

### 1.0 Introduction

In 2008, the first 750-kW turbine commercially produced by Unison was purchased by a Korean utility company (Figure 1), while the prototypes of both Unison's and Hyosung's 2-MW turbines were installed for type testing. Doosan's 3-MW turbine for offshore was still under development in 2008 and is scheduled for field testing in 2009. So far, progress in the Korean wind market remains a little behind schedule. At the end of 2008, the cumulative installed capacity was 236 MW (Table 1). The new installation of 43 MW, indicates the current difficulty caused by the increased price of imported wind turbines (due to currency exchange rate based on global economic crisis) and existing barriers of limited onshore sites and public acceptance issues (Figure 2).

In 2008, the Korean government set the Third National Basic Plan for New and Renewable Energy R&D and Deployment (Third Basic Plan for NRE). This is a revision of the Second National Basic Plan for NRE announced in 2003. According to the Third Basic Plan for NRE, the total installed capacity of wind turbines will be more than 7 GW in 2030. The data used in the following tables and this report are provided by the New and Renewable Energy Center under the Korea Energy Management Corporation (KEMCO).

### 2.0 Progress Toward National Objectives

At the end of 2008, 150 wind turbines were operating in Korea. According to the target in the Second Basic Plan for NRE,

an additional 2 GW of wind energy capacity is needed from 2009 to 2012 to reach the target. To achieve the goals of the plan, the Korean government set the Third Basic Plan for NRE. On 27 August 2008, the Third National Energy Basic Plan for Green Growth officially introduced green growth as "new national development paradigm" that creates new growth engines and jobs. Because Korea is the tenth largest energy consumer in the world, the economic feasibility of green energy has increased due to the high price of oil. The domestic market also has a good potential for greenhouse gas reduction. According to the new plan the capacity target for wind energy will be 4,336 MW by 2015 and 7,301 MW by 2030.

### 3.0 Benefits to National Economy

#### 3.1 Market characteristics

The Third Basic Plan for NRE states that for primary energy consumption, the share of new and renewable energy will be 4.33% in 2015 and 11% in 2030. For the electricity supply target, wind generation is expected to provide the largest contribution (up to 42% or 16.6 TWh) of the total generation of 39.5 TWh by new and renewable sources in 2030. To achieve this goal, the government is providing attractive incentive programs such as the 15-year guaranteed feed-in tariff, tax incentives, and subsidies for the local wind market. Encouraged by strong government support of R&D

<b>Table 1 Key Statistics 2008: Korea</b>	
Total installed wind generation	236 MW*
New wind generation installed	43 MW*
Total electrical output from wind	.421 TWh*
Wind generation as % of national electric demand	0.1%*
Target:	7,301 MW by 2030
* tentative	



Figure 1 Unison’s first commercial product of 750-kW direct drive, U50, has been installed in Korea Hydro & Nuclear Power Co., Ltd.

programs, several big companies have been participating in wind turbine development projects, including local production of components. In 2007, as a result of government support in previous years, 750-kW and 1.5-MW wind turbines were successfully tested and certified by GL and DEWI Offshore and Certification Centre GmbH, respectively. In 2008, two different 2-MW wind

turbines were installed and will remain under field testing until mid-2009.

The Korean wind farm business has been slow so far for several reasons, including the complex system for approval of developments caused by conflict among existing laws, public acceptance issues, and difficulty getting permits for grid connection. Also, onshore sites are limited because of mountainous terrain.

The onshore wind map feasibility study performed by the Korea Institute of Energy Research (KIER) estimates the potential for wind farm development at up to 7.8 GW. In addition to this onshore possibility, the government is supporting an offshore wind map study that indicates an additional expansion potential of about 18 GW, reflecting the advantage of being a peninsula country. However, offshore wind construction might be challenging due to deep-sea foundation issues, concerns over coastal fishery rights, military radar issues, and environmental issues.

### 3.2 Industrial development and operational experience

The Korean wind industry is growing rapidly, especially in the development of wind turbines and components, while most installations related to wind farm development still depend on imports. Even though existing wind farms have been gaining experience in operation and maintenance, the repair or exchange of parts is still in the hands of foreign manufacturers. For this reason, several imported wind turbines had to be shut down for long periods due to delays in the delivery of re-imported parts. This kind of problem is one reason why local manufacturers and developers are accelerating their efforts to build up

Table 2 Total Installed Wind Capacity in Korea									
Year	~2001	2002	2003	2004	2005	2006	2007	2008	Total
Capacity (MW)	7.9	4.7	5.4	50	30	77	18	43	236
Electrical Output (GWh)	32	15	21	48	130	239	399	421	1305



Figure 2 Taegi mountain's 40-MW wind part using VESTAS V80 turbines.

in-house technical expertise and supply the local market.

In 2008, three new big players—Hyundai Heavy Industries, Samsung Heavy Industries, and Hyundai-Rotem—entered the wind turbine manufacturing market in Korea with megawatt-scale wind turbines. In addition to the existing turbine manufacturers market initially formed by companies such as Unison, Hanjin, Doo-san Heavy Industries, and Hyosung Heavy Industries, all major shipbuilding heavy industries are finally ready to begin manufacture of wind turbines. Future business competition among these major heavy industries might open a new era accelerating technology development and the national wind industry as a core growth engine of green energy. The industrial value chain or supply chain had been formed with the existing infrastructure of utility companies, major shipbuilding heavy industries, and their components subcontractors. Taewong, Pyongsan metal, and Hyunjin Materials hold the biggest share of the world market for hot forging metal parts such as main shafts, tower flanges, and bearing rings. They are exporting major wind turbine components to Vestas, Enercon, Gamesa, GE Wind, and others. About half of the world's market for wind turbine towers is also covered by the Korean companies Unison and Dongkuk S&C.

#### 4.0 National Incentive Programs

According to the Third Basic Plan for NRE, except for energy from wastes and biomass, wind energy will supply the biggest portion (12.6%) of the final target for new and renewable sources in 2030. To

achieve this goal, the feed-in tariff is an important element of the government's incentive policies. Wind generation is eligible for a 15-year feed-in tariff of 107.29 Won/kWh, which is scheduled to be reduced by 2% every year after October 2009. According to this plan, however, the Renewable Portfolio Standard is scheduled to take effect in 2012, and it will be the one of the most important policies.

For demonstration projects or stand-alone small wind installations of less than 50 kW, the government provides subsidies up to 70% to 80%. The government also provides subsidies to local governments of up to 60% for the installation of a new and renewable facility. This subsidy allows one-tenth of the installation cost to be deducted from income or corporation tax for the year. Also, an import tariff rate reduction is applied for stand-alone or grid-connected wind generators and blades. The government also compensates any loss by commercial banks up to a certain portion when long-term project financing to renewable energy construction is offered at lower than commercial rates. A single renewable construction facility can make a proposal to KEMCO for a maximum of 10 billion Won that is payable over ten years following an initial five-year grace period.

#### 5.0 R, D&D Activities

Support of wind power is one way the Korean government can cost-effectively concentrate the R, D&D investment among new and renewable sources. The government's annual budget for wind R, D&D in 2008, 56.8 billion Won, has been aimed at localizing the manufacture of megawatt-size wind turbine systems and their components.

## National Activities

Recent government research has been carried out to develop 2-MW onshore and 3-MW offshore domestic turbine models. The research program is also running a 4-MW offshore wind farm demonstration project that will be completed in 2009.

The important results of government-sponsored projects during 2008 were the development of 2-MW direct-drive permanent-magnet-generator wind turbines, 5-MW offshore wind turbines, and a planning study for a 300-MW offshore demonstration wind farm to be completed by 2012. Hyundai-Rotem, the high-speed-train manufacturer, signed a development contract with the government for 2-MW direct-drive wind turbines in the next three years, while Hyosung Heavy Industries is developing a 5-MW offshore turbine. Korea Electric Power Corporation (KEPCO), the key national utility company, signed on as a primary investigator for planning the 300-MW offshore wind farm project. This significant government funding has helped reduce business risk at the initial stage and speed up technology development by domestic turbine manufacturers to cope with global competition. The national demonstration projects for both onshore and offshore offer a test-bed of those domestic developments.

### 6.0 The Next Term

During the next few years, the government is willing to support the installation

of domestically manufactured wind generators as demonstration projects. This support should help Korean manufacturers to install their turbines in several places. Government R, D&D support will also be focused on speeding up the domestic manufacture of turbine components like gearboxes, pitch and yaw systems, and bearings. According to the national R&D roadmap, long-term research soon will be initiated on smart-blade concepts for large-rotor-diameter turbines and offshore floating foundation structures for deep water. In addition, there are increased requests from the wind industry for education and training of experts and for international collaborative research. Offshore wind farm developers are looking forward to a new feed-in tariff for offshore, while onshore wind farm developers are trying to set up a new policy for direct connection to the existing grid instead of to the utility company's transformer stations.

Authors: Kil-Nam Paek and Seung-Young Chung, Korean Energy Management Corporation, and Chinwha Chung, Pohang Wind Energy Research Center, Republic of Korea.