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# SUSTAINABLE DEVELOPMENT OF RENEWABLE ENERGY RESOURCE IN KARNATAKA: A GEOGRAPHICAL ANALYSIS

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## Abstract:

Apart from conservative fuels already used for heating them, renewable energy sources are probable to play a significant role in the near future. This paper mainly aims at the sustainable development of renewable energy resources in Karnataka state, India. The methodology has been made by primary surveys of major wind power installed units at Gadag and Chitra Durga, and Secondary data has been used which is collected from various agencies, central renewable energy resource department, Bangalore bureau of economics and statistics, etc. ArcGIS software was used to extract the study area map. The interviews method is also adopted for concluding. Finally, the analysis shows that there is a potential of about 13000 MW for the development of wind power plants in the state, 3000 MW for the development of micro hydel plants, 66.5 lakh tones of agricultural waste, 1.4 lakh tone of cattle dung for establishing Biomass, and Biogas plants.

**Keywords:** *Renewable Energy Resource, Sustainable Development, GIS.*

## Introduction:

Renewable energy is divided from natural processes that are replenished Constantly in its various forms, it is divided directly from the sun or heat generated deep within the Earth. Included in the definition is electricity and heat generated from Solar, Wind, Ocean, Hydropower, Biomass, Geothermal, resource and biofuels, and hydrogen divided from a renewable resource.

Energy consumption is one of the greatest significant indicators showing the development stages of countries and the living standards of communities. Population raises, urbanization, industrializing, and technologic growth results directly in increasing energy consumption Sahil (Suryvansheea and Dr. Alok Chaubeb, 2013). (M.A. Ehyaei, A. Mozafari and M.H. Alibiglou 2011) – are presented that the exergy, economic & environmental analysis of Shahid Rajaee gas

turbine power plant in Iran About 16% of global final energy consumption comes from a renewable resource with 10% of all energy from traditional biomass. Mainly used for heating and 3.4% from hydroelectricity. new renewable (Small Hydro, Modern Biomass, Winds, Solar, Geothermal, and Biofuels) accounted for another 3% and are growing rapidly.

Karnataka is endowed with renewable energy potential like Wind, Hydro, Solar, Tidal, Geothermal energy resources, etc. Innovations in wind turbines and micro siting technologists have resulted in accelerated wind farms establishment. There is increasing social acceptance of various solar gadgets with the potential of substantial conventional power savings. Innovations in solar photovoltaic and thermal technology have made it feasible to harness grid and off-grid solar power generation projects a reality. Scientific processing and treatment of municipal waste entail power generation besides environmental benefits. The Bio-degradable Agro residue and waste (biomass) offer decentralized power generation technology by the Sugar, Paper, fertilizers, Chemical, Textile, Steel, Cement industry, etc. offers scope for power generation. "The utilization of RE Sources for the generation of energy results in zero carbon emissions", Renewable Energy projects have a tremendous potential of generation carbon credits.

There is a potential of about 13000 MW for the development of wind power plants in the state. Wind potential areas in the state are Chitradurga, Gadag, Chikkamgalur, Bellary, Davangere, Koppala, Bijapur, Bagalkot, Belgaum, etc., districts. There is a potential of about 3000 MW for the development of Small/Mini/Micro hydel plants in the state. There is adequate availability of agriculture residues (10.5 mill has agricultural land 66.5 lakhs tone) as well as animal waste from 14 million cattle's (1.4 lakhs ton of cattle's dung) for establishing Biomass and Biogas plants. As per the study report of IISC on the availability of surplus biomass, 950 MW of power can be generated. Solar is a fast-growing clean energy section of renewable, technological innovations are taking place to make it cost-effective. Karnataka is blessed with solar energy, solar insulation available for more than 300 days a year. Northern districts of the state like Gulbarga, Raichur, Bidar, Bijapur, Bellary, Bagalkot, Koppala, Belgum, Gadag, Chitradurga, etc., are well suitable to harness solar potential on MW scale.

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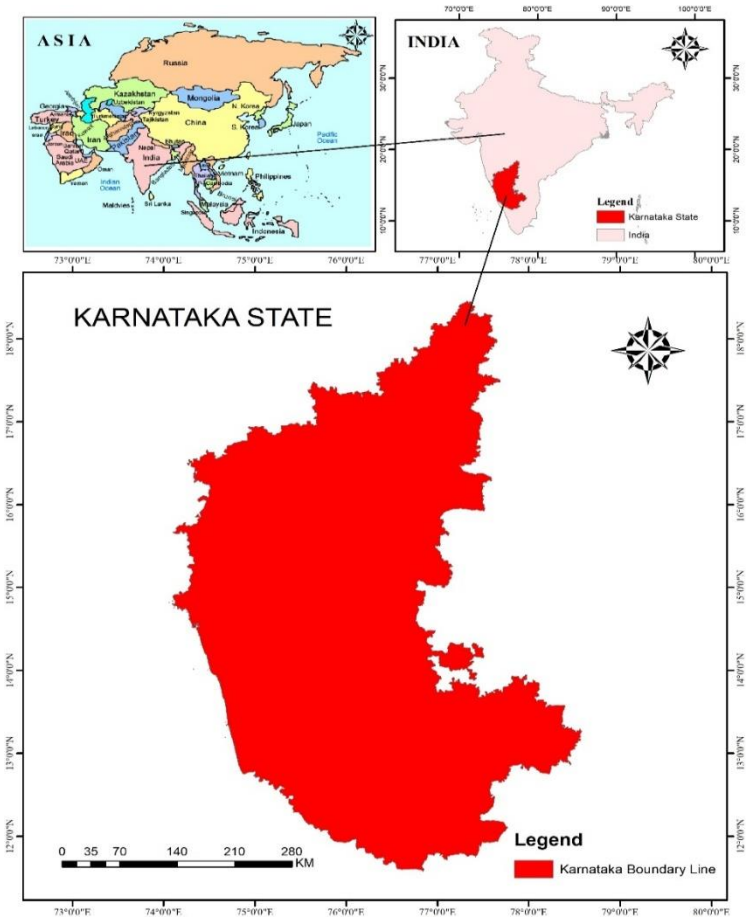
**Study Area:**

The Karnataka state is situated between 15.3173° North latitudes and 75.7139° East longitudes and lies in the West-central part of peninsular India. It is the maximum length from north to south is 700kms, and from east to west 400 km, on the north west by goa, on the east by Andra Pradesh, on the south and south east by Tamil Nadu, on the South-west by Kerala, and on the west by the Arabian sea.




*Map 1: Location map of Karnataka State.*

**Objectives:**

- To know the growth and distribution of renewable energy resource in Karnataka.
- To initiate necessary measures in energy conservation as per the guidelines of Bureau of Energy Efficiency (BEE), government of India.
- To know the growth and distribution of wind power in Karnataka.
- To harness the environment friendly RE Sources and to enhance their contribution to the socio-economic development.

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**Methodology:**

Secondary data has been used which is collected from various agencies, the central renewable energy resource department, Bangalore bureau of economics and statistics, etc. A study has been made by primary surveys of major wind power installed units at Gadag and Chitra Durga. The interviews method is also adopted for drawing a conclusion. Authentic published and unpublished data and information have been utilized. Finally, maps have been extracted from ArcGIS Software and tables have been interpreted and then after delivered the conclusion.

**Analysis:**

Climate change represents one of humanity's greatest challenges to counteract global warming and guarantee economic growth and propensity in future energy must be generated and utilized in an environmentally and climate-friendly way. Compared to fossil fuels renewable energies have the advantage that they are practically in-exhaustible and facilitate the development of renewable energy sources in the state.

**Table 1: The achievement of Karnataka in the renewable energy sector by September 2008 is as below:**

| Sl. No | R E Source | Potential MW | Achievement MW |
|---|---|---|---|
| 1 | Wind | 13230 | 1120.685 |
| 2 | Small hydro | 3000 | 416.096 |
| 3 | Cogeneration | 1500 | 339.900 |
| 4 | Biomass | 950 | 81.000 |
| 5 | **Total** | **18680** | **1987.675** |

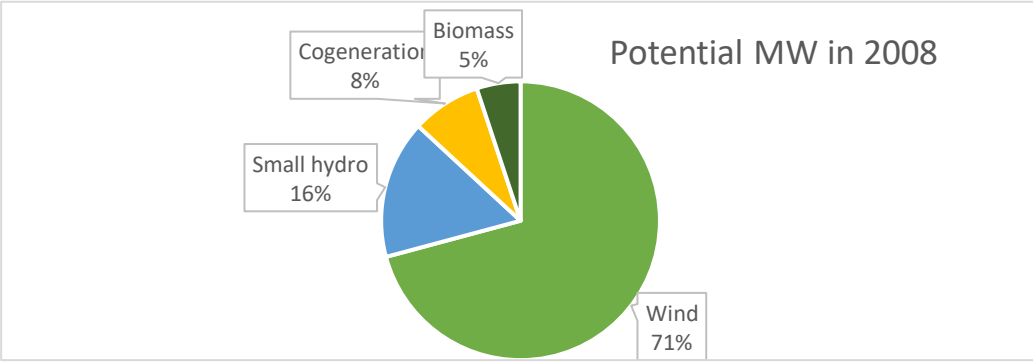


*Figure 1: Renewable energy source in potential MW (2008)*

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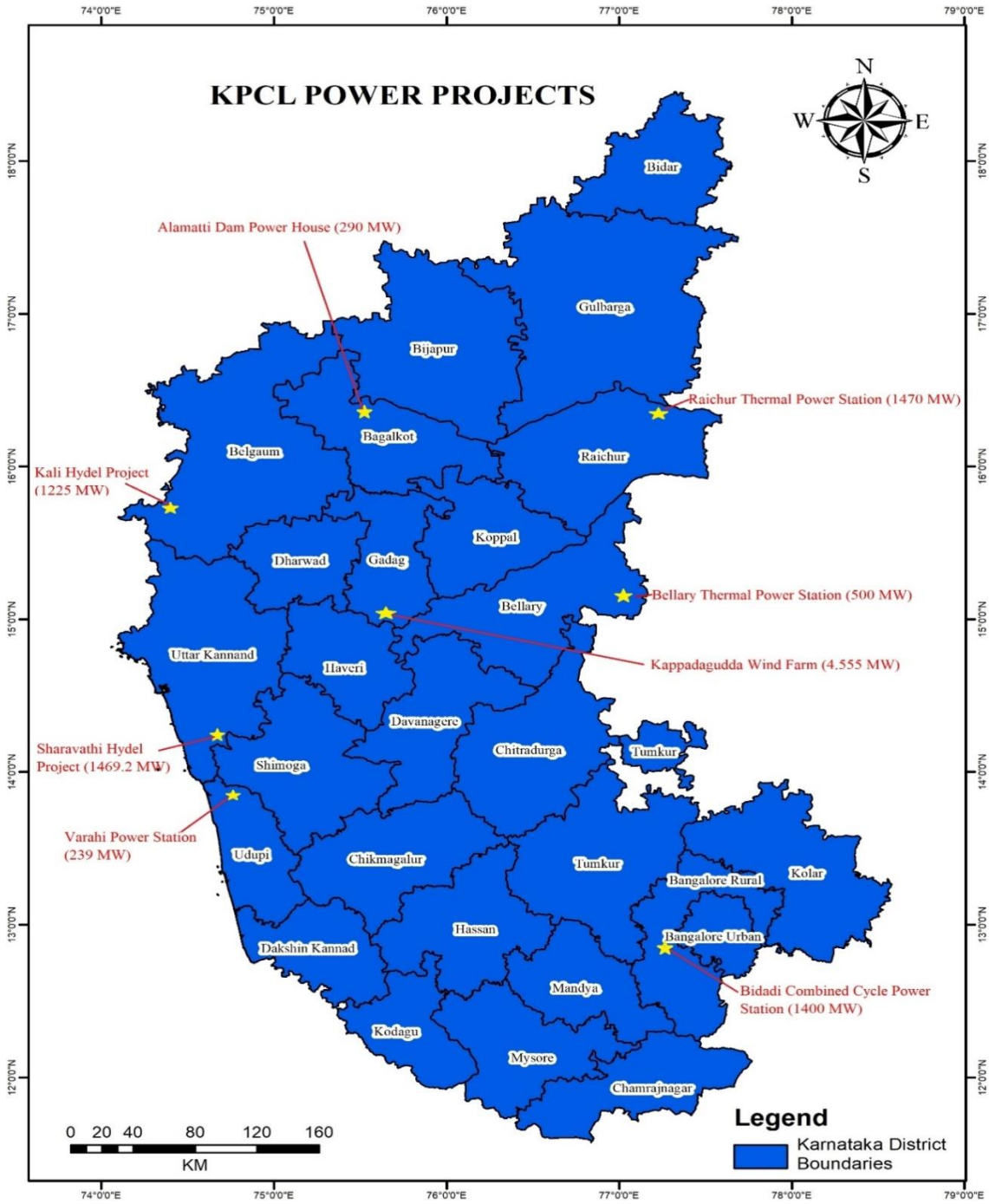
The Government of Karnataka established Karnataka Renewable Energy Development Limited (KREDL) on 8th march 1996 registered under the company's act 1956.

**KPCL Power Projects**




*Map 2: Karnataka Power Corporation Limited (KPCL) Power Projects location Maps in Karnataka State.*

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**Table 2: The year wise target for different renewable energy sources and the investment necessary during the policy period is given below:**

| *R E Source* | *Target MW* | *Year Wise Proposed Capacity Addition* | | | | | *Total investment (crores)* |
|---|---|---|---|---|---|---|---|
| | | *09-10* | *10-11* | *11-12* | *12-13* | *13-14* | |
| ***Wind power*** | *2969* | *630* | *680* | *530* | *530* | *599* | *15860* |
| ***Mini & small hydro*** | *600* | *100* | *100* | *150* | *100* | *100* | *2700* |
| ***Co-generation in sugar industry*** | *281* | *56* | *56* | *56* | *57* | *57* | *1120* |
| ***Bio mass/bio gas*** | *300* | *60* | *60* | *60* | *60* | *60* | *2100* |
| ***Waste energy*** | *50* | *10* | *10* | *10* | *10* | *10* | *400* |
| ***Total*** | *4200* | *856* | *906* | *806* | *806* | *826* | *22000* |

### A. Wind Power:

There is a potential of about 13000 MW for the development of wind power plants in the state. Wind potential areas in the state are Chitradurga, Gadag, Chikka mangalore, Bellary, Davanagere, Koppal, Bijapur, Bagalkot, Belgum districts, etc.

India has the fifth largest installed wind power capacity in the world. In 2009-10 India's growth rate is highest among the top two Countries (USA, China, Germany, Spain) As of 31, 2013 the installed capacity of wind power in India was 19661.15 MW mainly spread across Tamil Nadu (715 MW), Gujarat (3091 MW), Maharashtra (2976 MW), Andhra Pradesh (435 MW) and other states (3.20 MW). it is Estimated that 6000 MW of additional wind power capacity will be installed in India by 2014. Wind power accounts for 6% of India's total installed power capacity and it generated 1.6% of the country's power. There are many small wind farms in Karnataka, making it one of the states in India which has high members of windmill farms. Chitradurga, Gadag are some of the districts where there are a large number of windmills. Chitradurga alone has over 2000 wind turbines. The 13.2 MW Arasinagundi (ARA) and 16.5 MW Anabaru (ANA) wind farms are ACCIONA's first in India, located in the Davanagere district. They have a total installed capacity of 29.7 MW.

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In the Gadag District, there are 605 numbers of wind electric converters are Installed to produce a capacity of 482.175 MW of power. Large numbers (421) of wind Electric converters are found in Kappatagudda Spot and surroundings villages, 62 wind electric converters at Gajendragada, 9 wind electric convertors at Naragund, 20 wind electric convertors at Shirgund, 58 wind electric at Bannikoppa, Wind electric convertors at Nepal, Ron (Tq).

**Year wise growth of wind power in Karnataka:**

**Table 3: Year Wise Growth of Wind Power in Karnataka**

| Sl. No | State | Karnataka Generation (MU) |
|---|---|---|
| 1 | 1997 | 7.25 |
| 2 | 1998 | 11.72 |
| 3 | 1999 | 26.62 |
| 4 | 2000 | 39.47 |
| 5 | 2001 | 72.26 |
| 6 | 2002 | 92.86 |
| 7 | 2003 | 175.11 |
| 8 | 2004 | 308.16 |
| 9 | 2005 | 778.60 |
| 10 | 2006 | 1113.82 |
| 11 | 2007 | 1449.05 |
| 12 | 2008 | 1505.78 |
| 13 | 2009 | 1723.00 |
| 14 | 2010 | 2687.00 |

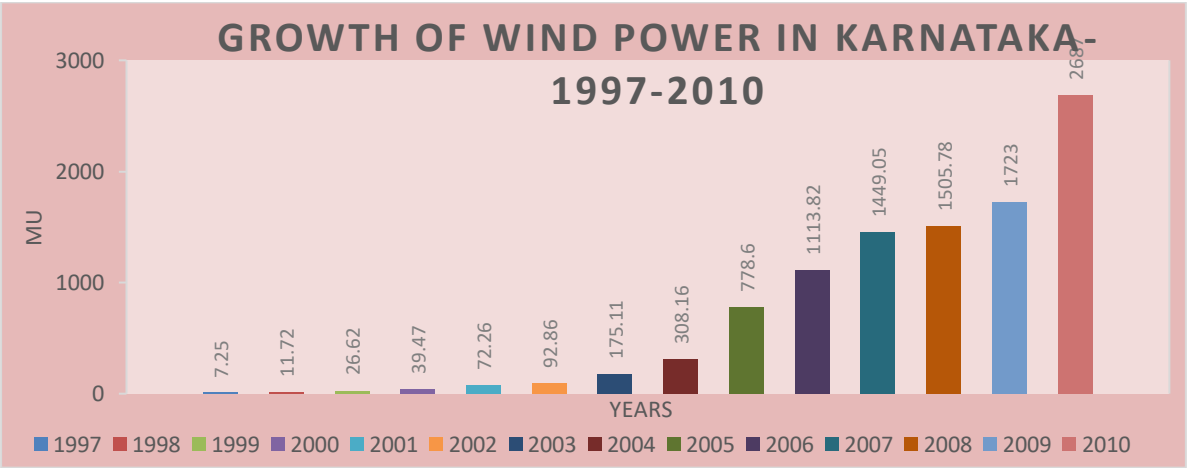


*Figure 2: Growth of wind power in karnataka-1997-2010*

**B. Small hydro**:

There is a potential of about 3000 MW for the Development of hydel plants in the state. It is specific site could be river or stream-based or canal-based, reserves based, etc.

**C. Co-generation:**

Karnataka has 53 sugar factories generation about 2 lakh tons of bagasse per day. This bagasse is sufficient to generate about 1500 MW power by using a medium/High-pressure boiler.

**D. Biomass:**

There is adequate availability of agricultural residues (10.5 mill ha agricultural land, 66.5 lakh, tone) as well as animal waste from 14 million cattle's (1.4 lakh tone of cattle dung) for establishing biomass and biogas plants. As per the study report of IISC on the availability of surplus biomass, 950 MW of power can be generated.

**E. Solar:**

Solar is a fast-growing clean energy sector of renewable, Technological innovations are taking place to make it effective Karnataka. Blessed with solar energy, Solar insolation is available for more than 300 days a year Northern districts State like Gulbarga, Raichur, Bidar, Bijapur, Bellary, Bagalkot, Koppal, Belgaum, Gadag, Chitra Durga, etc., are well suited to harness solar potential on MW scale. Solar cities will be developed in the state are Hubli- Dharwad, and Mysore. Municipal Corporation has been considered initially for developing as solar cities as per MNR Scheme. Urban Industrial solid waste tidal energy is also used for renewable power resources.

**Publicity and Awareness:**

1. KREDL will be actively involved in publicity and awareness of the use of renewable energy systems/devices through print and electronic media. Special events like Rajiv Gandhi Akshaya Urja Divas will be organised.
2. District-level Advisory Committees will be involved in publicity and awareness programs. NGOs and social/youth groups will also be involved and encouraged.

3. Special purpose Demo mobile vans fitted with various solar, solar PV, and Solar wind Hybrid systems will be used to educate the school and college students as well as the general public.
4. Similar to the state energy park, district-level energy parks will be established in all the districts and involved in publicity and awareness.
5. Akshaya Urja Energy Clubs formed in 52Engineering colleges will be involved in publicity and awareness.
6. To popularize the use and application of solar and other solar-wind hybrid equipment's/technology Institutions and the public.
7. To popularize the energy conservation measures, Energy conservation awards will be conferred as per BEE norms on the occasion of the Energy Conservation Day (14$^{th}$ December) every year.

**Conclusion:**

Karnataka is endowed with renewable energy potential like Wind, Hydro, Solar, Tidal, Exothermal energy resources. There is a potential of about 13000 MW for the development of wind power plants in the state, 3000 Mw for the development of micro hydel plants, 66.5 lakh tones of agricultural waste, 1.4 lakh tones of cattle dung for establishing Biomass and Biogas plants. 950 MW power can be generated. Solar is a fast-growing clean energy, solar insulation available for more than 300 days a year. In the year 2008, 1987.675 MW of power can be generated it increased to 2793.675 MW. During 2012-13 the utilization of renewable energy resources for the generation of energy resulted in zero carbon emission. The government of Karnataka popularizes energy conservation measures and awareness of the use of renewable energy through print and electronic media.

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