Wind Energy

It Blows You Away

Submitted By:
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"Coal, gas and oil will not be the three kings of the energy world for ever. It is no longer folly to look up to the sun and wind, down into the sea's waves"
Introduction
• Energy is a major input for overall socio-economic development of any society
• The prices of the fossil fuels steeply increasing
• So renewable are expected to play a key role
• Wind energy is the fastest growing renewable
• Wind turbines are up to the task of producing serious amounts of electricity
Principles
Uneven heating of earth’s surface and rotation

Map of world winds

Chinook
Mistral
Föhn
Levanter
Scirocco
Monsoons
Haboob
Brickfielder

Northeast trades
Westerlies
Southeast trades
Wind Power Density of India
Velocity with Height

Wind Speed Increase Factor vs. Height Above Surface (m)
Potential
- Huge potential exists
  - Available potential can contribute five times the world energy demand
- 0.4% contribution to total energy
Wind Energy is Currently The fastest Growing Energy Source
Installed Capacity (MW) in 2007

- Germany, 17000
- India, 3595
- USA, 7000
- Denmark, 3115
- Spain, 8959
Available Potential in India

- Wind
- Small Hydro
- Biomass
- Waste to Energy
Installed Capacity (MW) in India
## State wise potential in India, 2005

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>State</th>
<th>Gross Potential (MW)</th>
<th>Technical Potential (MW)</th>
<th>Installed Capacity (MW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Andhra Pradesh</td>
<td>8275</td>
<td>1920</td>
<td>121.1</td>
</tr>
<tr>
<td>2.</td>
<td>Gujarat</td>
<td>9675</td>
<td>1780</td>
<td>667</td>
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<tr>
<td>3.</td>
<td>Karnataka</td>
<td>6620</td>
<td>1180</td>
<td>847</td>
</tr>
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<td>4.</td>
<td>Kerala</td>
<td>875</td>
<td>605</td>
<td>2.0</td>
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<tr>
<td>5.</td>
<td>Madhya Pradesh</td>
<td>5500</td>
<td>845</td>
<td>58</td>
</tr>
<tr>
<td>6.</td>
<td>Maharashtra</td>
<td>3650</td>
<td>3040</td>
<td>1485</td>
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<tr>
<td>7.</td>
<td>Orissa</td>
<td>1700</td>
<td>780</td>
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<td>8.</td>
<td>Rajasthan</td>
<td>5400</td>
<td>910</td>
<td>470</td>
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<td>9.</td>
<td>Tamilnadu</td>
<td>3050</td>
<td>1880</td>
<td>3460</td>
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<tr>
<td>10.</td>
<td>West Bengal</td>
<td>450</td>
<td>450</td>
<td>1.6</td>
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<tr>
<td>11.</td>
<td>Other States</td>
<td>-</td>
<td>-</td>
<td>0.5</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>45195 MW</strong></td>
<td><strong>13390</strong></td>
<td><strong>7114 MW</strong></td>
<td></td>
</tr>
</tbody>
</table>
Turbine Evolution

Used for

• Pumping water
• Grinding grain

Mainly used for

• Generating Electricity
Two Types of Wind Turbines

Horizontal Axis Wind Turbine

Horizontal Axis Wind Turbine
VAWT [Vertical Axis Wind Turbine]

- Drag is the main force
- Nacelle is placed at the bottom
- Yaw mechanism is not required
- Lower starting torque
- Difficulty in mounting the turbine
- Unwanted fluctuations in the power output
Lift is the main force
- Much lower cyclic stresses
- Yaw mechanism is required
- 95% of the existing turbines are HAWTs
- Nacelle is placed at the top of the tower
Turbine design and construction

- Blades
  - Material used
  - Typical length
- Tower height
  - Heights twice the blade length are found economical
Turbine Aerodynamics

α = low

α = medium < 10 degrees

α = High Stall!!
Why Only Three
Airfoil Shape
A Typical HAWT
Improvements

- Concentrators
Future Wind Turbines

Wind Amplified Rotor Platform

The Modular WARP™ System Design
Disc type wind turbine

- Much more efficient than HAWT
- Requires less height
- Low noise
- Works in any wind direction
Economics
Determining Factors

- Wind Speed
- Turbine design and construction
- Rated capacity of the turbine
- Exact Location
- Improvements in turbine design
- Capital
Break Down Of Capital Cost

- Turbines: 45%
- Support Structure: 25%
- Power Collection: 13%
- Power Transmission: 8%
- Installation: 7%
- Project Management: 2%
Energy Cost Trend

1979: 40 cents/kWh

- Increased Turbine Size
- R&D Advances
- Manufacturing Improvements

2000: 4 - 6 cents/kWh

2008: 2.1 – 3.4 cents/kWh
Economic Advantages
- Greater fuel diversity
- No delay in construction
- Low maintenance costs
- Reliable and durable equipment
- Additional income to land owners
- More jobs per unit energy produced
- No hidden costs
Cost Comparison

<table>
<thead>
<tr>
<th>Energy Source</th>
<th>Cents/kW-h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coal</td>
<td>4</td>
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<tr>
<td>Gas</td>
<td>5</td>
</tr>
<tr>
<td>Wind</td>
<td>5</td>
</tr>
<tr>
<td>Hydro</td>
<td>6</td>
</tr>
<tr>
<td>Nuclear</td>
<td>7</td>
</tr>
<tr>
<td>Solar</td>
<td>18</td>
</tr>
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</table>
Future
Germany now and 2020

- At present 10% of the country’s energy is supplied by wind energy.
- By 2020 it is expected to go up to 26%.

![Energy Source Pie Chart]

- Natural Gas, 41%
- Wind, 26%
- Hard Coal, 21%
- Nuclear, 6%
- Hydro, 4%
- Brown Coal, 2%
So.....

- Price of wind power is coming down
- There is enormous capacity
- Energy storage, however, is still a problem
Conclusion
- Wind energy is pollution free and nature friendly
- Wind energy has very good potential and it is the fastest growing energy source
- The future looks bright for wind energy because technology is becoming more advanced and windmills are becoming more efficient
THANK YOU