

SELF-SUSTAINABILITY OF KARNATAKA'S RENEWABLE ENERGY: A REVIEW

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Abstract:

India is amongst the top countries when it comes to taking action on climate change mitigation. One such action is increasing the renewable energy generation. India is not yet completely self-sustainable in this sector. For the country to become totally self-sustainable in renewable energy sector, states in India also need to be self-sustainable on their own. On studying the factors affecting the energy sector in India, it is observed that states of Karnataka, Tamil Nadu and Gujarat are top performers in renewable energy generation. This article mainly focuses on self-sustainability of Karnataka in the renewable energy sector. Karnataka depends mostly on imported coal for energy. But coal creates a gap of 9.4GW of energy between self-sustainability and dependency. There are many renewable energy resources in Karnataka state. The development of solar and wind energy sectors is essential for the state to move forward in self-sustainability. This article includes a comparative analysis between Karnataka and the other two states viz. Tamil Nadu and Gujarat. This article reveals that Tamil Nadu is more effective in wind energy and Gujarat leads in solar energy harvesting as compared to Karnataka. As possible solutions, the article recommends that Karnataka could focus on installing Parabolic Dish technology to harvest solar energy in a better way and policy making, fundraising on wind energy sector. This would help the state in harnessing wind & solar energy to full potential. The co-benefit of self-sustainability in renewable energy sector for Karnataka is, it generates 26,000 & 833,000 job opportunities in wind and solar energy sectors respectively.

1. Introduction

A detailed study of the renewable energy sector of various states in India reveals that Karnataka, Tamil Nadu and Gujarat have the highest potential to generate renewable energy. Tamil Nadu and Gujarat are mostly self-sustainable in this matter. Karnataka's electricity production still depends largely on imported coal. To lead the way and set an example in 'green energy' production, Karnataka has to become totally self-sustainable in the renewable energy sector. This article mainly focuses on development of solar and wind energy sectors of Karnataka and compares it with Gujarat and Tamil Nadu's efficiency in the renewable energy sector.

2. Karnataka's electricity production:

In India, Karnataka is one of the main contributors to the renewable energy sector. Wind energy, small hydroelectricity projects, thermal energy, and solar energy productions together play a vital role in satisfying the electricity needs of the state. Among the total energy distribution of 29.8GW, the above-mentioned renewable energy resources constitute up to 16.8GW which is 56.3% of the total energy needs. Wind energy, hydro-power stations and bioenergy resources produce 5GW, 4.9GW and 1.9GW respectively (Indrajayanthan & Mohanty, 2022). However, nearly 44% of the total energy production depends upon fossil-fuel based resources. Thermal electricity production from coal has a share of up to 9.4GW in the total electricity production of the state which is nearly 32%! The coal required for this is mainly from Odisha and Jharkhand coal mines.

The state does not have any domestic coal resources. This dependency in-turn holds back the state from becoming totally independent in the energy sector.

Coal dependent electricity production certainly affects the “already existing” climate change issues of the state. Among all the High-Carbon Energy Resources (HCER), coal has the highest potential of emitting Greenhouse Gases (GHG). GHG emission by coal affects thermal heat changes in Western Ghats region and aggravates the air quality in northern Karnataka. A recent report in 2022, which was based on Multi-Criteria Decision Analysis (MCDA), states that the state ranks third in terms of the *clean energy potential*. The first two states are Gujarat and Maharashtra respectively (Indrajayanthan & Mohanty, 2022).

Since Karnataka does not have any coal mines, it has to import it from Odisha, Telangana, and Jharkhand which are nearly 700 to 1200kms away from the state. A report in 2018 stated that the process of importing coal by railway lines costs nearly up-to Rs1000crores annually” –(2018). This economic point-of-view is one of the main reasons for the state to become self-sustainable in the renewable energy sector.

3.Electricity production of Tamil Nadu and Gujarat:

3.1.Tamil Nadu:

Tamil Nadu is one of the top states of the country when it comes to harnessing the available renewable energy. Tamil Nadu’s power distribution constitutes nearly up-to 36.69GW. The renewable energy sector produces 58.5% of the total power generation capacity of the state (Indrajayanthan & Mohanty, 2022). Among all the available renewable energy resources for the state, wind energy generates 7654MW which is the highest wind electricity generation in the country (Varadan & Kumar, 2015). Muppandal wind farm in Kanyakumari is the largest wind farm in the country, which generates 1500MW of electricity (Wikipedia contributors, 2022). Although renewable energy production makes the state mostly sustainable in the energy sector, it still depends on coal for meeting their energy needs.

Low-Carbon Energy Resource (LCER) produces 20.9GW of electricity. This power generation capacity of LCER surpasses the capacity of the installed High-Carbon Energy Resource (HCER) (Indrajayanthan & Mohanty, 2022). However, GHG emission by coal affects the state’s climate change scenario. South-West and North-East seasonal rainfalls in Chengalpattu and Coimbatore are the most exposed districts to climate change due to GHG emission (Varadan & Kumar, 2015).

3.2.Gujarat:

Gujarat is among the top states in India, which has the potential to produce abundant renewable energy. The state’s electricity production depends on wind energy, solar energy, hydro-electric projects. The state has the capacity of producing 41.3GW of power using all its resources. Renewable energy sector has a share of 42.75% in the total energy production of the state (Indrajayanthan & Mohanty, 2022). Gujarat is the hotspot for solar energy generation with the

global irradiance of 5kW/meter-square/day. The state has the capacity of producing 16.09GW of solar energy using the installed solar plants (Elavarasan et al., 2019). Coal dependency has not spared even Gujarat. During the coal shortage period in 2021, Gujarat produced enough energy to meet the electricity needs (Nair, 2021). Coal has similar effects on Gujarat's climate as it has on Tamil Nadu and Karnataka's climate. Since it emits GHG, it has the potential to change the radiation of sunlight falling on the state. In contrast to the state's dependency on coal, it has the highest potential for clean energy generation (Indrajayanthan & Mohanty, 2022).

4.Comparing Karnataka with Gujarat and Tamil Nadu:

4.1.Electricity producing methods:

Gujarat and Tamil Nadu have the capacity of producing more renewable energy when compared to Karnataka.

- Key difference between Karnataka and other two mentioned states is the dependency of energy sector on coal. Karnataka is totally dependent up-on the imported coal. Tamil Nadu and Gujarat extract coal from domestic coal mines in addition to the imported coal.
- Wind energy harvesting is most effective in Tamil Nadu (Muppandal wind-farm) despite the state's installed plants having low-capacity as compared to Karnataka (Indrajayanthan & Mohanty, 2022).

• Efficiency of any Wind Energy Generators (WEG) is studied by the plant load factor (PLF). Plant load factor is ratio of total power generated by WEGs to the available energy in wind,

$$PLF = \frac{\text{total power generated by WEGs}}{\text{Total energy available in the wind}} = \frac{P}{\sum_{i=1}^N (1/2 p \pi r_i^2 V_i^3)}$$

N = number of WEG, p = density of the air, r = length of the single blade or radius, V = velocity of the air. (Ramasesha & Chakraborty, 2013).

1) The reason for more efficiency of WEGs in Tamil Nadu is the air density, which is more in Tamil Nadu than Karnataka. So, the available energy in wind increases as a result of high air density.

2) Industrial tariff is high in Tamil Nadu. Also the infrastructure facilities are better in Tamil Nadu (Palaneeswari, 2018).

- Gujarat has one of the largest solar energy generating systems in India. Karnataka also owns such a solar power plant in Pavgada district in Tumkur. There are limitations which hold-back Pavgada solar power plant from attaining its full potential (S. Rajendran, 2019). However, a recent research states that in Southern India Tamil Nadu and Karnataka are in a better position for tapping the solar energy potential.

4.2.Effects of coal shortage on energy sector of the states:

The considered three states depend upon coal for meeting their energy needs, so it's important for Karnataka to study effects of coal shortage on each state's energy sector.

- Among the three states, Gujarat has successfully overcome the coal shortage problem.

- A report in 2021 stated that Gujarat had dealt with the problem of coal shortage during the coal import crisis in October, 2021. It also stated that Gujarat produced enough energy to meet the energy needs of the states (Nair, 2021).

4.3. What makes Gujarat have a better clean energy potential?

According to a recent Multi-Criteria Decision Analysis (MCDA) report in 2022, Gujarat has the highest 'clean energy potential' in the country.

- According to the same report Gujarat's annual LCER installation rate is higher than the other two considered states. Gujarat has 2.448GW of annual LCER installation rate • The annual LCER installation rate is higher in Gujarat because of policy support whereas Karnataka and Tamil Nadu have 0.942GW and 1.271GW respectively. renewable energy sector gets from researchers and the state government.
- However, Karnataka's solar plants have more capacity of generating electricity when compared to the other two states. (Indrajayanthan & Mohanty, 2022)

5. Environmental views

As already mentioned in this article, the three states don't have much difference between them when it comes to the effect thermal electricity production has on their respective climates.

6. Some possible solutions for Karnataka's renewable energy sector and conclusion:

To become self-sustainable in the renewable energy sector, Karnataka has to cover the gap of 9.4GW of energy which is produced using coal.

6.1. Some recommendations:

- Karnataka state government should consider increasing tariffs towards renewable energy sector
- In solar energy sector, Karnataka's focus on Concentrating Solar Power (CSP) technologies will benefit the energy production. Parabolic Dish (PD) technology is one such technology in which a parabolic point-focus concentrator is used in a dish shape. The dish focuses all the radiation onto one receiver. A single parabolic dish can produce up-to 0.5MW of energy. PD-CSP tech is 50-100% efficient and it's the most efficient tech when compared to the other CSP technologies (Islam et al., 2018).
- In wind energy sector, Karnataka's focus on policy making is needed. The policies should focus on developing the technology so that the state can use the facilities to their full potential. This would make the state most effective in wind energy sector.

6.2. Some limitations:

Since renewable energy sector is totally based on nature, there are some uncertain factors,

- 1) Wind speed and density is based on geographical locations, which makes it difficult to predict sometimes.
- 2) Solar radiations falling on the states reduce if irregular rainfalls & hurricanes happen.

6.3. Employment opportunities:

Besides contributing to the climate change mitigation endeavor, achievement of self-sustainability in the aforesaid sectors is likely to generate a large number of job opportunities for the state's people also.

A recent report suggests that increasing green energy production in Karnataka can increase job opportunities for the state's people.

1. Wind energy provides up-to 26000 jobs
2. Solar off-grid generation can provide 833,000 jobs (Kattumuri & Kruse, 2017)

6.4. Future

This article mainly focuses on the most abundant renewable energy resources which are wind and solar. Main focus is on Karnataka's energy sector development in order to attain self sustainability in the renewable energy sector. Young researchers, policy makers should be encouraged in order to accelerate this study. Also understanding that this process can take years on end to work in our favor, is a good mindset to start with.

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