Intelligent energy for a greener planet

South Korea Offshore Wind Market
5th Asia Offshore Wind Day in Tokyo

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Generation Landscape in Korea (1)

The power generation sector is dominated by public companies and will likely continue to be for the next decade.

1. KOSIS
2. KHNP

- Korean GENcos (KHNP, KOEN, KOSPO, KEWP, KOMIPO, KWP) dominate the power generation sector and will continue to do so in the foreseeable decade (70% of the installed capacity), including offshore wind:
  - KOEN has more than 2 GW of wind projects in development and has been the center of attention in recent months
  - KHNP, KWP, KOSPO and KOMIPO are also now developing large pipeline of offshore wind

- Korean conglomerates will dominate the IPP landscape with POSCO already positioned as the largest
### Generation Landscape in Korea (2)

#### RPS Obligation Rate (% of yearly annual generation)

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate (%)</td>
<td>3.5</td>
<td>4.0</td>
<td>5.0</td>
<td>6.0</td>
<td>7.0</td>
<td>8.0</td>
<td>9.0</td>
<td>10.0</td>
</tr>
</tbody>
</table>

(Source: KNREC)

#### RPS Obligation by GENCO (2018 only)

<table>
<thead>
<tr>
<th>GENCO</th>
<th>KHNP</th>
<th>KOEN</th>
<th>KOMIPO</th>
<th>WP</th>
<th>KOSPO</th>
<th>EWP</th>
<th>Others</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>TWh</td>
<td>3.4</td>
<td>3.8</td>
<td>2.9</td>
<td>2.5</td>
<td>2.7</td>
<td>2.7</td>
<td>3.9</td>
<td>21.9</td>
</tr>
</tbody>
</table>

(Source: KNREC)

- RPS (Renewable Portfolio System) obligation is imposed on 21 power plants (as of 2018) that have more than 500mw power producing facilities

- The RPS Obligation for each GENco is derived from the formulas below where KHNP is given some leeway in terms of emission reduction given its nuclear status

\[
RPG_{n}^{KHNP} = NG_{n-1}^{KHNP} + (1 - \alpha_n) + G_{n-1}^{KHNP}
\]

\[
RPG_n = G_{n-1} + (G_{n-1}/\sum G_{n-1}^{s Genços} x N G_{n-1} x \alpha_n)
\]

**RE Obligation Example 1 - KOEN:**

In the case of KOEN, by 2023, it has to generate 7.6 TWh from RE, assuming a capacity factor of 0.35 for RE, this would translate into roughly 2.5 GW of new RE capacity necessary by 2023 (solar, onshore and offshore)

It remains questionable whether these RE targets are achievable, but there is nonetheless a massive need for new RE in Korea in the coming years

1. Guideline for new and renewable energy development, use and promotion Act, MOTIE
Based on the latest 2017-2031 Transmission Plan\(^1\) (released in July 2018), significant transmission reinforcement and upgrades are planned:

- There is clearly a big push by both the government and the underlying electric organizations to support the new “30-20“ RE policy, particularly for solar and specific offshore projects (South West and Jeju).
- Transmission reinforcement in the Sinan area may need to be re-evaluated considering (POSCO, SK, Hanwha, etc.)
- Power demand growth will be driven by Seoul (6 GW), Daejon (5 GW) and Busan (3 GW)

<table>
<thead>
<tr>
<th>Voltage (kV)</th>
<th>Existing Lines (km)</th>
<th>New Lines by 2031 (km)</th>
<th>Total (km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>765</td>
<td>1,019</td>
<td>26</td>
<td>1,045</td>
</tr>
<tr>
<td>345</td>
<td>9,753</td>
<td>1,171</td>
<td>10,924</td>
</tr>
<tr>
<td>154</td>
<td>22,836</td>
<td>8,965</td>
<td>31,801</td>
</tr>
<tr>
<td>HVDC</td>
<td>360</td>
<td>2,632</td>
<td>2,992</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33,608</strong></td>
<td><strong>12,794</strong></td>
<td><strong>46,762</strong></td>
</tr>
</tbody>
</table>

Timing of offshore wind projects and new transmission lines will be key

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1. Korea Electric Power Corporation, e2news.com
Off-taker Agreement

REC Multiplier

<table>
<thead>
<tr>
<th>Energy</th>
<th>Multiplier</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offshore Wind</td>
<td>2.0-3.5</td>
<td>Offshore</td>
</tr>
<tr>
<td>Onshore Wind</td>
<td>1.0</td>
<td>Onshore wind</td>
</tr>
<tr>
<td>Others</td>
<td>2.0</td>
<td>Fuel cell, Tidal power, Geothermal</td>
</tr>
<tr>
<td>ESS</td>
<td>4.0-4.5</td>
<td>ESS (Wind connected)</td>
</tr>
<tr>
<td>PV (normal land)</td>
<td>0.7-1.2</td>
<td>Normal land</td>
</tr>
<tr>
<td>PV (forest)</td>
<td>0.7</td>
<td>Forest</td>
</tr>
<tr>
<td>PV (floating)</td>
<td>1.5</td>
<td>Floating</td>
</tr>
</tbody>
</table>

- REC multiplier for offshore wind farm is given separately based on the distance from shore:
  - < 5km: REC x 2.0
  - 5 km to 10km: REC x 2.5
  - 10 km to 15km: REC x 3.0
  - > 15 km: REC x 3.5

- REC multiplier is reviewed every 3 years and latest revision took place in June 2018

- The REC calculation methodology has not yet been finalized the industry expects that the REC multiplier will be incremental, i.e. if a project is 12 km from shore, the average REC multiplier would be calculated for each 5 km portion

- Project developers will be able to secure a PPA with a GENCO or an existing IPP

- GENcos will offer a PPA that fixes the REC and SMP price for 20 years, although at a discounted value from the power exchange market

It will remain difficult for any foreign developer to secure a PPA without the participation of the GENco in the project

1. Guideline for new and renewable energy development, use and promotion Act, MOTIE|KHNP
Offshore Wind “Hot Spots”

Jeju
- Jeju Energy Corporation (JEC) manages a centralized auction process on the island
- Hallim OWF project (100mw), with KEPCO E&C is moving forward with a WTG tender
- JEC to own at least 30% of the projects and impose a 17% sales tax on the profits

Sinan & Wando
- > 4 GW of power license application in process
- Ordinance by the county for a minimum equity participation of 30% by the community
- OWF projects include POSCO, Hanwha, SK and many others...

Ulsan & Busan
- 6 GW of OWF is being proposed and discussed with active support from local government
- Government budget of USD500m projected to support floating offshore wind industry

Government-sponsored initiatives are spreading and the market is expected to increasingly rely on auctions by 2022
Regional Content & Supply Chain (1)

<table>
<thead>
<tr>
<th>Model</th>
<th>Doosan</th>
<th>Unison</th>
<th>Hyosung</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>WinDS3000</td>
<td>WinDS5500</td>
<td>WinDS8000+</td>
</tr>
<tr>
<td></td>
<td>U113</td>
<td>U136</td>
<td>HS90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>U136</td>
<td>HS139</td>
</tr>
<tr>
<td>Rated power</td>
<td>3MW</td>
<td>5.5MW</td>
<td>8MW</td>
</tr>
<tr>
<td></td>
<td>2.3MW</td>
<td>4.2MW</td>
<td>2MW</td>
</tr>
<tr>
<td>Rotor size</td>
<td>134M</td>
<td>140M</td>
<td>TBD</td>
</tr>
<tr>
<td></td>
<td>113M</td>
<td>136M</td>
<td>90M</td>
</tr>
<tr>
<td>Wind class</td>
<td>S</td>
<td>1B</td>
<td>1B</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>S</td>
<td>IIA</td>
</tr>
<tr>
<td>Launching</td>
<td>Launched</td>
<td>2019</td>
<td>2022</td>
</tr>
<tr>
<td></td>
<td>2018</td>
<td>2019</td>
<td>2019</td>
</tr>
</tbody>
</table>

- Out of 12 domestic WTG manufacturers established since 2007, only three are still in business with Hyosung’s status to be confirmed

- All stakeholders in the industry want to maximize the benefits to the Korean economy and many are pushing for obligatory local content (including the use of domestic WTGs)

- The new policy guideline has yet to be finalized, but **two views** are prevalent:
  1. A large number of stakeholders are not supportive of stringent domestic content that result in additional cost to the public with little marginal benefit in creating economic growth and jobs
  2. Government should continue to support the Korean domestic wind industry and continue its plan in developing a domestic supply chain. Some incentives that are being discussed include:
     - Additional REC multiplier to domestic WTGs
     - Government-backed O&M contract for domestic manufacturers (for bankability purposes)
### Regional Content & Supply Chain (2)

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Domestic Presence</th>
<th>Experience</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OEMs</strong></td>
<td>Full WTG</td>
<td>High</td>
</tr>
<tr>
<td><strong>Sub-suppliers Tier 1</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Main Components)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Towers, hubs, blades and gearboxes</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td><strong>Sub-suppliers Tier 2</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Subassemblies)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ladders, fiberglass, control systems, hydraulics, power electronics, fasteners, resin, machine parts, motors</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td><strong>Foundation</strong></td>
<td>Foundation</td>
<td>High</td>
</tr>
<tr>
<td><strong>Engineering</strong></td>
<td>Design and Installation</td>
<td>High</td>
</tr>
</tbody>
</table>

- There is a number of well-established domestic WTG component suppliers that have been trusted suppliers of the large well-known foreign OEMs
- As opposed to Taiwan, there is already an existing supply chain in Korea for many parts of a WTG
- It will be interesting to see whether there any synergies between Korea and Japan that might exist in the future
Floating Offshore (1)

Coastal Areas where water depth exceed 50m

- The majority of the offshore wind projects currently in development in Korea are near shore (<5 km from shore) in order to minimize water depth.

- While the project sponsors are doing all they can to minimize the negative impact projects could have on the communities, the risk of the community opposing the project increases the closer a project is to the shore (and also the compensation $$$).

- More importantly, the areas where the wind is at its highest also correlate with larger water depth.

Floating offshore wind will open up more development potential and possibly limit the conflicts with communities.

1. South Korean Ministry of Trade, Industry and Energy
Floating Offshore (2)

- Floating project areas are being promoted in locations where the economy is **heavily reliant on shipyard industry** for jobs (with the exception of Jeju)

- Challenging conditions due to volcanic soil
- Pristine touristic and retirement destination with concerns to scenic impact of WTG near shore
Floating Offshore (3)

Axis 1
WTG Demo
$270 m
- Floating WTG concept (4 x 5 MW)
- Operation monitoring

Axis 2
OSS Demo
$140 m
- Floating Concept Installation
- Operation monitoring

Axis 3
Permitting
$90 m
- Environmental Impact Assessment
- Community Approval

R&D: 2018-2022

Prototype and Testing: 2022-2026

Commercial Deployment: 2026-2030

Policy Highlights:
- More than $300 m in subsidies and $200 m from private investments
- 90% of local content by 2030
- 2 GW by 2030
- Feasibility study expected to be completed this year
Conclusion

• Will Korea leap-frog Japan and Taiwan?

• Supply chain paradigm is different in Korea than Taiwan
  • Significant synergies between Japan and Korea could arise
  • Sub-supply chain for wind turbines in Korea is more mature than Taiwan

Thank you !!!!