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Research Article

Wind Energy Integration with Desalination Industry– Analysis of Wind Power Potential in Chennai,Nagapattinam and Puducherry of South India

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Abstract

India is a highly populated developing country. Fresh water has become a scarce commodity in most parts of the world. The total water resource available in India is only 4% of the world's fresh water resources. The domestic water requirements are projected to increase by more than 50%. Desalination could be a feasible solution to overcome fresh water scarcity. But the high capital cost and large power requirement are the problems faced and wind power is not utilized properly in India, because of the problems with integration of grid .This paper suggests non-grid wind power to supply the desalination unit for effective utilization of the wind power to increase the number of desalination units in India . This paper analyses the feasibility of wind forms in south East coastal regions of Tamilnadu and Puducherry.

Keywords: *Desalination, dc drive , grid problems, water scarcity, wind speed analysis*

1. Introduction

Tamil Nadu, the South East region of India accounts for 4% of land area, has only 3% of the water resources of the country. The total surface water potential of state is 36 km^3. There are seventeen major river basins in the state and with 61 reservoirs and about 41,948 tanks. There are about 24 lakh hectares irrigated by surface water. Purity of Water is also a serious concern due to pollution by effluents, sewage etc. The government of Tamil Nadu has indicated that provision of drinking water to the people as the highest priority. Excess abstraction of water for domestic and industrial supply will adversely affect the fresh water leads to the mixing of saline water with surface water. In coastal aquifers the excessive pumping causes saline water intrusion towards fresh water. Desalination of sea water (Emilia Kondili1 et al)has become one of source to supply fresh water to meet the demand of drinking water and irrigation purpose. But the requirement of power is large which obstructs the growth.The world population is set to grow by 0.9% per year on average, from the target of around six billion in 2008 to eight billion in 2035. Currently 1.4 billion people do not have access to reliable electricity in developing countries with about 85% of those in rural areas. With 404 million people in India still without electric power anddesalination plants could meet the seasonal variation in demand of water.But the limited availability of conventional energy supply could overcome by the sufficiency of wind power In the high wind potential areas, the wind power based desalination plants comprise a technically feasible and financially attractive solution.

2. Background

The coastal areas are often in favour of the desalination system. The area with minimum of 5m/sec velocity could be a feasible area for the industry. (Emilia Kondili et al)(for 50m hub height). of standalone units. The standalone desalination unit and irrigation pumps could over come the demand on conventional power from grid.. In India, the industry is still heavily dependent on tax incentives that tend to attract a narrow range of investors. The Indian power sector is plagued with inefficiencies and severe reliability problems. The problems with grid integration with generated wind power leads to complexity and lesser efficiency.

3. Indian grid Scenario and Challenges

The best wind sites in various states with high wind potential, and thus the large scale wind power generation are located in remote locations. However, since grid infrastructure is often insufficient to transport the wind power to the load centres, the power output needs to be consumed within the regional or national power grid. (Indian wind energy outlook, 2011) would pose some problems related to the stability and efficiency of the interconnected systems.. In India, the local distribution network system is weak and substantial augmentation is

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required with layout of parallel evacuation infrastructure which increases the project cost .

To Maximize power capture, Taller towers, Large rotor diameters, Higher designed efficiency at partial loads, low cut-in wind speeds, Efficient generator, modern electronics are the essential technlogies needed to implement. The benefit to be obtained from carbon dioxide reductions is dependent on the fuel that wind power displaces. Wind power is a clean, renewable source of energy which produces no greenhouse gas emissions or waste products in itself. By directly reducing the use of fossil fuels, wind power significantly reduces carbon dioxide emissions, other particulate matter and pollutants (from coal based plants). Depending upon the fuel being replaced,the operation of 1 MW wind turbine will save 2,000 tonnes or more of carbon dioxide emissions annually. It usually takes a wind turbine three to six months to produce the energy that goes into producing, and recycling the wind turbine after its 20-25 year lifetime. After that, wind power produces no carbon dioxide emissions. The expected carbon dioxide savings from wind power are 243 million tonnes globally. In 2010, we passed 500 million tonne per year between 2015 and 2020, thereafter climbing to 843 million tonnes per year of carbon dioxide savings by 2030. The slow growth of wind power as envisaged by the Reference scenario would mean that by 2020, wind power would have saved just 5.5 billion tonnes of carbon dioxide globally, and this wouldrise to 13 billion tonne by 2030 (Indian wind energy outlook, 2011). It is definitely more efficient to make investments in improved energy efficiency and harnessing wind power to meet the current demand-supply gap. Wind power is already in a position to provide a significant portion of India's planned capacity addition up to 2030, with simple regulatory and grid modernization initiatives. Unlike oil and coal , wind power is not subject to fluctuating fuel prices which drain India's limited foreign reserves would have saved just 5.5 billion tonnes of carbon dioxide globally, and this wouldrise to 13 billion tonne by 2030 foreign reserves.

4. Energy access

In India, each and every citizen should be guaranteed a minimum standard of access to the electricity grid (decentralized or national) and clean cooking facilities. India, with over a billion people, today consumes 645 TWh of electricity (comparable with Brazil which is home to only one sixth of this population). 404 million Indians have no access to electricity, and limited access to other modern fuels such as LPG. This scenario of low energy access is reflected in the Human Development Index which ranks India relatively low at 119 among 169 nations, according to the most recent Human Development Index (HDI) released by the UN Development Programme (2010).According to the IEA, India's economic growth will average7.9% during the period 2008-2015 and then slow down to average 5.9% between the periods 2015-2035 (Indian wind energy outlook, 2011) In the last two decades, India has more than doubled its electricity capacity to 170 GW. is a very common phenomenon in smaller towns and during the summer months. Since 2007, only around 12,000 villages have been electrified and approximately100,000 villages are yet to be electrified, and over 44 million households do not have access to energy. In comparison, 95% of urban households now have access, but even then, this is not guaranteed at all times as load shedding state that 'Humanity is facing a choice between a peaceful decision on its common energy future or wars for resources in the near future'. However it is clear that grid extension in rural areas is often not cost effective, so centralized electricity generation with small wind, hydro and solar are best suited to provide the much needed options. Wind power, through its scalability and speed of deployment, can reduce India's carbon footprint but also help towards achieving energy security by reducing its dependence on fossil fuel imports in the long term. It is important for the government to conduct an in-depth study of true costs of developing a low carbon green economy in the near future.

5. Prospects of Implementing Non Grid Theory

Recently to improve the efficiency of the wind power generation, the concept of non grid wind power isemerging. overcoming the problems of complexity in frequency and phase control for large capacity power generation and full utilization of wind power generated during high wind speeds direct connection of wind power to large scale applications is recommended. It eliminates the need for high technology from developed countries and above 90% efficiency of wind power utilization.(K. Suomalainen et al, 2013) The identified applications that can be matched with non gridwind power are high energy consuming industries (Emilia kondili et al) such as chloral alkali, sea water desalination and electrolytic Aluminium and hydrogen production. Sea water desalination is taken for feasibility study in India so that demand for fresh water could be reduced without depending on grid power. As a base, fixed pitch wind turbine is proposed and recent research proposes doubly salient electromagnetic generator (Indian wind energy outlook, 2011). The reverse osmosis (RO) process has membrane units which can be applied to all sizes. Seawater is pressurized such that water molecules pass through the semi-permeable membrane, thus producing freshwater. Compared with the distillation, RO has lower energy consumption and simple system structure. To adapt to the intermittency of wind power, RO treatment units frequently start and stop, requiring the installation of multiple processing units. This reduces the utilization of RO processing units and increases production costs. Furthermore, its complex pre-processing units, high requirements for operators and regular replacement of membrane modules all contribute to difficulties in their widespread applications in developing countries, such as China. Innovative non-grid theory was introduced by Dr.WeidongGu in 1985. This is definitely a feasible solution to overcome power demand faced by our country and desalination application with non-grid wind power will overcome the challenges on grid connection and poor efficiency of wind generation. The economic analysis on AC drives of desalination system without grid, DC drive desalination without grid and replacement of grid supply in existing desalination units in Tamil Nadu with non grid could be done. As a pre-feasibility study, the places with water demand in South East region ok, (2011) coastal areas are identified. In Chennai, Puducherry, Nagapattinam andTutucorin, the annual average wind pattern Data taken from NASA and analysed using HOMER and RET Screen software. Energy density is calculated using MATLAB program.

Table 1 Annual Wind Scenario

Months	Chennai Wind Speed m/sec	Nagapattinam Wind Speed m/sec	Puducherry Wind Speed m/sec
Jan	4.87	2.73	3.42
Feb	4.46	3.37	3.72
Mar	4.45	3.60	3.17
Apr	4.49	3.91	3.62
May	4.86	4.06	3.86
Jun	5.52	4.18	4.03
Jul	5.30	3.90	3.60
Aug	5.24	3.66	3.47
Sep	3.83	3.25	2.85
Oct	3.56	2.96	2.37
Nov	4.56	2.53	2.27
Dec	5.28	2.70	2.41
Average wind speed	4.7017	3.40	3.07

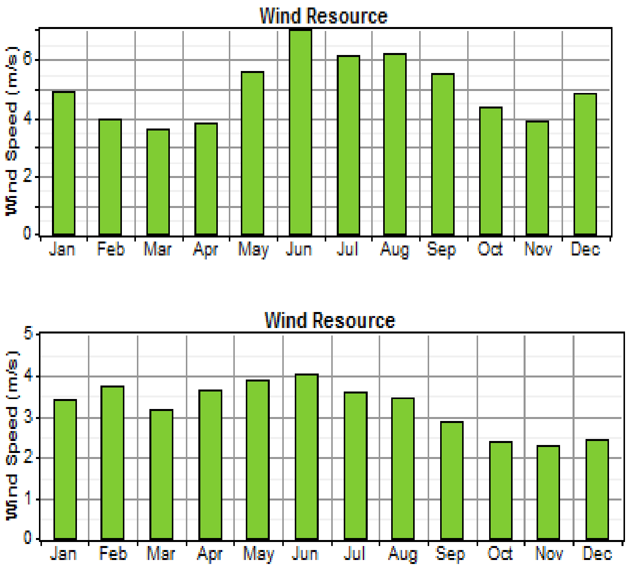
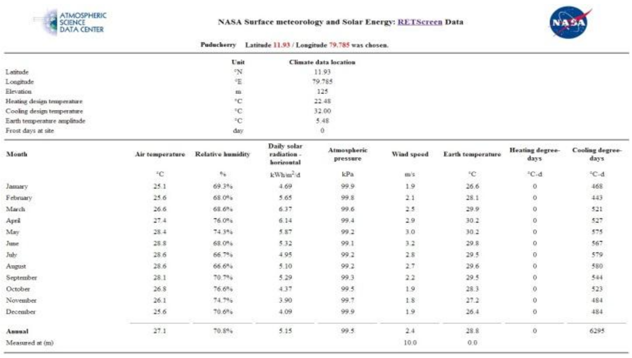


Fig. 1 Chennai, PuducherryAnnual Wind Pattern (Homer)



NASA Surface meteorology and Solar Energy: RETScreen Data

Puducherry Latitude 11.93 / Longitude 79.785 was chosen.

	Unit	Climate data location
Latitude	°N	11.93
Longitude	°E	79.785
Elevation	m	125
Heating design temperature	°C	22.48
Cooling design temperature	°C	32.00
Earth temperature amplitude	°C	5.48
Frost days at site	day	0

Month	Air temperature	Relative humidity	Daily solar radiation - horizontal	Atmospheric pressure	Wind speed	Earth temperature	Heating degree-days	Cooling degree-days
	°C	%	kWh/m²/d	kPa	m/s	°C	°C-d	°C-d
January	25.1	69.3%	4.69	99.9	1.9	26.6	0	468
February	25.6	68.0%	5.65	99.8	2.1	28.1	0	443
March	26.6	68.6%	6.37	99.6	2.5	29.9	0	521
April	27.4	76.0%	6.14	99.4	2.9	30.2	0	527
May	28.4	74.3%	5.87	99.2	3.0	30.2	0	575
June	28.8	68.0%	5.32	99.1	3.2	29.8	0	567
July	28.6	66.7%	4.95	99.2	2.8	29.5	0	579
August	28.6	66.6%	5.10	99.2	2.7	29.6	0	580
September	28.1	70.7%	5.29	99.3	2.2	29.5	0	544
October	26.8	76.6%	4.37	99.5	1.9	28.3	0	523
November	26.1	74.7%	3.90	99.7	1.8	27.2	0	484
December	25.6	70.6%	4.09	99.9	1.9	26.4	0	484
Annual	27.1	70.8%	5.15	99.5	2.4	28.8	0	6295
Measured at (m)					10.0	0.0		

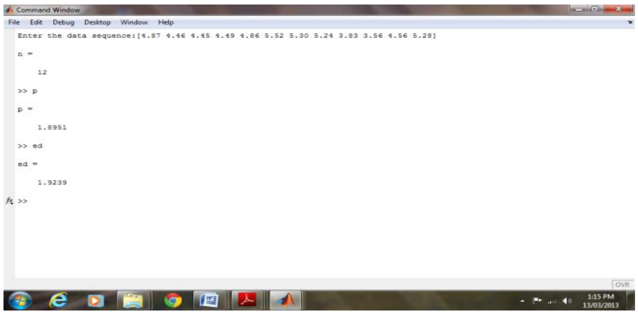


Fig. 3 MATLAB results Chennai

Chennai The capacity factor is found to be 1.895 Energy density is found to be 1.9239

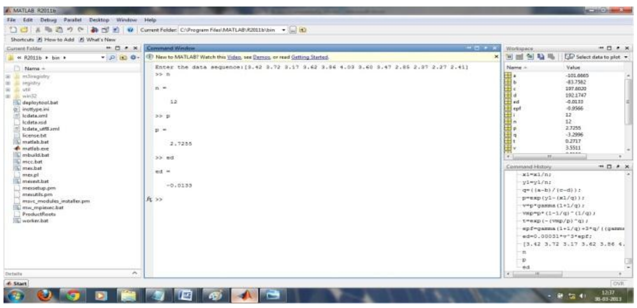


Fig. 4 MATLAB results Puducherry

Puducherry The capacity factor is found to be 2.7255 Energy density is found to be -0.0133

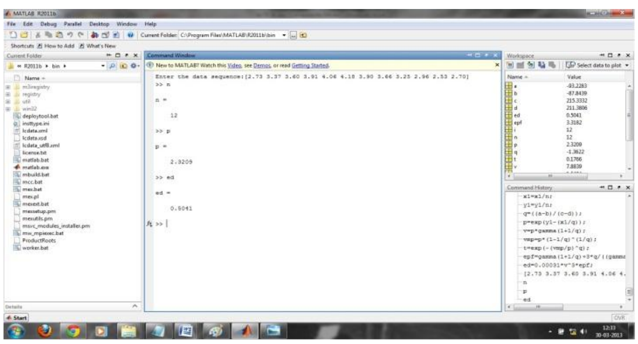


Fig. 5 MATLAB results Nagapattinam

Nagapattinam The capacity factor is found to be 2.3209 Energy density is found to be 0.5041

Conclusion

The problem of fresh water scarcity and power demand existing in India is analysed. The feasibility of using renewable power to seawater desalination is explained. The prospects of implementing non-grid wind theory to wind-powered desalination system is suggested. Pre-feasibility analysis is done by analysing the wind pattern of selected places from south East regions of India and energy density was calculated using MATLAB. Chennai found to be more feasible to move to the next step of feasibility and economic analysis to design a stand-alone desalination unit driven by wind power. Since there are two desalination units with grid power are already in operation at Chennai ,the replacement of grid power with renewable source could also be analysed.

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