CH2356 Energy Engineering

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Wind Power

Dr. M. Subramanian

Associate Professor
Department of Chemical Engineering
Sri Sivasubramaniya Nadar College of Engineering
Kalavakkam – 603 110, Kanchipuram (Dist)
Tamil Nadu, India
msubbu.in[AT]gmail.com


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Wind Power

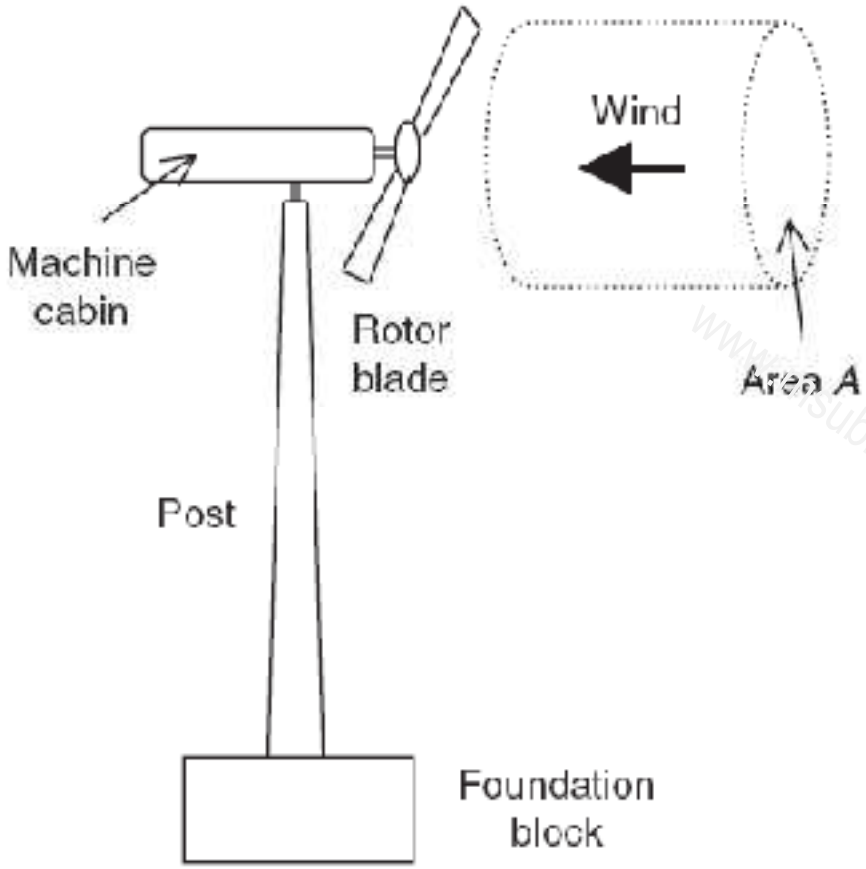


Figure 12-3. Schematic of a wind turbine.

$$P_{\text{wind}} = \frac{\Delta \text{KE}_{\text{air}}}{\Delta t} = \frac{1}{2}\rho_{\text{air}} A v_{\text{air}}^3$$

$$A = \pi R^2$$

$$P_{\text{wind}} = \frac{\pi}{2}\rho_{\text{air}} R^2 v_{\text{air}}^3$$

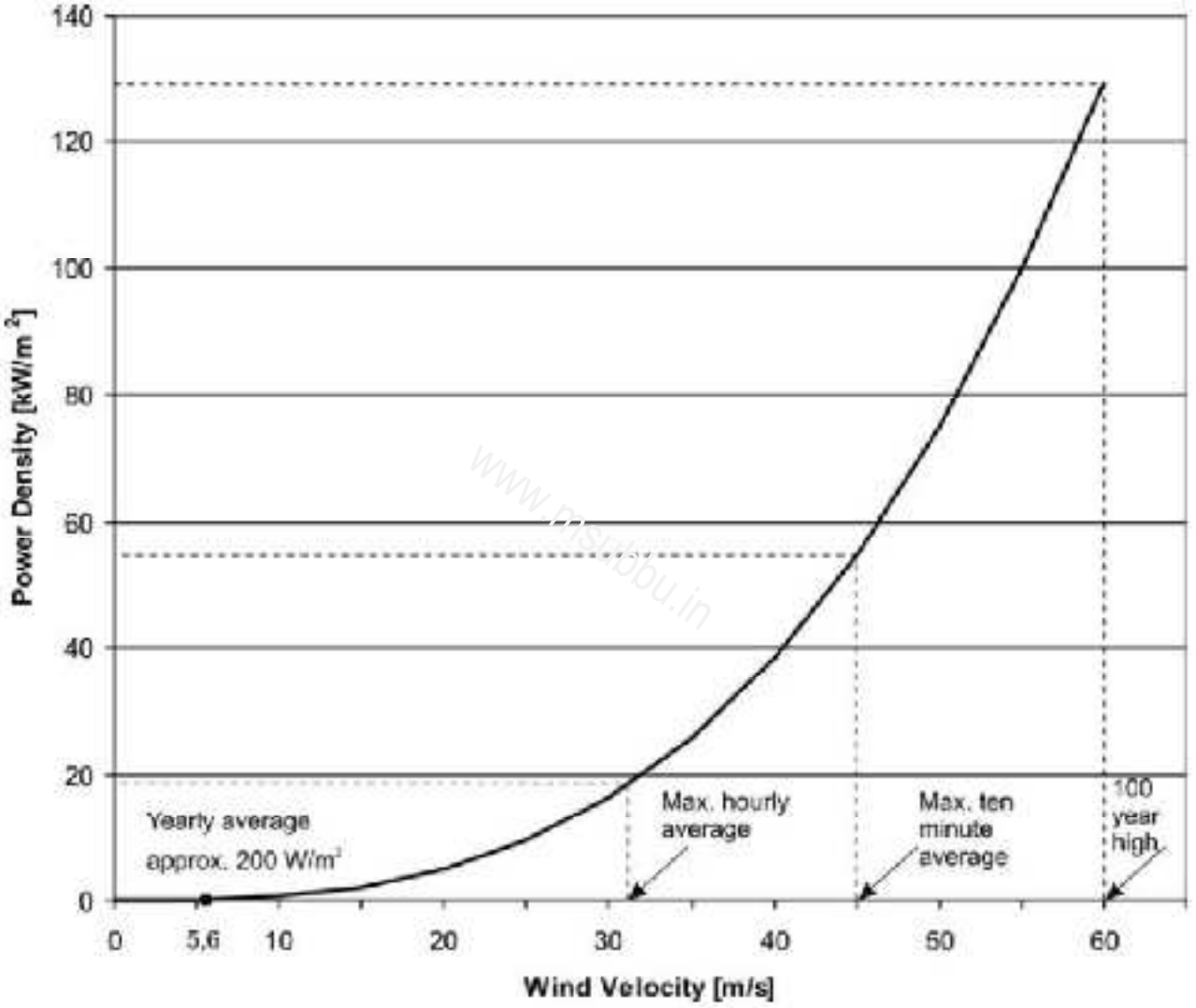
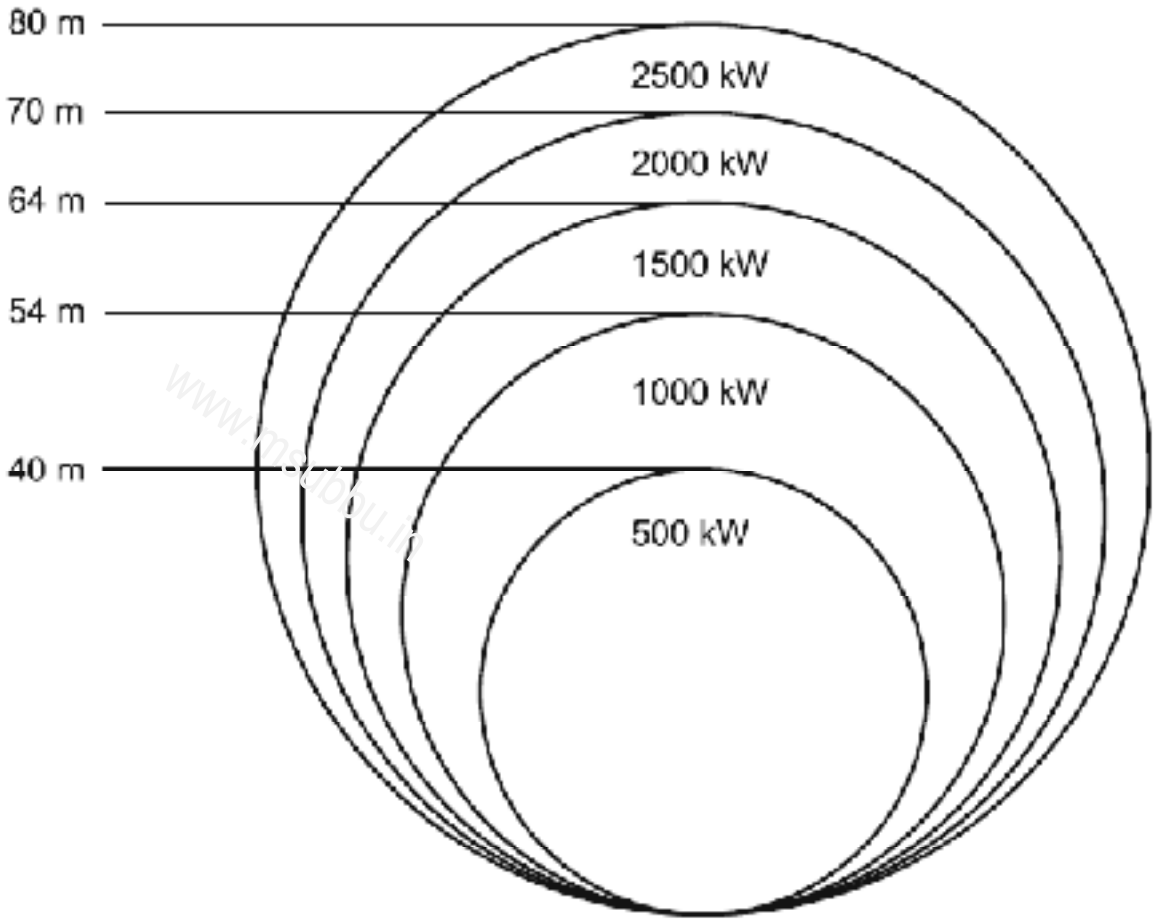
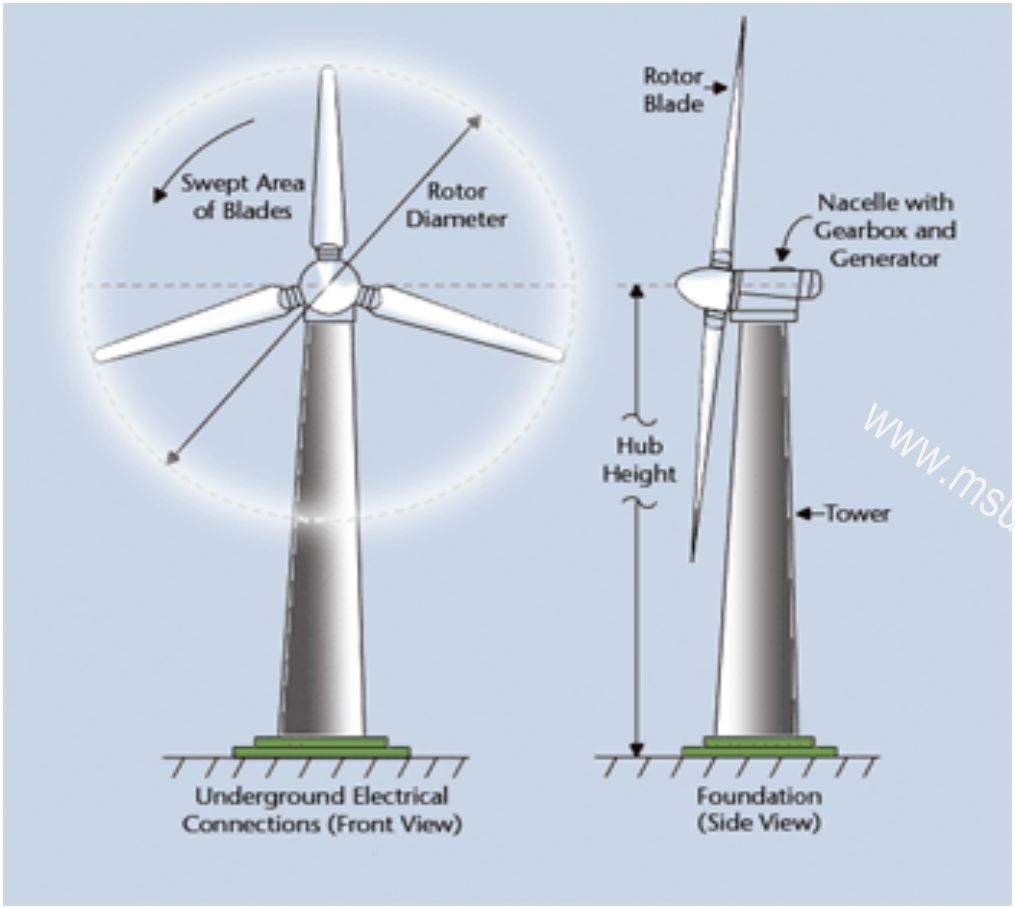


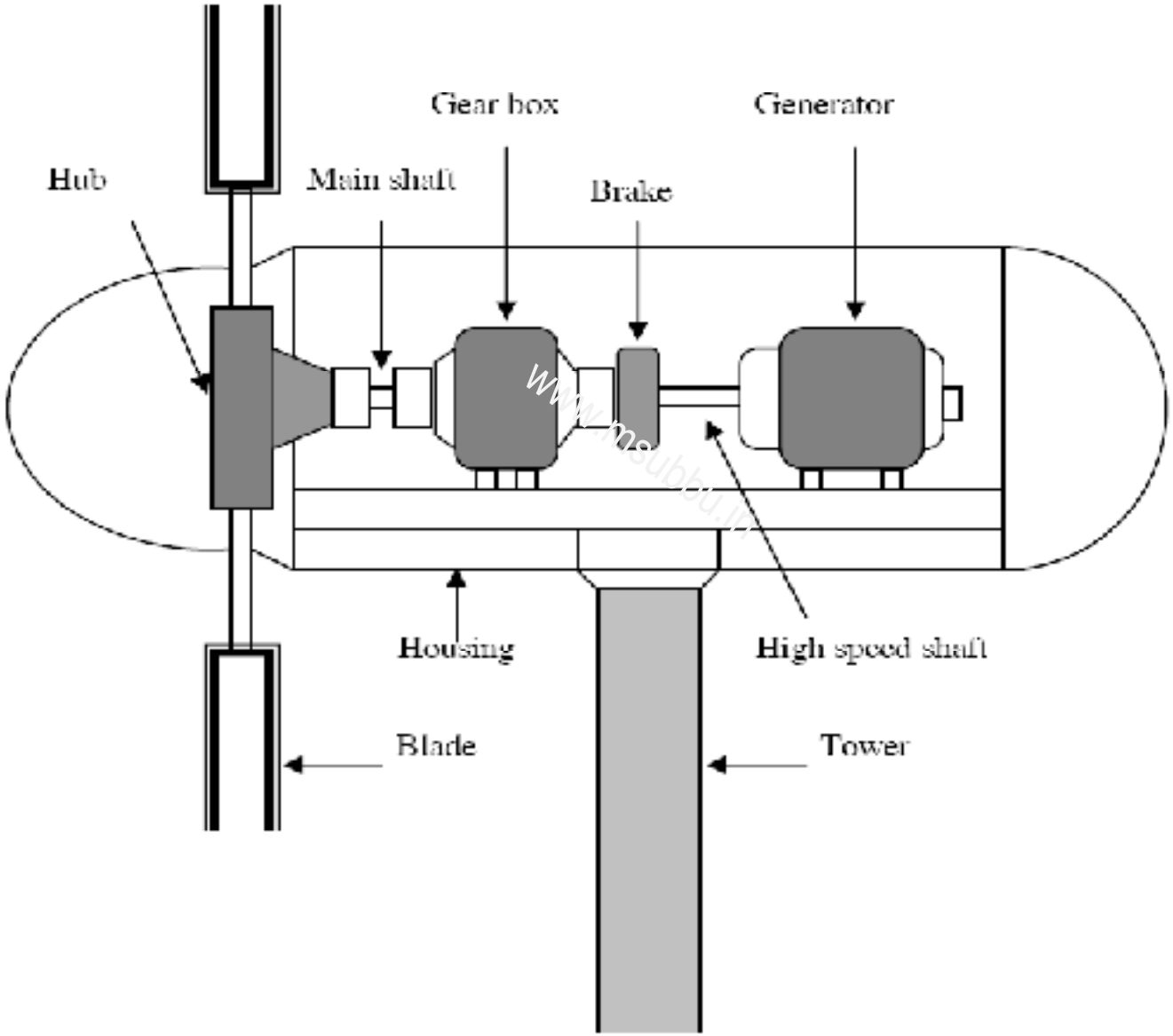
Fig. 3.2 Relationship between wind velocity and power of wind (wind speed for Germany)

Fig. 3.1 Power output increases with the rotor diameter and the swept rotor area





Components of Wind Turbine



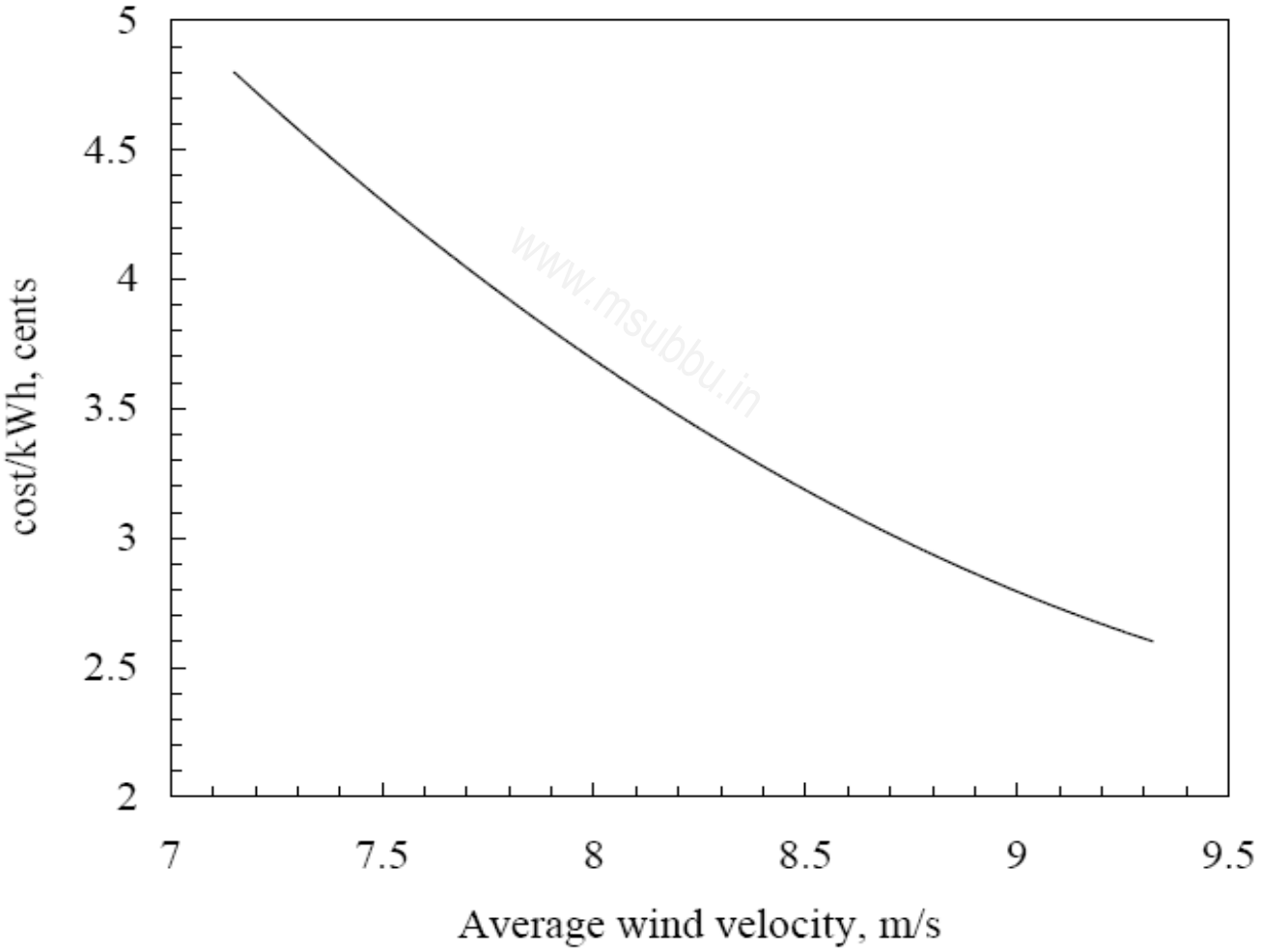
Wind Power Generation

- Before setting up a wind turbine generator, the availability of wind - the wind speed and direction for a ten minute average is checked.
- Since the winds on the sea coast are of high speed and vary in speed, wind turbine generators are usually not installed in these areas.
- The preferred wind speed for optimum power generation is around 12 m/sec (40-50 km per hour) above which the turbines have to be switched off to avoid damage .
- The average height of the wind turbine is 200 meters while the blades could span 80 meters.

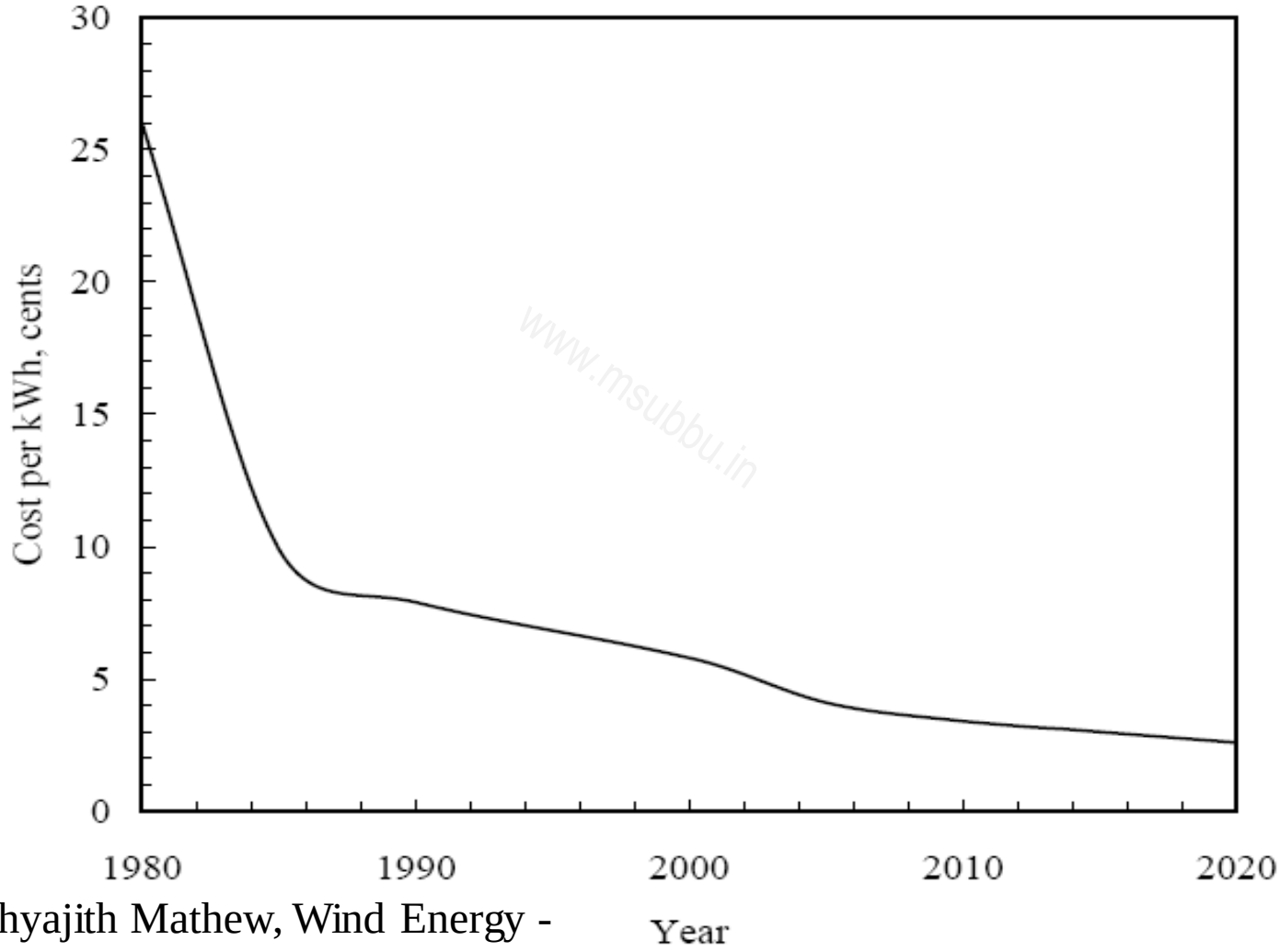
Suzlon - models

Model	Capacity (kW)	Hub Height (Meters)	Rotor Diameter (Meters)
S 33	350	60 / 70	33
S 52	600	74	52
S 64/66/70	1250	56 / 65 / 74	64 / 66 / 69.1
S 82	1500	78.5	82
S 88	2100	80	88

Effect of Wind Velocity on Cost of Energy Production



Cost of Wind Energy

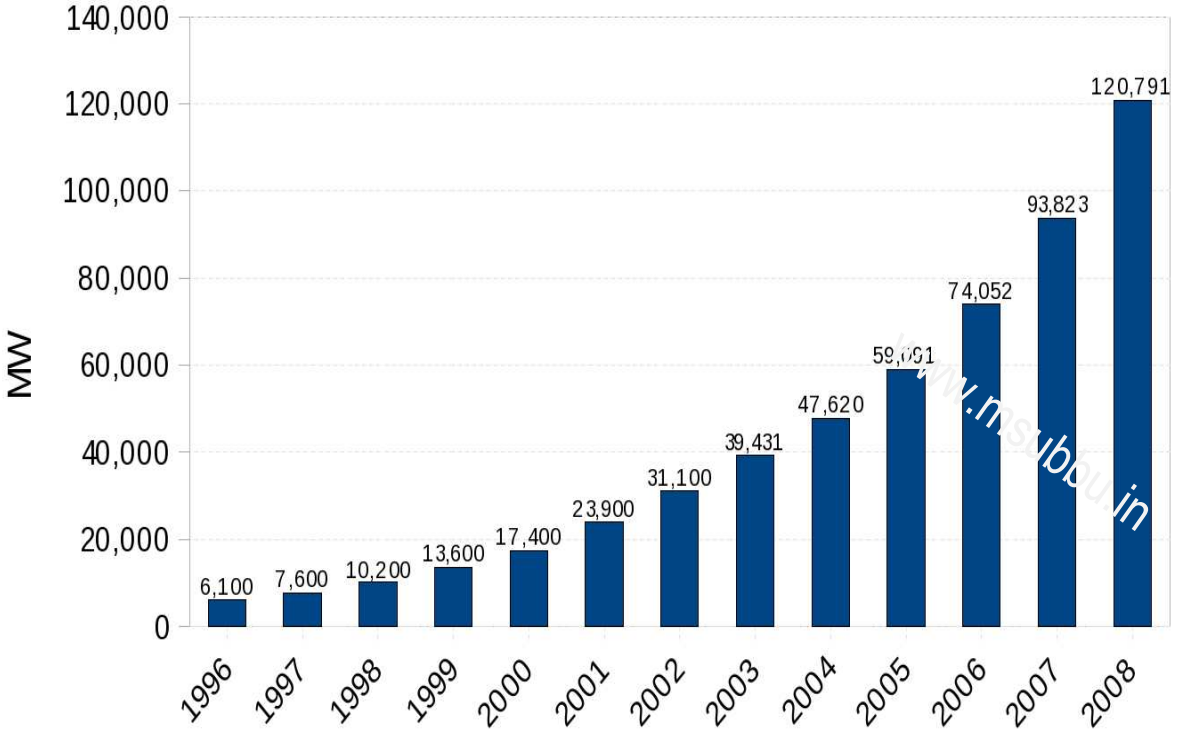


Sathyajith Mathew, Wind Energy - Fundamentals, Resource Analysis and Economics, Springer, 2006

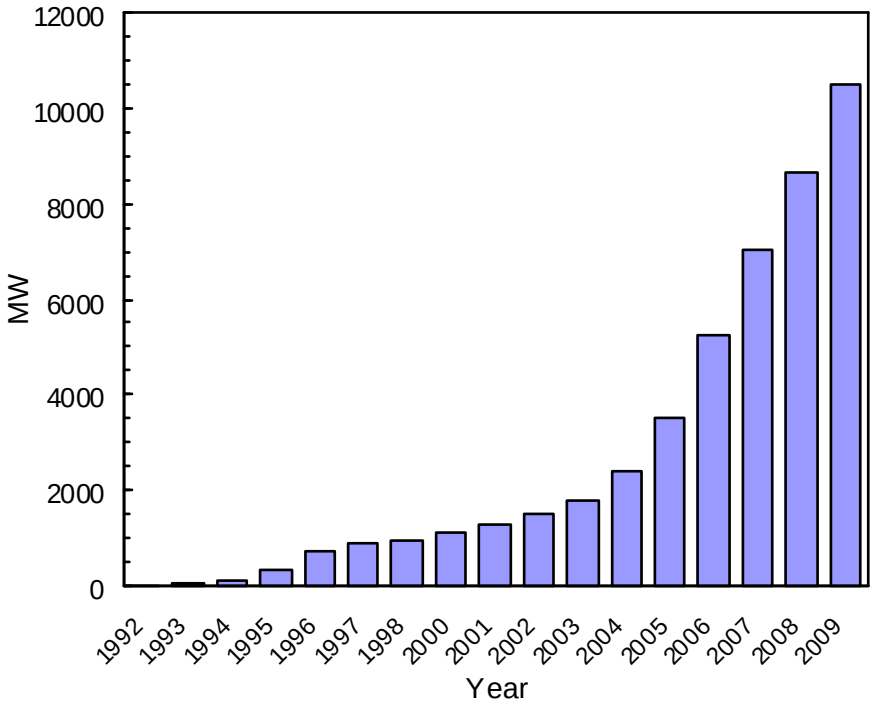
Wind Power – World Status

- Global wind power potential: 870 TW
- At the end of 2009, worldwide installed capacity of wind-powered generators was 159.2 GW. Energy production was 340 TWh, which is about 2% of worldwide electricity usage
- Several countries have achieved relatively high levels of wind power penetration (with large governmental subsidies), such as 20% of electricity production in Denmark, 14% in Portugal and Spain, 11% in Republic of Ireland, and 8% in Germany in 2009

Wind Power Installations



World



India

Installed capacity at the end of 2008

1	USA	25.2 GW
2	Germany	23.9 GW
3	Spain	16.7 GW
4	China	12.2 GW
5	India	9.6 GW
6	Total	**120 GW**

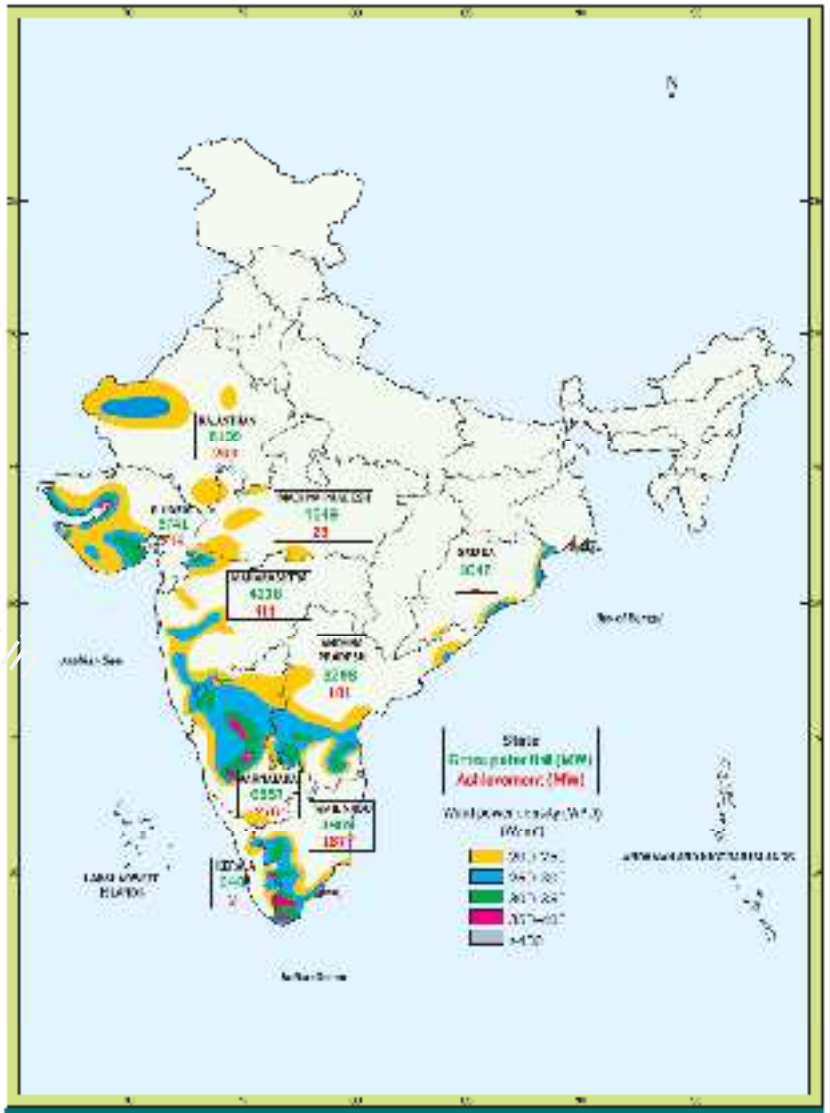
At the end of 2009, worldwide of wind-powered generators was 159.2 GW.

By June 2010 the capacity had risen to 175 GW.

Wind Power in India

Wind power installations in India as on 2010: 11.8 GW

Estimated wind power potential of India: 48.6 GW



Wind power potential and achievements as on 31 December 2004

India – Approved Wind Farmable Sites

SlNo	State	Stations with Annual Avg. WPD > 200 W/m^2 at 50 m height
1	Tamil Nadu	41
2	Gujarat	38
3	Andhra Pradesh	32
4	Maharashtra	31
5	Karnataka	26
6	Kerala	17
7	Lakshadeep	8
8	Madhya Pradesh	7
9	Rajasthan	7
10	Orissa	6
11	Andaman, Uttarakhand, West Bengal (each one)	3
12	Total	**216**

State	Generation up to 2005-06 (MU)	Generation during 2006-07 (MU)
Tamil Nadu	15413	5269
Gujarat	1461	455
Andhra Pradesh	1041	149
Maharashtra	3440	1692
Karnataka	2342	1398
Others	1177	603
Total	**24874**	**9565**

Source: C-WET, June 2009

http://www.cwet.tn.nic.in/

Wind Power in India

- The development of wind power began in the 1990s
- 5th largest in wind power installed capacity
- Tax benefits: 80% depreciation in the first year and 10 year tax holiday, many of the highest tax payers in the country invest their money in wind farms
- Wind power accounts for 6% of India's total installed power capacity, and it generates 1.6% of the country's power
- Despite the high installed capacity, the actual utilization of wind power in India is low because policy incentives are geared towards installation rather than operation of the plants. This is why only 1.6% of actual power production in India comes from wind although the installed capacity is 6%. The government is considering the addition of incentives for ongoing operation of installed wind power plants

Wind Power in India (contd.)

- Vestas, Suzlon and Enercon are the major suppliers of wind power equipment in India

- In February 2009, Shriram EPC bagged INR 700 million contract for setting up of 60 units of 250 kW (totaling 15 MW) wind turbines in Tirunelveli district by Cape Energy

Status as on November 2008

SlNo	State	Installed Capacity (GW)
1	Tamil Nadu	4.1
2	Maharashtra	1.8
3	Gujarat	1.4
4	Karnataka	1.1
5	Rajasthan	0.7
6	Andhra Pradesh	0.1

Status as on March 2010

SlNo	State	Installed Capacity (GW)
1	Tamil Nadu	4.9
2	Maharashtra	2.1
3	Gujarat	1.9
4	Karnataka	1.5
5	Rajasthan	1.1
6	Andhra Pradesh	0.1

Wind power is being purchased @ Rs. 3.40 / unit

Udumalpet (Tamil Nadu)

Wind turbines in Udumalpet (Tamil Nadu)

Disadvantages of Wind Power

- The major disadvantage of wind power farms are the low load factors of 20-30% .
- They are not reliable since wind patterns keep changing.
- Seasonal variability introduces a challenge in integration of wind power into electricity grids, requiring balancing with other technologies such as hydropower and pumped-storage hydroelectricity
- Also, the area required is large, a 225MW plant may take up an area of size 35 km by 5 km.
- Other allegations (not proven) are that the wind turbine cause droughts and affect bird life