Wind Energy Potential and Development in Indonesia

Soeripno Martosaputro

Wind Hybrid Power Generation Market Development Initiatives
(WHyPGen Project)

Kawasan Puspiptek Gedung 620 B2TE-BPPT,
Setu – Tangerang Selatan 15314, Banten, Indonesia
Phone: +62-21-7560940, Fax: +62-21-7565670
www.whypgen-bppt.com
ripnoms@whypgen-bppt.com, ripnoms@gmail.com

Presented at APCRES 2013, Ayodya Resort Bali Hotel, September 30 - October 02, 2013
Outline:

- Introduction About WHyPGen Project
- Wind Energy World Wide
- Indonesia Wind Energy Resource Assessment Status
- Wind Turbine Technology Status
- Implementation
- The Barrier
- Conclusion
**The Project Aims**: 

to promote the adoption of Wind Hybrid Power Generation (WHyPGen) technology through the facilitation, development, application and promotion of the commercialization of on-grid WHyPGen technology.

- **Rate of growth of GHG emission in the power sector is reduced**
  - 16.050 mt

- **Installed capacity of WHyPGen facilities**
  - 9.4 MW

- **Total electricity generation from installed WHyPGen facilities**
  - 18,115 GWh
**Goal**
- Reduction of GHG emission in the power sector

**Objective**
- Facilitation of commercial on-grid WHyPGen systems for environmentally sustainable electricity supply

**Activities**
- Comp. #1 Technology Application & Assessment
- Comp. #2 Technology Demonstration
- Comp. #3 Financing Initiatives
- Comp. #4 Policy & Institutional Support
- Comp. #5 WHyPGen Promotion
- Comp. #6 Market Development & Industrial Support
Renewable Power Capacity in World, 2012

### World Total
- **Wind Power**
- **Solar PV**
- **Bio-power**
- **Geothermal Power**
- **CSP and Ocean**

- **World Total**
  - **Wind Power**: 480 GW
  - **Solar PV**: 210 GW
  - **Bio-power**: 128 GW
  - **Geothermal Power**: 210 GW
  - **CSP and Ocean**: 128 GW

### Countries
- **China**: 90 GW
- **United States**: 86 GW
- **Germany**: 71 GW
- **Spain**: 31 GW
- **Italy**: 29 GW
- **India**: 24 GW

*not including hydropower
Global Cumulative Installed Wind Capacity, 2012

- The Biggest Wind Turbine: Enercon E-126 (7.5 MW) and Re Power 6.15 MW
- Total Installed Capacity, 2012 ~283 GW [Gwec],
- Top Five Country installed:
  - China 75.324 MW,
  - USA 60.007 MW,
  - Jerman 31.308 MW,
  - Spain 22.796 MW, and
  - dan India 18.421 MW,
Wind Energy Development – Indonesia

- The implementation of wind energy technology in Indonesia is still low its around 1.6 MW installed capacity.
- The implementation of isolated wind energy systems typically in remote area / location or islands, and they are frequently installed as part of R & D project.
- Several area along the coastal/shore of northern and southern part of Java Island, eastern part of Madura island, south and north Sulawesi island, east Lombok island etc, have applied wind turbine for electricity generation. Mainly used for stand alone system and hybrid
- Up to present, the largest wind power generation facility is installed at Nusa Penida-Bali, for the total capacity of 735kW, and followed by the total of 540kW wind power installation at Sangihe-North Sulawesi and Selayar – South Sulawesi
- On going project to develop wind farm to setting up around 300 MW install capacity for near future at several sites at :
  - Bantul
  - Sukabumi
  - Lebak
  - South Sulawesi (Jeneponto and Sidrap)
  - East Nusa Tenggara (Oelbubuk)
Indonesia Wind Data Status

- Measurement in situ, there are sites;
  - Conducted by Government (LAPAN, MEMR etc): >130 sites
  - Conducted by donor (Wind Guard, wind rock int, EU, World bank): 36 sites (mostly at NTT, South Sulawesi and Nias Island)
- Secondary data from BMKG, WMO, NCDC, 3TIER, AWS Truepower and other
- Existing Wind Map by NREL-USA: Sumba and Timor Islands
- Total sites: 166 sites, >>> 35 sites potential
- On going measurement for new and validation sites by several company and institution: ~20 sites
Global Wind Speed (MESO scale) by 3TIER

5 km resolution

Wind Energy Potential
## Wind Energy Potency in Indonesia

Summary data from conducted activity on wind resources assessment and research that have been selected for 166 sites

<table>
<thead>
<tr>
<th>Resources potential</th>
<th>Wind Speed at 50 m, (m/s)</th>
<th>Wind Power density, at 50 m, (W/m²)</th>
<th>Number of sites</th>
<th>Provinces</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marginal</td>
<td>3,0 – 4,0</td>
<td>&lt; 75</td>
<td>84</td>
<td>Maluku, Papua, Sumba, Mentawai, Bengkulu, Jambi, East and West Nusa Tenggara, South and North Sulawesi, North Sumatera, Central Java, Maluku, DIY, Lampung, Kalimantan</td>
</tr>
<tr>
<td>Fair</td>
<td>4,0 – 5,0</td>
<td>75 - 150</td>
<td>34</td>
<td>Central and East Java, DIY, Bali, Bengkulu, East and West Nusa Tenggara, South and North Sulawesi</td>
</tr>
<tr>
<td>good</td>
<td>&gt; 5,0</td>
<td>&gt; 150</td>
<td>35</td>
<td>Banten, DKI, Central and West Java, DIY, East and West Nusa Tenggara, South and North Sulawesi, Maluku</td>
</tr>
</tbody>
</table>

*Source: LAPAN wind data*
Wind Site Measuring

<table>
<thead>
<tr>
<th>Region</th>
<th>Sites</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sumatera</td>
<td>18</td>
</tr>
<tr>
<td>Jawa dan DIY</td>
<td>37</td>
</tr>
<tr>
<td>Kalimantan dan Sulawesi</td>
<td>38</td>
</tr>
<tr>
<td>Bali dan NTB</td>
<td>15</td>
</tr>
<tr>
<td>Nusa Tenggara Timur</td>
<td>54</td>
</tr>
<tr>
<td>Maluku</td>
<td>8</td>
</tr>
<tr>
<td>Papua</td>
<td>2</td>
</tr>
<tr>
<td>Total Sites</td>
<td>166</td>
</tr>
</tbody>
</table>
Wind Farm Potential Sites

- **Sulawesi Banten**
  - Sidrap: 100 MW
  - Jeneponto: 162.5 MW

- **Banten**
  - Lebak: 100 MW

- **West Java**
  - South Sukabumi: 100 MW
  - South Garut: 150 MW

- **Central Java/ DIY**
  - Gunung Kidul: 15 MW
  - Bantul: 50 MW
  - Purworejo: 50 MW

- **NTT**
  - Oelbubuk: 10 MW
Other Potential Sites
Sumatera Area

- North Aceh
- South West Coastal (Enggano)
- Natuna Island
- Bangka Belitung
Other Potential Sites
Kalimantan

- West Coastal
- South Coastal
- East Coastal
Other Potential Sites

Sulawesi

- North Sulawesi
- Gorontalo
- South Sulawesi
- South East Sulawesi
Other Potential Sites
Maluku and Papua

- South Papua
- West Papua
- Kepala Burung
- South East Maluku
- South West Maluku
Other Potential Sites

Nusa Tenggara Barat and Nusa Tenggara Timur

- Rote Ndao area
- Sumba Area
- Kupang Area
- Bima Area
Other Potential Sites

Java, Madura and Bali

- South West Banten Area
- South Sukabumi, Garut
- Southern part Central and East Java
- Madura
# Wind Resources Assessment

<table>
<thead>
<tr>
<th>Site</th>
<th>$V_{ave}$ m/s</th>
<th>Weibul Parameter</th>
<th>WPD W/m²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>C (m/s)</td>
<td>k</td>
</tr>
<tr>
<td>Baron DIY</td>
<td>5,8</td>
<td>6,6</td>
<td>2,34</td>
</tr>
<tr>
<td>Lebak - Banten</td>
<td>5,5</td>
<td>6,2</td>
<td>2,07</td>
</tr>
<tr>
<td>Nusa Penida – Bali (20m)</td>
<td>4,9</td>
<td>5,5</td>
<td>1,97</td>
</tr>
<tr>
<td>Oelbubuk NTT</td>
<td>6,7</td>
<td>7,8</td>
<td>2,33</td>
</tr>
<tr>
<td>Sukabumi West Java</td>
<td>6,6</td>
<td>7,4</td>
<td>2,54</td>
</tr>
<tr>
<td>Purworejo Central Java</td>
<td>5.32</td>
<td>5.9</td>
<td>1.52</td>
</tr>
<tr>
<td>Garut West Java *)</td>
<td>6.6</td>
<td>7.5</td>
<td>3.29</td>
</tr>
<tr>
<td>Sidrap South Sulawesi *)</td>
<td>7.04</td>
<td>7.9</td>
<td>2.06</td>
</tr>
<tr>
<td>Jeneponto South Sulawesi *)</td>
<td>8.11</td>
<td>9.3</td>
<td>2.73</td>
</tr>
<tr>
<td>Selayar South Sulawesi (24m)</td>
<td>4.6</td>
<td>5.2</td>
<td>1.83</td>
</tr>
</tbody>
</table>

*) Data source: 3TIER
Several types for small-medium scales WECS capacity (50W to 100 kW) prototypes for electrical and mechanical pumping have been developed by several institutions and companies.

Wind Turbine Development World Wide:

Enercon E-126 (7.5 MW) and n Re Power 6.15 MW

Wind turbine Classes (IEC Standard):

<table>
<thead>
<tr>
<th>Turbine Class</th>
<th>IEC I High Wind</th>
<th>IEC II Medium Wind</th>
<th>IEC III Low Wind</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual average wind speed</td>
<td>10 m/s</td>
<td>8.5 m/s</td>
<td>7.5 m/s</td>
</tr>
<tr>
<td>Extreme 50-year gust</td>
<td>70 m/s</td>
<td>59.5 m/s</td>
<td>52.5 m/s</td>
</tr>
</tbody>
</table>
Wind Hybrid Power Generation

- To overcome the intermittent of wind characteristics
- Combined with existing Diesel Power Generation to reduce / saving oil fuel
- Suitable for remote places where no grid is available in the area
- Supporting the electricity for public lighting, house hold, home industry and water pumping for drinking water and irrigation
- In special case, good alternative to support the fishery (cold storage) and cellular phonr energy charge
Hybrid System at Several Sites

- Hybrid Wtg+PV at Lombok Island
- Hybrid Wtg+Pv+Diesel at Rote Ndao
- Hybrid Wtg+Diesel at Sumenep Madura

Note:
- Hybrid Wtg+PV used for battery charging for house lighting
- Hybrid wtg+PV+diesel at Rote Ndao used for isolated grid
- Hybrid Wtg_pv-diesel used for battery charging for ice machine
- Hybrid Wtg+PV+grid for BTS
Small on grid connection at Selayar and Nusa Penida

- On grid system (micro grid) at Selayar Island
  - Installed capacity 200 kW,
  - 2 unit x 100 kW

- Installed capacity 735 kW, consist of:
  - 6 units of each 80 kW
  - 3 units of 85 kW
Lesson Learn from The Existing Wind Power Generation in Indonesia

- Several implementation, do not use a good FS supported properly, so its often not successful
- Not available skilled technical workers, and they are not given enough technical training for O & M
- spare parts are not available easily obtained in the market, thus to solve the problem becomes too late
- Electric prices are relatively low, it is not sufficient to cover O & M
- Local industry do not develop
BARRIER of WIND TECHNOLOGY IMPLEMENTATION IN INDONESIA

- Wind turbine prices are still relatively expensive
- Electricity tariff from RE is still relatively low
- Most of the wind turbines are technically function with regular maintenances. For this task, spare-parts must be availability
- Maintenance jobs are particularly more problems at the remote areas due to the lack of technical persons and spare-parts delivery
- Some wind turbines do not perform according to the given specifications. Main reason is the sitting or design of operating system due to the lack of wind data and less technical assessment or FS
- More private companies and industry had indicated their interests in marketing and local fabrications, however, they need the stimulus for better contributions
- The better and best wind data actually located at remote area at eastern part Indonesia, but demand and access to location are limited
Policy /Regulation on Wind Energy Development

• Wind power electricity tariff, not establish yet
• Roadmap on Technology, Market and Industry wind sector did not implemented, need clear step by step to reach the target
• Limited Standard for wind technology equipment,
• Local content for wind turbine component
• Financial Scheme for wind power generation
Thank You

This is our Dream

WHyPGen Project (B2TE-BPPT)
Kawasan Puspiptek Serpong, Gd. 620
Tangerang Selatan, 15413
www.whypgen-bppt.com
ripnoms@whypgen-bppt.com
ripnoms@gmail.com