal sparkle of 6-7 h out of each day with an ideal term of illumination that can be used to produce electrical energy through sun powered boards for 5-6 h of the day. It is a country rich of regular assets with an essential fuel source that can be overseen and used to meet public energy needs, particularly the requirements of electrical energy to far-off networks. Be that as it may, dependence on energy got from fossil diminished gave freedoms to grow ecologically cordial fuel sources (wellsprings of energy got from new what's a more, environmentally friendly power source). Considering ESDM information (2016), Indonesian geothermal stores added up to 17,546 MW and its capability of about 29.543 MW. Introduced limit of geothermal force plant (until 2018) is 1,438 MW. Power strength from enormous scope hydropower measured at 75.091 GW, while the capability of smaller than expected/miniature hydro was around 19,385 MW. The capability of wind energy is 60,647 MW, while the capability of power from bio energy is around 32,653 MW.[10]

## 2.3. Concentrating Solar Thermal Power (CSP)

Concentrated Solar Power (CSP) innovation is perhaps the most encouraging possibility for moderating the future energy emergency. The separated force from CSP innovation is extremely spotless, solid and ecological well disposed. An outline of CSP advancements like Parabolic Box, Solar Tower, Parabolic Dish, Linear Fresnel innovation have been depicted in this paper. Examination among these advancements has been represented in this work. For mitigating the current force emergency in Bangladesh CSP innovation has extraordinary openings, since the normal Direct Normal Irradiance (DNI) in Bangladesh is 4-6.5 KWh/m<sup>2</sup> which is appropriate for a wide range of CSP innovation. Reasonable areas for various CSP plants in Bangladesh are likewise proposed based on proficiency, required territory and measure of DNI got.[11]

Worldwide CSP limit in activity filled solely in developing business sectors. Worldwide CSP limit became 11.5% in 2019 to 6.4 GW, with 603 MW of limit coming on the web [12]. Although this was well beneath the normal yearly increment (24%) of the previous decade, CSP kept on spreading to new business sectors, including Israel, Kuwait and France. South Africa and China additionally brought new plants into administration. Unexpectedly, as much pinnacle

limit as allegorical box limit was finished during 2019. At year's end, an expected 22GWh of warm energy stockpiling (TES) was working related to CSP plants across five landmasses. Practically all business CSP under development – situated in Asia, the Middle East and Latin America – will incorporate TES[12].

In India, concentrated solar thermal power has tremendous economic potential. In India, the economic potential of concentrated solar thermal power is projected to be 571 GW, assuming annual direct normal irradiance of over 2000 kWh/m<sup>2</sup> and wind power density of 150 W/m<sup>2</sup>[13].

Concentrating solar thermal power is becoming more widespread in Nigeria. It is mostly due to the country's vast solar potential, which can support any technology. The total installed operating concentrating solar thermal power plant has reached 4926 MW, according to 2016 reports. When construction is finished, 2056 MW of power will be available, with another 1609 MW is currently under development [14].

Solar thermal power that is concentrated is a very environmentally beneficial way to generate electricity. Noor 1 was the first of its kind, developed in Morocco. This is the world's first environmentally conscious solar thermal concentrating power plant. Since then, many countries have developed these types of power plants, including the United States, Canada, India, Spain, and others. Noor 1 generates 510 MW of energy per year from concentrating solar thermal power, making it the world's largest concentrating sun thermal power plant. This plant additionally features a solar cell-based additional generation of 72 MW [7].

### 2.4 Solar Thermal Heating and Cooling

Sun powered warm limit arrived at 479 gigawatts-warm in 2019, with China representing 69% of the aggregate [15]. Unexpectedly, the aggregate worldwide limit declined (1%) contrasted and the earlier year, since establishments in China did not cover the nation's requirement for substitutions [16]. [16]. Augmentations in the other biggest business sectors for sunlight-based warming and cooling stayed stable, with vital development in Greece, South Africa, Cyprus, Denmark, Tunisia and Brazil, adjusting decreases in Germany, Israel Australia, Switzerland, Italy, Poland and Switzerland [17]. The year was splendid for sunlight based locale warming in Denmark, China and Germany, with 24 frameworks (totaling 196 megawatts) recently appointed. Fruitful advancement additionally created interest elsewhere in Europe [5]

Solar heating and cooling account for a significant share of global energy use. According to 2017 data, global solar heating and cooling systems provided 388 TWh of heat yearly. In the same year, 35 GW-thermal were also put into service. By the end of 2018, the overall capacity of solar-powered thermal heating was predicted to be 472 GW. Due to a lack of thermal energy storage efficiency, the use of thermal heating and cooling is fairly limited. Recent research has reduced the importance of this issue, as the usage of Puretemp68, paraffin wax, and SA/PA gas has improved energy storage efficiency. As a result, this technique allows for more efficient energy storage [18].

Buildings mostly use solar thermal heating and cooling. Additionally, the amount of energy used by building accounts for a significant portion of the total energy consumption. Buildings, for example, account for 40% of total energy use in Europe and Australia [19]. The total solar thermal power of the world had reached 472 GW by the end of 2017. China had completed the largest portion (324.5 GW) of the total installed capacity (472 GW) by the end of 2017. Europe has 51.8 GW, North America has 18.6 GW, Asia except China has 12.1 GW, South America has 12.3 GW, the Middle East and North East has 6.8 GW, Australia and New Zealand has 6.5 GW, and the rest of the world has 24.3 GW. These figures are based on 2017 data [20].

The fig. 1 depicts the share of renewable energy in global policy database.

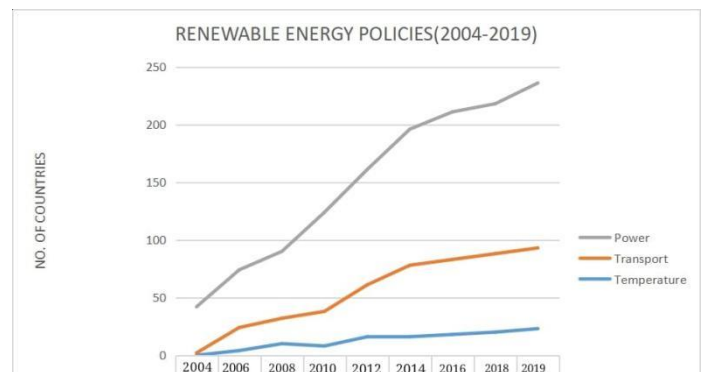


Figure 1. Share of renewable energy in global policy database

Figure 1 does not show all arrangement types being used. Much of the time nations have ordered extra monetary motivations or public account instruments to help environmentally friendly power. A nation is considered to have an arrangement (and is tallied a solitary time) when it has at any rate one public or state/commonplace-level arrangement set up. Force approaches remember feed-for duties (FITS)/feed-in charges, offering, net metering and inexhaustible portfolio guidelines. Warming and cooling strategies incorporate sun powered warmth commitments, innovation non-partisan sustainable warmth commitments and inexhaustible warmth FIT. Transport approaches incorporate bio diesel commitments/commands, ethanol commitments/orders, and non-mix orders [21].

### 3. TRENDING TECHNOLOGY STATUS AND PROSPECTS

There is an all around said axiom "that study of today is the innovation for later" which is being demonstrated by RET's innovation. Venture all through the world in environmentally friendly power and innovation remains practically unaltered until 2019, although toward the finish of the 2019s there is a tremendous blast on the economy which was contributed by inlet nations [22].

As previously mentioned, solar technologies aid in the reduction of greenhouse gas emissions, hence reducing global warming. An evaluation of a research conducted in California found that installing 113,533 household solar systems reduced CO<sub>2</sub> emissions by 696,544 metric tons

[23]. Scientists have produced some impressive results in their research. Perovskite solar cells, for example, had a 3.8 percent efficiency when it initially hit the market in 2009, this was the efficiency. According to recent research conducted by Hong Kong scientists, the efficiency of perovskite solar cells can be significantly boosted by using MoS<sub>2</sub> as an active buffer layer. This leads to the formation of perovskite-silicon tandem solar cells. The current efficiency of perovskite-silicon tandem solar cells is 25.5 percent [24]. That is by the way, has the highest power conversion efficiency in the world [25].

New interest in the field of sustainable power force and powers (excluding Hydro power ventures that is bigger than 50 MW) all around the globe was raised its asset to USD 301.7 billion of every 2019, up 5% from that of 2018[26]. The interests in hydropower ventures bigger than 50 MW all around the globe were discovered to be around in any event USD 316.7 billion. The all out interest in sustainable power and innovation has crossed about USD 200 billion imprint each year since 2010, and now in 2019 its arrived at USD 282 billion of every 2019[27].

Dollar interest in new inexhaustible force limit (counting all hydro power) again far crossed the interest in coal, flammable gas and atomic force limit in 2019, representing 75% of the complete new force producing limit. Interest in renewable zeroed in further on wind and sunlight based force as they are the most essential renewable, the estimation of wind power was first mulled over in 2010. Investment in little scope sun oriented PV establishments (under 1 MW) expanded 43.5% to USD 52.1 billion overall during 2019[27].

Sustainable power and innovation venture shifted to a great extent from the district to locale, beginning its change from America, including the United States and Brazil, however yet there is destruction in all other worlds around Asia area, nation including China, Europe, India, and the Middle East. Considering all out financing of sustainable power limit (not including hydropower bigger than 50 MW), China by and by had the best offer (30%) all around the asian area, and the pattern is trailed by the United States (22%), Europe (19.5%) and Asia-Oceania (16.2%; which bars China and India). More modest offers were found in immature nations such as Africa and the Middle East (5.8%), the Americas (Not mulling over Brazil and the United States, 6%), India (4%) and Brazil (2.9%) [27].

The previously mentioned nations for the most part the center east and Asian nations are contributing because they are getting a huge measure of electric force from a few restoration fuel sources (counting solar, tidal and wind), A schematic outline is appeared beneath for better agreement. The fig. 2 show share of renewable energy in global electricity generation.

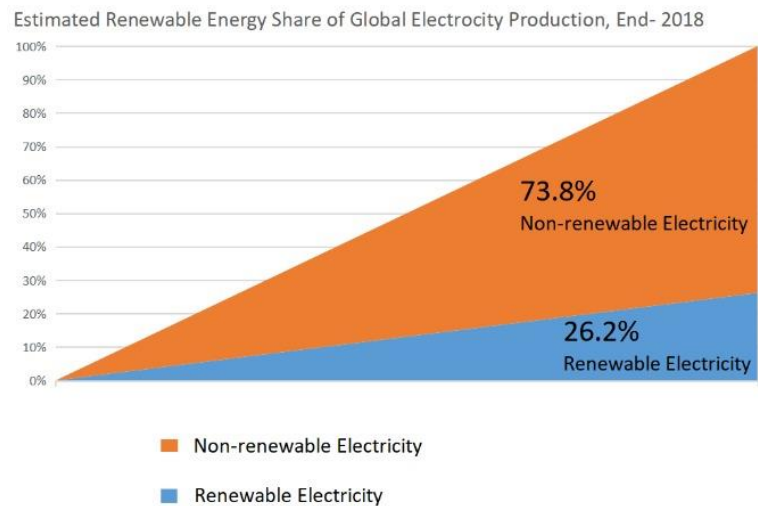


Figure 2. Share of renewable energy in global electricity generation

#### 4. POLICY FRAMEWORK FOR RENEWABLE TECHNOLOGY IN DIFFERENT COUNTRIES

A developing number of locales coordinated approaches towards guaranteeing more noteworthy combination of variable inexhaustible power (VRE). Numerous kinds of environmentally friendly power approaches are found at all jurisdictional levels, including targets, feed-in levies and expenses, barter, sustainable portfolio norms, administrative orders, construction laws, direct budgetary help strategies, financial help arrangements, and approaches to encourage the reconciliation of VRE age into public energy frameworks. Environmentally friendly power targets, which fill in as an important route for public and private entertainers to show a guarantee to the energy progress, range from legitimate government declarations to classified plans with completely created measurements and consistence measures[28]. Targets additionally shift in centre, from a solitary innovation or area to economy-wide.

The European Green Deal can be effectively carried out by cleverly advancing the profound decarbonisation by going with the financial and mechanical change this essentially suggests, what's more, by guaranteeing the social comprehensiveness of the general interaction. In any case, this is a confounded errand which requires a change in perspective of the economy from petroleum derivatives to zero-carbon in a manner that is socially and politically practical. The European Green Deal can be considered as a proficient redistribution system, cultivating venture moves and work replacement in key monetary areas, while making a difference the most weak fragments of society all through the interaction. Based on the likely results of environmental change, probably the greatest test confronted for governments overall is the change of energy frameworks from petroleum products to sustainable energies. Environmental change is answerable for the expansion in outrageous climate occasions, just as an whole arrangement of most sultry years on record. In acknowledgment of this, 179 nations and the EU spent fourteen days in Paris during

December 2015 working out a consent to keep worldwide temperature increment well under 2 °C and if conceivable, underneath 1.5 °C. The decrease in temperature must be accomplished through a huge decrease in the outflow of ozone depleting substances. Known as COP21, (The 21st Conference of the Parties to the UN Framework Convention on Climate Change) it was one of the biggest social events of world pioneers at any point seen. The US promised to cut US environment contamination by 26–28% from 2005 levels. The EU intends to cut discharges by 40% by 2030 on 1990 levels. China's objective is to arrive at top CO<sub>2</sub> discharges by 2030 at the most recent, bring down the carbon force of GDP by 60% to 65% under 2005 levels by 2030, and to build the portion of non-fossil energy transporters of the complete essential energy supply to around 20%[23]. Subsequent to focusing on the Paris Agreement, the decrease of nursery gas outflows is thought to be accomplished through the execution of public energy strategies.

In June 2019, the UK turned into the primary significant economy to revere 'net-zero' by 2050 in law, which passes on the speeding up force for net-zero around the world[29].

The government of India has devised a scheme to encourage the use of renewable energy sources in the production of electricity. By 2022, India intends to generate 100 GW of electricity using solar energy. This was discussed in the budget for 2015/16. The government's initiative to promote solar energy uses a variety of measures, including: - (1) Feed-in tariffs (2) Power purchase agreements (3) Generation-based incentives (4) Viability gap funding, as well as additional benefits[13].

Before the finish of 2016, in any event 176 nations had focuses for sustainable power. In any event 150 nations had received targets identifying with the portion of energy from renewable in power; at any rate 47 nations had renewable focuses set up for warming and cooling; and at any rate 41 nations had focuses for transport [7]. To be viable, targets need the help of cross-sectoral arrangements and measures spreading over warming and cooling, transport, and force. Strategies on the side of the sending of renewable received by nations, for example, targets are cantered overwhelmingly on power age; generally few offer explicit help for renewable in the warming and cooling or transport areas. Administrative strategies for the force area exist in twice the same number of nations concerning the vehicle area and six fold the number of with respect to the warming and cooling area [30].

## 5. SUMMARY

For most Renewal Energy Technologies', costs stay high contrasted with petroleum derivative other options. Many Renewal Energy Technologies' are moderately juvenile in fact and are, subsequently, ready for additional (and maybe critical) cost and execution upgrades. Further, advancements, for example stockpiling frameworks and dynamic burden the board warrant further examination. Technology development ought to be supplemented by propels in framework level reconciliation, geospatially and transiently high goal asset information, gauging, frameworks the board, arranging, and diagnostic approaches.

To coordinate Renewal Energy Technologies' into the energy framework, it is vital to incorporate portfolio moves toward that address central points of interest, for example, extensive and equivalent cost/advantage of all energy alternatives, arrangement of steady and unsurprising strategy conditions, and momentary pathways as more extensive atmosphere related (and CO<sub>2</sub>-cost related) enactment and arrangements are created[15]. Evaluating Renewal Energy Technologies' in energy frameworks is particularly significant as transport charge quickens. This reaches from power/energy framework models to coordinated appraisal models. Sun based energy has the ability to give all of the energy we will actually require. Most of the environmentally friendly power ventures are less efficient practical, in light of the fact that high speculation and danger related with the undertaking. However, still government contributing and expanding the portion of Renewal Energy.

## 6. CONCLUSIONS

The following conclusions can be drawn from the review analysis

- GHG emanations related with energy extraction and use are a significant part of any methodology tending to environmental change relief.
- Renewable energy advances (Renewal Energy Technologies') just as bio-fuels innovations have been quickening quickly during the previous many years, both in innovation execution and cost-intensity — and they are progressively picking up piece of the pie.
- These innovation choices offer numerous positive credits, yet in addition have special cost/advantage exchange offs, such as land-use rivalry for bio assets and inconstancy for wind and sun oriented electric age advancements.
- Given the developing interest and use in RET's as a practical short-and long haul choice for restricting future environmental change, main points of contention that should be tended to for expanded utilization of Renewal Energy Technologies'

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