Development and Utilization of Wind Energy in Korea

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ABSTRACT: *Korea has a variety of favorable conditions for utilizing wind as energy. First of all, as a geographical characteristic, it is a peninsular country with its three frontiers surrounded by sea. Such a location makes the country influenced, all the year round, both by sea winds and by seasonal winds, so that it has a good possibility of putting its rich wind resources to use as an energy source. Particularly, in view of the results of observations and analysis of actual data about wind sources, it is quite possible to build wind power plants in many regions across the country, such as inhabited islands dotted on its southern and western coasts around the Korean peninsular, a number of uninhabited islets attached the main islands, large-scaled reclaimed lands, and major inland areas.*

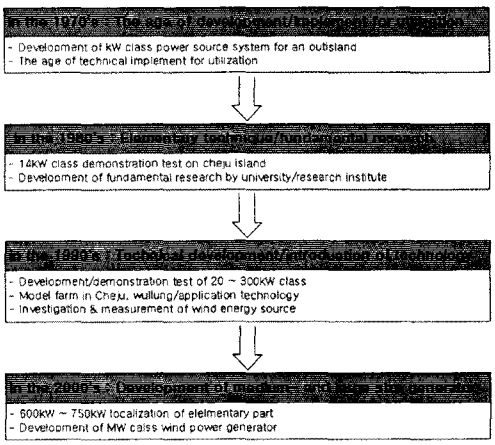
In Korea, the attempt to develop the technology of wind power generation started in the 1970' s. It was since 1988, when the Law on the Promotion of Alternative Energy Development was enacted, that research and development activities for employing the wind force as a part of energy source have got into full swing. At that moment, however, due to the low level of domestic technological development, such efforts were mainly focused on the attainment of basic technologies with regard to wind power generation. Recently, there have been many noticeable changes in the international as well as domestic environments, such as the conclusion of the International Climate Treaty and the increase in public concerns of natural environment. It is quite possible to predict that the demand for wind power generation will increase in the near future.

Therefore, recognizing that wind, as a clean energy source, can be a promising method for coping with the International Climate Treaty and for replacing the fossil fuel, oil, this essay investigates the development history of wind power generation systems and the status of technological development in Korea and presents an appropriate model for the development of the power generation system that can compete with other energy sources.

1. Chronological Review of the Technological Trends

In Korea, the study of wind power generation started with the onset of the oil crisis in the 1970' s. The first wind power plant was the 2kW-class wind power generator that the Korea Institute of Science and Technology built in Utsum, Hwasung, Kyeongki Province. The technological trends from the past to the present can be outlined as follows. In the 199 0' s, particularly, the Korean government took several positive policies to commercialize medium-size wind power generators. The government induced the private sector to participate in the development of wind power generation, constructed a model area to promote the use of wind energy and to develop the operation technology of wind power plants, and conducted comprehensive analyses of domestic potential for wind sources.

In addition, development projects for medium- and large-size wind power generators (600kW~750kW) are carried out. In the light of the present progress in principal parts and technological development, it is expected that, at least at the end of the 2000' s, wind energy will be in full-scale commercialization and MW-class generators will be developed as well.



<Fig. 1> Chronological Review of the Technological Trends

2. R&D Activities and its Results of Wind Power Generation System

After the legislation of the Law on the Promotion of Alternative Energy Development in 1987, the amount of investment, from 1988 to 1999, in the projects related to the wind power numbers all in \9.6 billion, including the government investment of \4.9 billion. As results, several important projects have been implemented: a pilot-model development for small-size (20kW-class) horizontal-axis wind power generators, that for medium-size (50~300kW) vertical-axis wind power generators, construction of the operation technology of medium-size wind power generation systems, a pilot model development for medium- and large-size (750kW) horizontal-axis wind power generators, and development of analytical methods for measuring domestic wind power sources. Specifically, the projects for developing medium- and large-size generators are summarized as shown in the following table 1.

<Table. 1> Existing state of technical development of WECS

Project	Management	Period	Remarks
Development project for vertical-axis wind power generator system and installation	Hankuk Fiber	'92.4 ~'96.12	completion
Development project for medium- and large-size WECS and application technique	Korea institute of energy research	'95.7 ~'98.6	completion
Development project for horizontal-axis wind power generator system and practical experimental	Hankuk Fiber	'97.1 ~'00.12	progressive
Development of control system and power connecting equipment for 750kW class WECS	Korea Electro-technology Research Institute	'00.1 ~'02.12	2000' newly
Development project of transmission and induction generator for wind power generator	Hyosung Co., Ltd.	'00.1 ~'01.12	2000' newly
Investigation and measurement around the korean peninsular	Korea institute of energy research	'00.1 ~'02.12	2000' newly

At present, some projects are also under way. The project for developing 750kW-class horizontal-axis wind power generator equipped with the rotor blade has already been conducted; now, it is under operational experiment in Muan, Jeonbuk Province. The project for home production of the power converter, which has been so far imported from abroad, began in 2000, aiming at completing the project in 2002. The study of the medium- and large-size (600~750kW) generators and its power transmitter has been carried out with the schedule of completion in 2001. These efforts increase the availability of the wind power plant in practical use.

At the same time, surveys on the domestic wind energy resources as a basic research have continuously implemented. It is estimated that this will make it possible to draw the wind energy map through measurement of the domestic wind resources and to make a long-term plan for supplying wind power plants based on the map.

With these efforts, the participation of the private sector in the wind power industry helped preparing for the commercialization of wind energy, and the characteristic of it as a multiple technology set in the fundamental development stage the technology of the system integration that links various key technologies.

3. Main Technological Achievements

The technological achievements, as a result of the efforts to develop the wind energy until today, can be largely classified as two parts: achievements of basic technologies and those of commercialization technologies.

First, in the former part are included the following lists: (1) obtaining the estimates of the potential for wind energy sources in several regions through the investigation and measurement both in and around the Korean peninsular, (2) securing basic technologies through basic studies of air pressure of the system, structural design and vibration characteristics, (3) acquiring the results of the basic technologies through manufacture of pilot models of research-purpose small- and medium-size (2~50kW) wind power generators, and (4) constructing the operation technology of the wind power generation system.

Second, the latter part includes the following examples: (1) conducting the project for home production of and completing the field experiment of the wind power generation system (50~300kW), (2) completing the development projects for the pilot models of medium- and large-size (750kW) horizontal-axis generators and now being under practical experiment, (3) securing the basis for

commercialization by the participation of the technical industries in the fields of the rotor, rotor power transmitter, electric power converter, generation, and control device of the wind power generation system.

Table 2. shows the participants of the technical industries in development of the wind power generation system according to their own technical fields. Eng

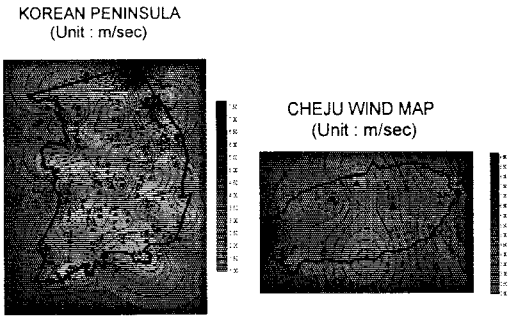
<Table. 2> Existing state of professional organization

Elementary system	Related business circles	Technological level
Blade/Material	Hankuk fiber	Preparation for common use(750kW)
Power transmission device	Hyosung heavy industry	Hankuk fiber
Power generator	Hyundai heavy industry	Hankuk fiber
Power connection and System control	Korea Electrotechnology Research Institute	Development 750kW Holding of elementary technique
Equipment and fabric structure	Common use in domestic	application
System introduction /installation	Hyosung Ssang yong Hankuk fiber SONCY., Co. Ltd.	Cheju Hangwon Cheju Hangwon JunNam Muan Small class WECS

4. Geographical distribution of the wind energy

The information about the regions rich in wind energy resources has been already identified by the analysis of the data that Korean Weather Forecast Bureau collected and by the field study of the regions. According to the survey, the regions having high 4-6 degrees of the wind force are Cheju Island, the Eastern coast of Kyeongbuk province, the Western coast of Jeonla province, and the Daekwanryoung district. Particularly, it demonstrated that Cheju Island, the Eastern and Southern coasts, and high mountain areas in inland are excellent in wind energy resources.

Fig 2 is a wind energy map that shows the distribution of the wind resources in Korea.



<Fig. 2> Distribution of the wind energy resource in korea

The energy density that present technological level makes it possible to use wind energy resources is approximately 200W/㎡. The regions cited as ones available to wind power generators are the large-scale reclaimed lands in the Western coast, the Saemankum seawall (11km), the Sihwa seawall (12km), and the Daeho seawall. What' s more, in the large-scale reclaimed land areas in the Western coast it is possible to construct a grand complex for wind power generation.

The saliently strong wind regions in Korea are the high mountain areas in inland and several coastal areas, of which Daekwanryoung in Kangwon province, Pohang of Kyeonbuk province, Mokpo in Jeonnam province, Keoje Island in Kyeongnam province, Pusan, Kunsan in Jeonbuk province, Inchon are preferable to installing the wind generators.

Cheju Island, which is most windy in Korea, has basic data of the wind resources through field survey. At present, a 4.2MW-class wind power generation complex is constructed in the Hangwon district of the Island. Besides, almost all districts of the Island, for example, Youngdang, Supji, and Udo, are known as possible wind power generation compounds.

In view of the results of the survey on wind power resources, it is estimated that Korea has an average wind energy density of 100W/㎡ across the country. In particular, the energy density of Cheju Island and Pohang in Kyeongbuk amounts to 500W/㎡. These estimates mean that it is possible to produce electric power of 660,000,000MWh per year. But, it is estimated from the research so far conducted that the actual amount available from the wind power potential is about 33,000MWh/year (8,000,000TOE/year).

In addition, Korea is a peninsular country with the three frontiers surrounded by sea, the meaning of which is that it has an endless potential for extending its wind sources to the offshore.

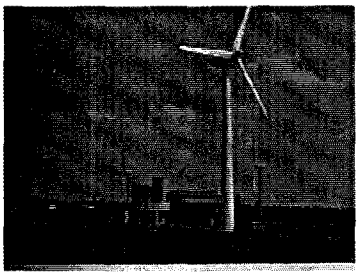
5. Implementation of Wind Power Generation systems

The type of wind power generators, so far installed in Korea, is generally classified as research/experimental and commercial ones. In 1995, a model complex was constructed in Walyrong, Cheju, and a test complex for developed generators was built in Muan, Jeonnam province. Presently, the main trends are toward construction of the small- and medium-size wind power complex as demonstrated in the example of the energy supply business in Cheju.

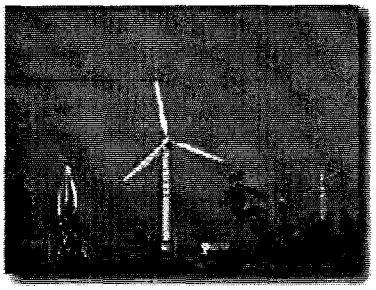
At the end of 2000, Korea had a total of 6.7MW wind power generation capacity. The first wind power plant in Cheju was the Hangwon Wind-farm that began to construct in 1997. Until now, it has a total of seven power plants, with the generation capacity of 4.2MWh. All equipment was introduced from abroad. At the end of 1999, It supplied a total electric power of 5,900MW/h as the first commercial power generation area in Korea. Besides, three 180kW-class wind generators were constructed in Wullung Model complex in Cheju and they are now under operation experiment.

Ullungdo has one 600kW-degree wind power plant in Hyunporyeong through the local energy project. In 2000, another power plant was constructed.

<Fig. 3> Hangwon wind farm



<Fig. 4> Walyrong wind farm



<Fig. 5> Muan wind farm

6. Recent Policy Issues in the Alternatice Energy Sector

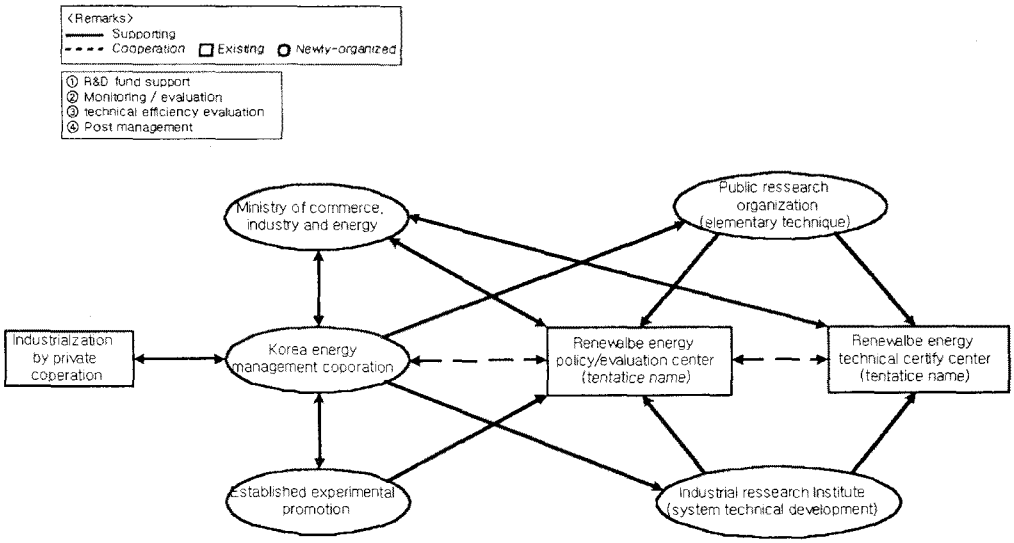
• Improvement of the budget and loan system for the alternative energy: it needs to increase the budget for the alternative energy development and extend the coverage of loan subsidy by using the energy special account, securing a regular proportion of sales of the government-investment institutions, and establishing an aid fund for the electrical industry, energy tax, etc.

• Reflexive adjustment, according to a regular interval, of the interest of the government loan subsidy (repayment in five year with a three-year grace period) in connection with the market interest.

• Introduction of the incentive system based on the market principle: 1) introduction of energy/carbon taxes in order to induce the decrease in energy consumption and carbon exhaust content by imposing taxes on the basis of caloric value or carbon content; 2) extension of the scope of tax reduction; 3) introduction of the green pricing scheme, a pricing system that consumers voluntarily accept additional expense burden by realizing the importance of the environmental problems.

• Reformation of laws and rules: compulsory purchase of alternative energy development

• Rational fulfillment of role



7. Conclusion

Lacking natural resources, Korea needs to change its industrial structure into the type of low energy consumption and take its efforts to develop technology in order to adapt itself to the conclusion of the International Climate Treaty.

In particular, though there are many ways, besides the alternative energy, in developing the energy technology, such as energy conservation, efficiency improvement, clean energy, and carbon dioxide treatment technology, recently the focus is on the technology of wind power generation because the wind energy is possible to secure by using the domestic resources alone as well as it is possible to minimize the environmental pollution like reduction of greenhouse gases.

Also, in the 21st century when the paradigm of energy transforms from the energy gathering stage to the energy cultivation and from obtainment of energy sources to that of energy technology, the objective of the energy policy came to emphasize stable energy supply, environment-friendliness accompanied by cost-effectiveness, human-friendliness, and high efficacy of technology. These arouse the importance of the wind energy as an alternative.

The policy issues that have been recently raised regarding wind power generation are: 1) revision and complement of the energy system; 2) construction of regional cooperation system for the preparation of the clean development regime; 3) rational allocation of the role for systematic management and operation in relation to control, monitoring, and evaluation of R&D and confirmation of technical capacity.

The technological focus of the wind energy, so far, has been chiefly on the basic technologies and system technology. To transform it into a whole comprehensive technology, both technical performance evaluation and technology confirmation tasks should be included in it. Furthermore, in the aspect of the supply of the wind power system, it needs to change the preponderance of the wind energy policy from established experimental level to promotion of the wind power commercialization.