## Cut-in note

# Wind energy potential in Karnataka, India

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### ABSTRACT

For securing maximum output of power using a given type of wind electric generator, an assessment of the wind resource available at any prospective site is essential. Estimation of wind power potential is based on data of the wind frequency distribution at the site, are collected from official meteorological data. The analyses show that coastal and dry arid zones in Karnataka have good wind potential.

## 1. INTRODUCTION

Wind energy commerce is one of the fastest-growing and economic energy sectors in the world [1, 2]. However, the wind resource is governed by the climatology of the region concerned and has large variability in location and season. Hence, the need to conduct wind resource surveys for exploiting wind energy, as below for Karnataka, India.

## 2. METHODOLOGY

The State of Karnataka in western central India is approximately within latitudes 11°31' and 18°45' North and longitudes 74°12' and 78°40' East; see. Figure 1 with the different agroclimatic zones. Karnataka is situated on a tableland where the Western and Eastern Ghat ranges converge into the Nilgiri hill complex. Karnataka's total land area is 191,791 sq. km. It accounts for 5.35% of the total area of the country and ranks eighth in size among major States. For administrative purpose the State is divided into 27 districts, which are sub divided into 175 taluks. Karnataka is divided into 10 agroclimatic zones, considering texture, depth and physio-chemical properties of soil, rainfall, elevation, topography, major crops and type of vegetation. The zones are (1) Northeastern Transition, (2) Northeastern Dry, (3) Northern Dry, (4) Central Dry, (5) Eastern Dry, (6) Southern Dry, (7) Southern Transition, (8) Northern Transition, (9) Hilly zone, and (10) Coastal.

It is customary to average the wind speeds during each hour and use the hourly mean wind speed as the basic parameter in calculations of wind power. The relationships between annual mean wind speed (at anemometer height of 10 m) and potential value of the wind energy resource as considered in India are listed in table 1.

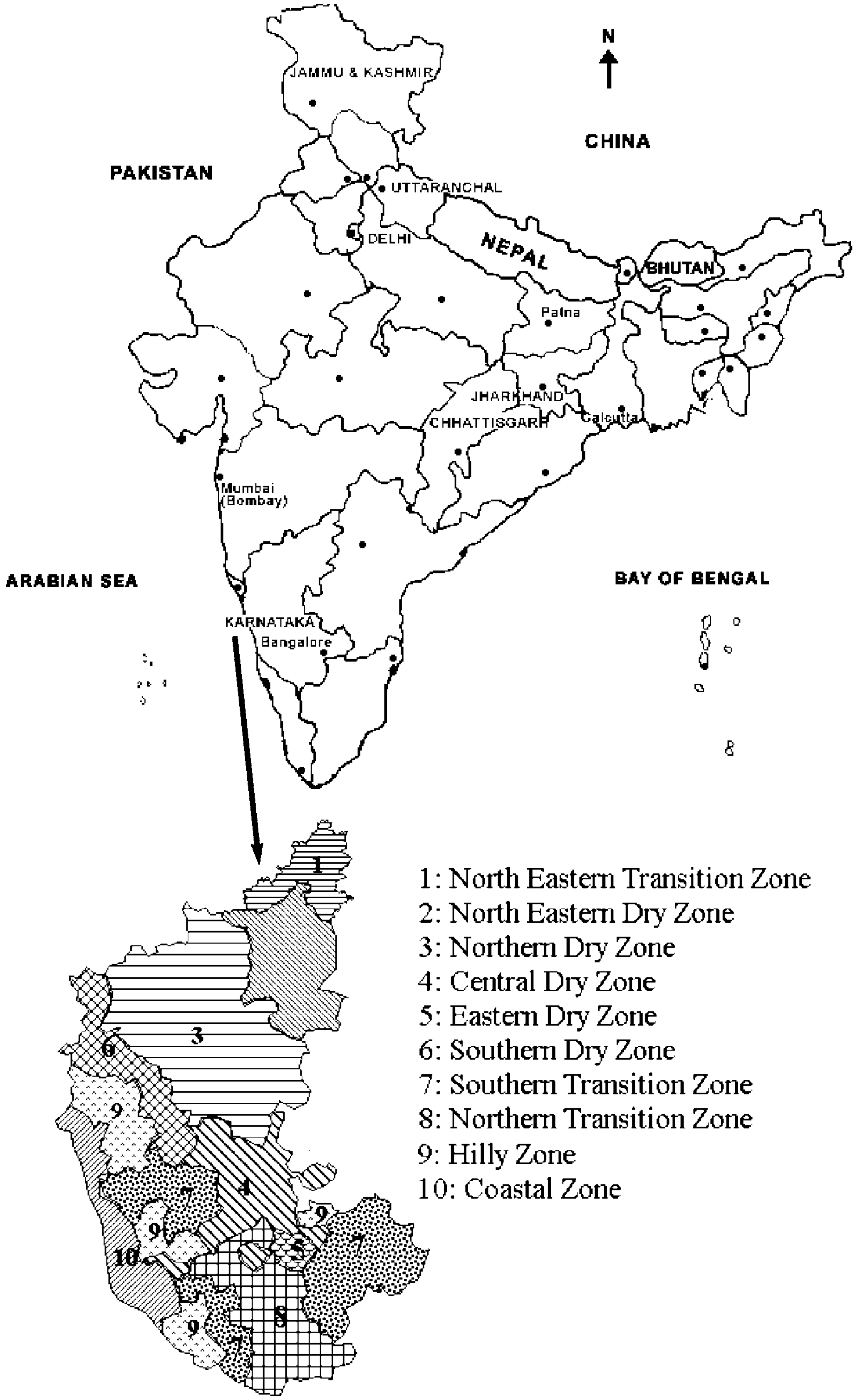


Figure 1. Study area with Agro climatic Zones

**Table 1. Relationship between annual mean wind speed and wind energy potential**

| Annual mean wind speed @ 10 m Height | Indicated value of wind resource |
|---|---|
| < 4.5 m/s | Poor |
| 4.5 – 5.4 m/s | Marginal |
| 5.4 – 6.7 m/s | Good to Very Good |
| > 6.7 m/s | Exceptional |

In locations where data are not available, a qualitative indication of a high annual mean wind speed can be inferred from geographical location, topographical features, wind-induced soil erosion, and deformation of vegetation. However, accurate determination of the mean annual wind speed requires anemometer data for at least 12 months.

Availability of wind energy and its characteristics have been studied for 45 locations in Karnataka based on primary data at selected locations and data collected from the meteorological observatories of the India Meteorological Department (IMD), where 3-cup anemometers with 127 mm diameter conical cups, in conformity with international practice, are used. Anemometers at different meteorological stations are normally at 10 m height, but if at a different height the data are adjusted to 10 m by the IMD according to methods of .the World Meteorological Organization. Since modern wind turbines have hub heights greater than 10 m, we extrapolate to 30 m above ground using equation 1.

$$v = v_o\,[h/h_o]^k \qquad (1)$$

Where, v: wind speed at height h (m/ s), $v_o$: wind speed at anemometer height $h_o$ (m/ s), h = height at which wind speed is measured m), $h_o$: anemometer height (10 m), k = height exponent (0.14)

Wind energy conversion systems would be most effective in these locations during May to August. The Energy Pattern Factor (EPF) and Power densities at 30 m are computed for sites with hourly wind data. With the knowledge of EPF and mean wind speed, mean power density is computed for the locations with only hourly monthly data. Wind power density of a stream of air with density d moving with a velocity $v_m$ is given by,

$$P = K_{Em}\, d\, v_m^3 / 2 \qquad (2)$$

Where, $K_{Em}$ is the energy Pattern factor.

$$K_{Em} = (\sum v_i^3 / N_m) / v_m^3 \qquad (3)$$

Where, $v_i$: Hourly wind speed during the month, $N_m$: number of hourly wind speed values during the month, and $v_m$: monthly mean wind speed. For a Rayleigh distribution of wind speed, $K_{Em}$ = 1.91. Values of $K_{Em}$ varies from 1.05 (Jogimatti), 1.33 (Chikkodi) to 1.44 (Gokak, Khamkartti)

## 3. RESULTS AND DISCUSSION

Wind potential analysis across agro-climatic zone confirms the role of geographic, topographic and meteorological characteristics of a location to wind speed variability. Table 2 lists locations in the respective agro-climatic zones with mean wind speed greater than 18 km per hour (i.e. > 5 m/ s) [4]. Among these sites, wind energy generators totaling a capacity of 3.5 MW have been functional since 1998-99 at Chikodi. Figure 2 depicts monthly variations across Northern dry zone

**Table 2. Wind monitoring stations with annual mean wind power density (> 150 W/m$^2$)**

| Location | Latitude | Longitude | Wind speed at 30m, m/s | Power Density, W/m$^2$ |
|---|---|---|---|---|
| Arasinagundi | 14°29'N | 76°50'E | 7.5 | 458 |
| B.B. Hills | 13°26'N | 75°45'E | 7.7 | 468 |
| Chikkodi | 16°20'N | 74°30'E | 6.5 | 264 |
| Godekere | 13°20'N | 76°40'E | 5.5 | 155 |
| Gokak | 16°07'N | 74°47'E | 5.9 | 168 |
| Gujannur | 14°58'N | 75°54'E | 6.5 | 184 |
| Hanamsagar | 15°54'N | 76°02'E | 6.1 | 173 |
| Hanumanhatti | 15°55'N | 74°43'E | 6.1 | 165 |
| Horti | 17°05'N | 75°40'E | 5.6 | 173 |
| Jogimatti | 14°10'N | 76°22'E | 8.7 | 498 |
| Jogimatti | 14°11'N | 76°25'E | 8.6 | 493 |
| Khamkartti | 15°45'N | 74°35'E | 5.8 | 159 |
| Kahanderayanahalli | 14°30'N | 75°45'E | 5.6 | 183 |
| Madekeripura | 14°13'N | 76°27'E | 7.5 | 244 |
| Malgatti | 15°52'N | 75°55'E | 6.1 | 156 |
| Sangundi | 16°15'N | 75°44'E | 5.7 | 153 |
| Sogi A | 14°55'N | 75°59'E | 7.4 | 200 |
| Sogi B | 14°54'N | 75°59'E | 6.8 | 184 |

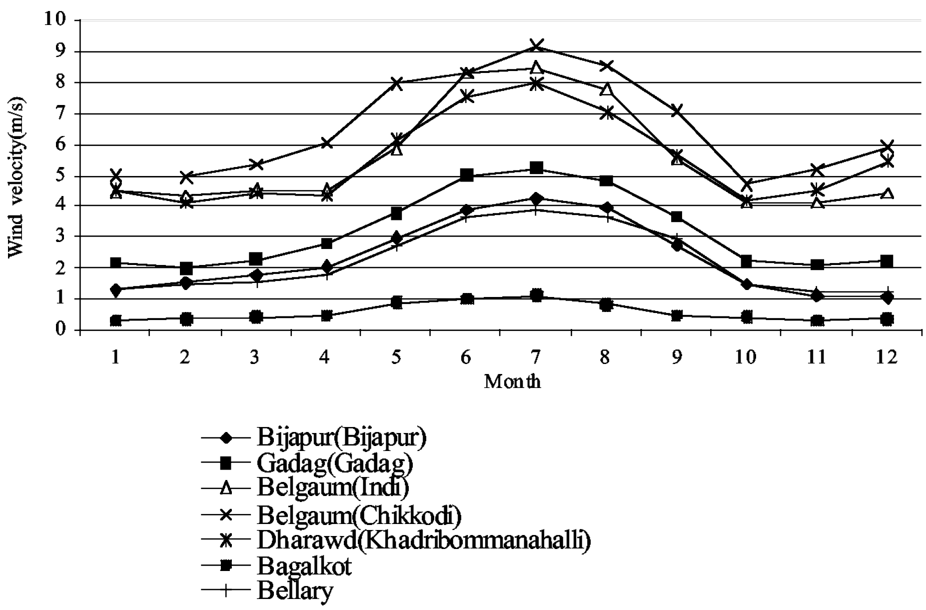


Figure 2. Monthly variation of wind velocity in Northern Dry Zone

## 4. CONCLUSIONS

Initial analyses of wind speed across the agroclimatic zones show that Northern dry zone in Karnataka has good wind potential, which if exploited would help local industries and agriculture. These initial tabulations can be used for preliminary strategic wind power planning, to be followed by detailed study at proposed sites.

## REFERENCES


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