# RENEWABLE ENERGY IN KARNATAKA: CURRENT STATUS AND FUTURE POTENTIALS

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## Abstract

Today the world is moving away from overwhelming dependence on fossil fuels, and within fossil fuels, away from coal and oil in favor of gas. In recent years energy industry shows a significant transition to clean energy. In the era of sustainable development; clean energy is a huge economic opportunity and a necessary element of socioeconomic development and plays a prominent role in catering Energy needs of the world. The scale of energy transformation in India is stunning. The primary objective for deploying renewable energy in India is to advance economic development, improve energy security, improve access to energy, and mitigate climate change. Renewable energy penetration is highly variable by the state in India. The share of solar and wind in India's ten renewables-rich states (Tamil Nadu, Karnataka, Gujarat, Rajasthan, Andhra Pradesh, Maharashtra, Madhya Pradesh, Telangana, Punjab, and Kerala) is significantly higher than the national average of 8.2%. Karnataka is the first southern State in India to notify Karnataka Renewable Energy Policy to harness green, clean renewable energy sources for environmental benefits and energy security. Further the Karnataka is one of the few states that has abundant availability of nearly every source of energy, from nuclear to conventional to renewable. It has been proactive in developing these sources to achieve its aim of providing electricity for all by 2030. The State has an installed renewable energy capacity of 16537.46 MW through proactive policies, solar park development, and public awareness. Karnataka state has been doing exceptionally well in terms of creating capacity in the country. The state has the potential to generate an estimated 55.86 GW Wind power potential at 100 M, AGL, and 124.15 GW Wind power potential at 120 M, AGL. capacity and 24.70 GW Solar power potential. In the above scenario of the huge potentiality of generating renewable energy from different sources, the present research paper aims to identify the current status and future potentials of renewable energy sources in the state of Karnataka.

**Keywords:** Sustainable development, Renewable Energy, Future potentials, Current status.

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## 1. INTRODUCTION

Energy is acknowledged as a key input towards raising the standard of living of citizens of any country, as is evident from the correlation between per capita electricity consumption and Human Development Index (HDI). Today energy mix of the world largely depends upon Fossil fuels. But fossil fuel is no longer a reliable source to meet increasing energy demand and guarantee a sustainable world in the future (Roser, 2022). This is because of its known environmental effects linked to climate change, global warming, and severe pollution. Today world is moving away from overwhelming dependence on fossil fuel, and within the fossil fuels, away from coal and oil in favour of gas (Kirtay, 2010). In recent years energy industry shows a significant transition to clean energy. In the era of sustainable development; clean

energy is a huge economic opportunity and a necessary element of socioeconomic development and plays prominent role in catering Energy needs of the world (Charles Rajesh Kumar. J, 2020). It is already accepted; the growth of the future economy is dependent upon renewable energy and it is an inseparable part of contemporary sustainable development.

For a livable climate and to align with the Net Zero Emissions by 2050 Scenario, we need to end our reliance on fossil fuels and invest in alternative sources of energy that are clean, accessible, affordable, sustainable, and reliable. To achieve this governments not only need to address current policy and implementation challenges but also increase ambition for all renewable energy uses (Renewables 2021: Analysis and Forecast to 2026, 2022). Further improving competitiveness, ambitious targets, and policy support across the globe is expected to enhance the future potential of renewable energy. To achieve this India has also set ambitious targets for renewable energy in the context of climate change commitments, with a goal to increase the proportion of renewable energy sources in the country's electricity generation mix to up to 40% by 2030.

he primary objective for deploying renewable energy in India is to advance economic development, improve energy security, improve access to energy, and mitigate climate change. Renewable energy offers a way for India to meet this growing demand and improve its energy security by diversifying fuel sources while reducing environmental impacts. But getting there would require a massive shift in investment. India has set a target to reduce the carbon intensity of the nation's economy by less than 45% by the end of the decade, achieve 50 percent cumulative electric power installed by 2030 from renewables, and achieve net-zero carbon emissions by 2070 (Manohar, 2023). Low-carbon technologies could create a market worth up to $80 billion in India by 2030.

The scale of energy transformation in India is stunning. Over the past five years, coal power made up over two-thirds of capacity additions in India's generation, and currently accounts for more than 60% of India's power-generating capacity (Waldron, 2017). In order to green the electricity generation process, India has announced an ambitious target of installing 500 GW of renewable energy plants by 2030. This is higher than India's total fossil fuel-based installed electricity generation capacity in 2019. (Dey, 2020) The country is pursuing an ambitious energy strategy to increase renewable power - mainly from solar and wind including bioenergy and small hydro.

Renewable energy penetration is highly variable by the state in India. The share of solar and wind in India's ten renewables-rich states (Tamil Nadu, Karnataka, Gujarat, Rajasthan, Andhra Pradesh, Maharashtra, Madhya Pradesh, Telangana, Punjab, and Kerala) is significantly higher than the national average of 8.2%. Solar and wind account for around 29% of annual electricity generation in Karnataka, 20% in Rajasthan, 18% in Tamil Nadu, and 14% in Gujarat (financial year [FY] 2020 - 21). India's renewables-rich states already have a higher share of variable renewable energy than most countries internationally (Renewables Integration in India, 2022). Karnataka, the southern state of Karnataka an early adopter of renewable energy and blessed with ample renewable energy resources of all forms including wind, solar, small hydro, biomass, and cogeneration. The State has an installed renewable energy capacity of 16537.46 through proactive policies, solar park development, and public awareness. Karnataka state has been doing exceptionally well in terms of creating capacity in the country. Karnataka is the only State in the country which is overachieving RPO in both solar and non-solar segments, apart from Andhra Pradesh. They have surplus solar and non-solar energy. The Karnataka Renewable Energy Development Limited (KREDL) is an organization working to promote renewable energy in the state.

**Table 1. Renewable energy progress status as on 31-03-2022 in Karnataka**

| SI.NO | Renewable energy sources | Allotted capacity in MW | Commissioned capacity in MW |
|---|---|---|---|
| 01 | Wind | 24974.87 | 5276.05 |
| 02 | Solar | 14461.67 | 8110.49 |
| 03 | Cogeneration | 2212.65 | 1731.16 |
| 04 | Biomass | 395.13 | 139.03 |
| 05 | Small Hydro | 3010.05 | 1280.73 |
| 06 | Waste to Energy (WTE) | 51.00 | 0.00 |
| 07 | Hybrid wind and solar | 50.00 | 0 |
| **Total** | | **45155.57** | **16537.46** |

Source: The Karnataka Renewable Energy Development Limited (KREDL), Government of Karnataka

It operates under the Energy Department, Government of Karnataka. The Karnataka Renewable Energy Policy was announced by KREDL for the period of 2016-21. This policy aims at adding 1000 MW capacity each year from renewable energy resources. The state has the potential to generate an estimated 55.86 GW Wind power potential at 100 M, AGL, and 124.15 GW Wind power potential at 120 M, AGL. capacity and 24.70 GW Solar power potentials. In the above scenario of the huge potentiality of generating renewable energy from different sources, the present research paper aims to identify the current status and future potentials of renewable energy sources in the state of Karnataka.

## 2. LITERATURE REVIEW

Human requires energy for cooking, heat, lighting, and transportation in daily life. Some of the requirements are classified as basic needs, including heat and cooking (P. Balakrishnan, 2019). Currently, one of the most important goals of developing countries is to supply energy, because there is a direct relationship economic growth and energy supply (Liu, 2017). Considering poverty and deprivation in India, access to energy for all at affordable prices is of utmost importance. India has limited reserves of fossil fuels, which will be exhausted very soon due to increased industrialization and the life standards of the people. We all can witness the drastic degradation of these conventional energy sources. The need for an hour is to switch to renewable energy (R V Patel, 2019).

Access to energy for all may be enhanced through both diversification of the sources of imports and increased domestic production and reduced requirement of energy (Bhati, 2020). Today, India is heavily dependent on oil and gas imports while also importing coal. Renewable energy resources are innovative options for electricity generation and their potential is enormous in India (Omar Ellabban & Blaabjerg, 2014). With rising maturity of renewable energy technologies, aided by decline in their costs and upon environment considerations, the Government has already articulated its decision to boost Renewable Energy capacity (National Energy Policy, 2017). The period 2017-2040 will, therefore, witness a transformation in the electricity sector of India, calling for policy action across the entire value chain of generation, transmission, and distribution.

The important spur for the renewable energy industry in India lies with the constraint of the cost, if it is achieved, the energy mix of India will change itself. Technology needs to be re-engineered to achieve the above objective (T.S. Devaraja, 2021). A large domestic manufacturing base has been established in the country for renewable energy systems and products. Further, the government is encouraging foreign investors to set up renewable power

projects with 100 percent foreign direct investment. The Indian Renewable Energy Programme has received wide recognition internationally in recent years. Many countries have evinced interest in cooperation with India for the promotion of new and renewable energy (Arun Kumar Singh Tomar, 2018). According to the CSTEP report, the four southern states (Karnataka, Kerala, Tamil Nadu, and united Andhra Pradesh) are the major contributors to India's renewable energy ambitions (Jacob, 2021). The report added that it requires an investment of around Rs 9,245 crore by 2030 to strengthen intra-region transmission infrastructure, in addition to the transmission network strengthening plans by the Central Electricity Authority (Deepthi Swamy, 2015).

In India Karnataka is currently the State with the best equipped power systems to transition its electricity system from being fossil-powered to renewable energy sources, followed by Andhra Pradesh and Gujarat (Koshy, 2023). And, Karnataka is the first southern State in India to notify "Karnataka Renewable Energy Policy in 2009 to harness green, clean renewable energy sources for environmental benefits and energy security. further government of Karnataka is always a forerunner in evaluating and adapting new RE markets in the country. Keeping the RE potentials in the State and the above opportunities into consideration, the Karnataka Renewable Energy Policy 2022-2027 aims at deepening the RE markets in the State and make Karnataka an attractive destination for investors in the RE sector (Karnataka Renewable Energy Policy 2022-27, 2023). The focus of Karnataka Renewable Energy Policy 2022-2027 is to advance the RE market development in the State and facilitate the Government of India in meeting the RE target of 175 GW by the year 2022 or any other capacity targeted thereafter.

## 3. RENEWABLE ENERGY IN KARNATAKA

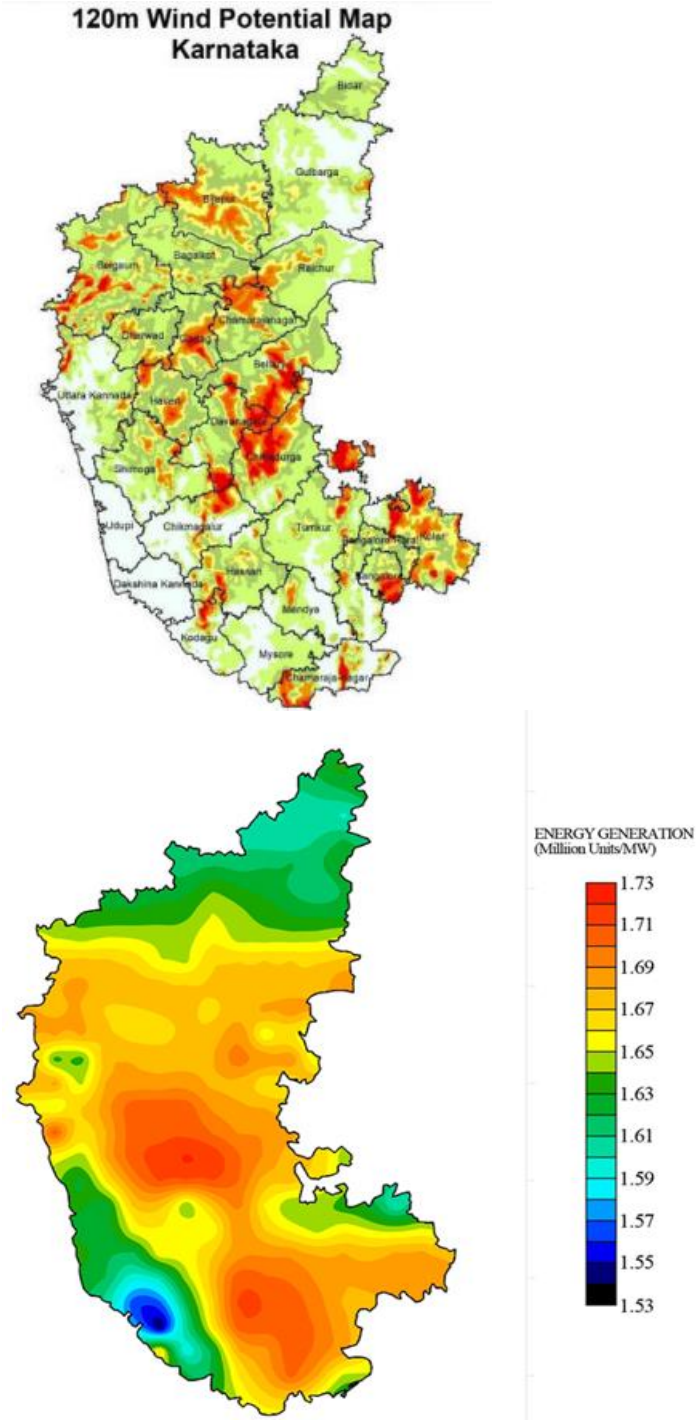
### 3.1. Karnataka's renewable energy potential

Karnataka is one of the few states that has abundant availability of nearly every source of energy, from nuclear to conventional to renewable. It has been proactive in developing these sources to achieve its aim of providing electricity for all by 2030. In Karnataka, 51% of the power comes from renewable energy sources, 34% from thermal, 12% from hydro and 3% from nuclear. Even the peak demand in summer was managed with minimal reliance on thermal power (Naik, Karnataka set to ramp up RE power, 2022). Economically-feasible renewable energy potential in Karnataka is estimated at a total of 209.28 GW.

**Table 2. A comparison of Karnataka's renewable energy potential with selected states in 2023**

| Sl .NO | State/UT | Solar Potential (GW) | Wind Potential (GW) | SHP (GW) | Bio Mass (GW) | Total (GW) |
|---|---|---|---|---|---|---|
| 1 | Andhra Pradesh | 38.44 | 119.13 | 0.41 | 0.15 | 158.13 |
| 2 | Gujarat | 35.77 | 226.58 | 0.20 | 1.01 | 263.57 |
| 3 | Karnataka | 24.70 | 180.01 | 3.73 | 0.84 | 209.28 |
| 4 | Madhya Pradesh | 61.66 | 25.88 | 0.82 | 1.07 | 89.43 |
| 5 | Maharashtra | 64.32 | 143.60 | 0.79 | 1.59 | 210.29 |
| 6 | Rajasthan | 142.31 | 146.52 | 0.05 | 4.60 | 293.48 |
| 7 | Tamil Nadu | 17.67 | 102.55 | 0.60 | 4.60 | 125.42 |

Source: The Ministry of New and Renewable Energy (MNRE), Government of India & EAI




Source: National Institute of Wind Energy & Solar PV Energy Generation Map of Karnataka, India (Jaymin Gajjar*, 2015).

Among the types of renewable energy, the wind has been the most popular and approachable energy source in Karnataka in recent years. The use of wind energy as a renewable energy source is one of the means of achieving the lowest-priced energy. wind energy can make a significant contribution to the state's current and future energy needs. The potential wind energy of Karnataka is spread across the state and has the potential of producing 180.01 GW of energy (both at 100 and 120 M, AGL) (Bastin, 2022). The Karnataka state receives an average of 240-300 sunny days, The state receives global solar radiation in the range of 5.1–6.4kWh/m2 during summer, 3.5–5.3kWh/m2 during monsoon, and 3.8–5.9kWh/m2 during winter and has the potential of producing 24.70 GW of energy (Jaymin Gajjar*, 2015).

Karnataka has the highest SHP capacity in the country, with a potential of 3.73 GW across 834 sites as designated by the Ministry of New and Renewable Energy (Gaining Momentum:

Karnataka's solar segment sees focused growth, 2016). Only 34 percent or 1280.73 MW has been realized so far. The SHP target for the state for 2023 is to reach a cumulative capacity of 1,500 MW. With one of the better tariffs for the segment as compared to other states. Biomass is a renewable resource and is estimated to be in surplus across Karnataka. It has been identified as a potential source of power generation. Biomass is derived from the by-products of various resources like crops such as paddy, corn and sugarcane, wood waste, and forest residues (Rao, 2013). The state has a vast potential of about 0.84 GW for the development of biomass power plants from the surplus biomass available in the state. At present there are 20 numbers of Biomass power plants operating in the State.

### 3.2. Renewable energy production and Exploitation in Karnataka

Karnataka has a large potential for renewable energy exploitation in several areas. Over half of Karnataka's total installed capacity is through Renewable sources and the State is attracting a lot of investments in the green energy sector (Naik, 2023). The State has the right mix of thermal, hydel, Solar & wind energy, and the mixed source of energy generation is an advantage for the state to tide over any crisis.

**Table 3. A comparison of Karnataka's renewable energy production with selected states in 2023**

| SI. No | STATES | Small Hydro | Wind Power | Bio mass | Solar | Total |
|---|---|---|---|---|---|---|
| | | (MW) | (MW) | (MW) | (MW) | (MW) |
| 1 | Andhra Pradesh | 163.31 | 4096.65 | 567.16 | 4530.76 | 9357.88 |
| 2 | Gujarat | 91.64 | 9925.72 | 110.73 | 8887.73 | 19015.82 |
| 3 | Karnataka | 1280.73 | 5276.05 | 1902.15 | 8110.49 | 16569.42 |
| 4 | Kerala | 266.52 | 62.50 | 2.50 | 723.49 | 1055.01 |
| 5 | Madhya Pradesh | 123.71 | 2844.29 | 134.94 | 2801.25 | 5904.19 |
| 6 | Maharashtra | 381.08 | 5012.83 | 2639.13 | 3772.09 | 11805.13 |
| 7 | Rajasthan | 23.85 | 4681.82 | 125.08 | 16405.75 | 21236.50 |
| 8 | Tamil Nadu | 123.05 | 9983.12 | 1045.79 | 6536.77 | 17688.73 |
| 9 | Telangana | 90.87 | 128.10 | 220.37 | 4657.18 | 5096.52 |

Source: The Ministry of New and Renewable Energy (MNRE), Government of India

In 2023, the total renewable energy-based power capacity of Karnataka state has reached peak level and is almost exclusively dominated by Solar and Wind. Karnataka's Installed capacity is 16569.42 MW, ranked 4 and the state accounts for 13.81% of India's installed capacity based on Renewable Energy. During the same period Installed capacity based on Wind power is 5276.05 MW ranked 3 and the state accounts for 12.64% of India's installed capacity based on Wind power. Considering the above development scenario of wind energy in Karnataka, it may be concluded that the number of wind power plant installations will considerably increase in the future. Installed capacity based on Solar Power (ground-mounted + rooftop + off-grid) in Karnataka is 8110.49 MW, ranked 3 the state accounts for 12.92% of India's installed capacity based on Solar power. Further, the installed capacity based on Small Hydro Power in Karnataka is 1280.73 MW, ranked 1 and the state accounts for 26.14% of India's installed capacity based on Small Hydro Power. The Installed capacity based on Biomass and Waste to Energy in Karnataka is 1902.15 MW, ranked 3 and the state accounts for 17.78% of India's installed capacity based on Biomass and Waste to Energy.

**Table 4. A comparison of Karnataka's renewable energy Exploitation status with selected states in 2023**

| Sl .NO | State/UT | RE potential (GW) | RE production (GW) | % of RE exploited |
|---|---|---|---|---|
| 1 | Andhra Pradesh | 158.13 | 9.36 | 5.92 |
| 2 | Gujarat | 263.57 | 19.02 | 7.21 |
| 3 | Karnataka | 209.28 | 16.57 | 7.92 |
| 4 | Madhya Pradesh | 89.43 | 5.90 | 6.60 |
| 5 | Maharashtra | 210.29 | 11.81 | 5.61 |
| 6 | Rajasthan | 293.48 | 21.24 | 7.24 |
| 7 | Tamil Nadu | 125.42 | 17.69 | 14.10 |

Andhra Pradesh has developed 5.92 % of its economically feasible renewable energy potential while Gujarat has realized 7.21 %, Madhya Pradesh 6.60 %, Maharashtra 5.61 %, Rajasthan 7.24 %, and Karnataka is exploited around 8 % of its renewable energy potential. Further, Almost half of the gross potential is technically exploitable, and only one-third of this potential is economically exploitable. Unfortunately, most of this potential has not yet been adequately explored.

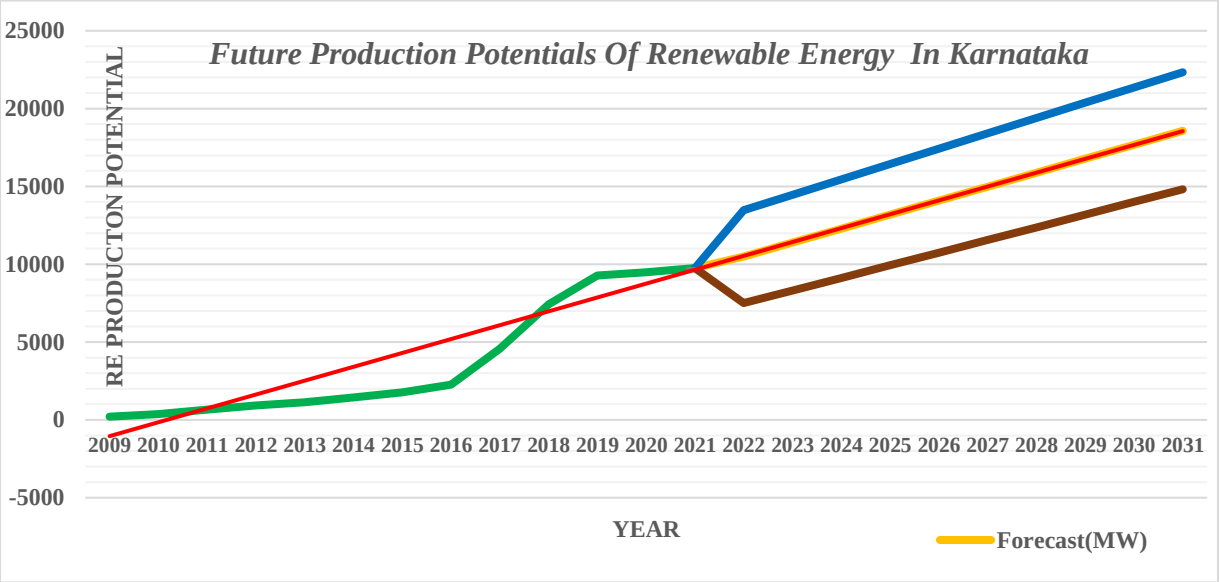
### 3.3. Future production potentials of renewable energy in Karnataka.

India has been one of the global champions in adopting renewable energy as part of its energy transition. Several Indian public sector undertakings (PSUs) have also been committing to install renewable energy capacity in a bid to decarbonize their operations, diversify their business portfolio and contribute to the government's renewables plans. IEEFA and CEF forecast India's renewable energy capacity to grow rapidly with 35-40 GW of new capacity additions annually through to FY2029/30, reaching 405GW. Indians' energy transformation induced by competition from variable renewable energy sources and hyperinflation in fossil fuel commodity prices (Vibhuti Garg & Srivastava, 2022).

**Table5. Estimated future production potential of renewable energy in Karnataka.**

| | | | | | | |
|---|---|---|---|---|---|---|
| Future production potentials of renewable energy in Karnataka | Year | **2022** | **2023** | **2024** | **2025** | **2026** |
| | Forecast | 10491.97 | 11389.99 | 12288.01 | 13186.03 | 14084.05 |
| | UCL | 7506.87 | 8312.295 | 9119.717 | 9928.968 | 10739.9 |
| | LCL | 13477.07 | 14467.69 | 15456.31 | 16443.09 | 17428.2 |
| | Year | **2027** | **2028** | **2029** | **2030** | **2031** |
| | Forecast | 14982.07 | 15880.09 | 16778.11 | 17676.13 | 18574.15 |
| | UCL | 11552.38 | 12366.3 | 13181.54 | 13998.03 | 14815.67 |
| | LCL | 18411.76 | 19393.89 | 20374.68 | 21354.24 | 22332.64 |

In India Karnataka and Gujarat are among the major states making the most progress in the transition to clean electricity. Karnataka being one of the top Indian state in terms of highest renewable energy (RE) installation for the past several years has announced the new 'Karnataka Renewable Energy Policy,' which will be valid for the 2022-2027 period to Harness the full potential of renewable energy. The policy aims to develop key energy markets in the state, including the green energy corridor, renewable energy parks, solar, wind, energy storage, hybrid power projects, biomass, co-generation, waste-to-energy projects, and mini and small hydropower projects.




Further, the policy aims to project Karnataka as a preferred investment destination for renewables and create an ecosystem for sustainable and green energy development. The state aims to develop 10 GW of additional renewable projects, with or without energy storage systems, and 1 GW of rooftop solar installations in the next five years (Ranjan, 2022). With the backdrop above policy scenario and its past performance in the renewable energy sector, it is estimated that the renewable energy installed capacity of Karnataka (Solar and Wind) may reach from 10491.97 MW to 14084.05 MW by 2026 and may reach up to 18574.15 MW by 2031. additionally, the policy also mentions new business models that can be utilized for the development of renewable energy in the state. Public Private Partnership (PPP) has been promoted for the development of Ultra Mega renewable energy parks, wherein the Karnataka government may invest up to 50% equity in the project.

## 4. CONCLUSION.

Karnataka is the first southern State in India to notify "Karnataka Renewable Energy Policy in 2009 to harness green, clean renewable energy sources for environmental benefits and energy security. further government of Karnataka is always a forerunner in evaluating and adapting new RE markets in the country. Karnataka is stepping up its efforts to add renewable energy capacity and contribute to the country's overall target. It is focusing on developing its vast solar and wind potential. The state has cleared the regulatory roadblocks for solar projects by enacting Karnataka Renewable Energy Policy 2022-2027 and created a favorable ecosystem for the growth of the segment. This is reflected in the significant capacity being added through solar parks being developed by the Solar Energy Corporation of India and KREDL. Overall, the outlook for Karnataka's renewable energy sector remains positive. With the right policies in place, the sector is likely to witness strong growth and investments.

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