# Comparative Analysis of a Competitive Technology for Major Future Energy Resources

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***Abstract*** – Recently advanced countries are making every effort to promote the efficiency of electric power production and supply, to deal with the environmental problems, and to develop the new energy. In particular, they are driving forward to develop various technologies for electric power in mid-long term, that are technology for building infrastructure of power transportation, establishing service network for account management using electronic technologies, elevating economic productivity by innovative electronic technologies, control-ling the discharge of global warming gas, using clean efficient energy, and so forth.

However, power technology of Korea lagged behind than technology of advanced countries. Also, resources for developing power technology are limited in our country. Therefore, it is necessary to improve the efficiency of R&D investment. For it, our country must compare and analyze with technologies of advanced countries which are taking competitive advantage in the main future energy. Through comparative analysis, limited R&D resources of our country must be concentrated on technologies that can secure competitive advantage from now on.

***Keywords*** – Solar PhotoVoltaics Technology, Solar Thermal Electric Power, Wind Power Generation System, Solid Oxide Fuel Cell, SOFC, Molten Carbonate Fuel Cell, MCFC, Proton Exchange Membrane Fuel Cell, PEMFC

## I. INTRODUCTION

The main technologies of the future energy are Solar PhotoVoltatics technology, Solar Thermal Electric Power, Wind Power Generation System, Biomass energy manufacturing technology, Solid Oxide Fuel Cell(SOFC), Molten Carbonate Fuel Cell(MCFC), Proton Exchange Membrane Fuel Cell, and so forth.

In this paper, technical standard of each nations (United States, Japan, Europe, Korea) and each elemental technology among technologies of future energies are the object of comparison and analysis (Adopting a Semi Delphi way).

Besides, this paper provides a basic data of the field with investigation and analysis of international research organizations and study of each technologies, that domestic research institutions must review for the study in the future.

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## II. TECHNOLOGY STANDARD ANALYSIS OF THE MAIN FUTURE ENERGY

### *A. Technology of Solar PhotoVoltatics*

Solar PhotoVoltatics is a technology, that Solar energy converts directly into an electricity energy without pollution and qualification. The basic principles are as follows. When a solar shed is irradiated to a solar cell which is composed by semiconductor pn concatenation, electron-hole pair occurs by a optical energy. As electron-hole moves, an electromotive force is occurred by photovoltaic effect, in which an electric current streams across n floor and p floor. Then electric current runs through electrical load which is connected outside.

American National Renewable Energy lab, Sandia National, Electric Power Research Institute, Siemens Solar Industries, AstroPower, in Japanese AIST, CRIEPI, Sharp, MHI, Kyocera, in European JRC, Fraunhofer, RWE, ECN, ENEA, ENEL are promoting development of above technologies.

In our country, technical development is promoted by Korea Institute of Energy Research (KIER) and Korea Electric Power Research Institute (KEPRI), Photon Semiconductor & Energy, LS Industry System, and so forth.

The main evaluation items of elemental technology of solar photovoltatics are a crystalline silicon solar cell, a thin film solar cell, system for housing / building, linkage, peripheral device for solar photovoltatics. Among others, manufacturable technology of crystalline silicon solar cell was analyzed with importance of the highest.

It was analyzed that Japanese technology was the most excellent in the area of solar photovoltatics technology. When Japanese technical standard is called 100, American technical standard is 96, and technical standard of Europe is 97. So that we could see the technological gap is not so big. Our country was evaluated with technical standard of approximately 56.

It is analyzed that technical standard of Japan is most excellent in all section of detailed technical field as follows, a crystalline silicon solar cell, a thin film solar cell, a thin film solar cell, system for housing / building, system linkage, peripheral device for solar photovoltatics.

However, technological gap between Japan and United States and Europe is not so big.

Table 1 Technical standard evaluation of solar photovoltatics

| Country | Technology standard |
|---|---|
| The United States | 96 |
| Japan | 100 |
| Europe | 97 |
| Korea | 56 |

### *B. Technology of Solar Thermal Electric power*

Until now all over the world, the mainstream of solar energy research are as follows. They are heating / boiling system of a house, water heater, dryer of agricultural / aquatic products, collector of low price and solar photovoltatics of small scale. Research of Solar Thermal Electric Power does not have more progress, because of the problem concerning with acquisitional way of high temperature and development of high temperature materials which are necessary for power generation.

American Sandia National Lab, Japanese NEDO, European EU(9 organizations which participated in IEA START Program besides Spain, Germany), besides, Australian Univ. of Sydney are promoting development of above technologies. In the country, technical development is promoted by the Korea Institute of Energy Research (KIER) for CLFR(Compact Linear Fresnel Reflector) etc.

The main comparative item of technology for Solar Thermal Electric power are technology of capacity (MW), system design supervision, system evaluation operating technology, system low price composition technology in aspect of the technology of system. Among others, importance of system design supervision technology was analyzed highly.

The main evaluation items of elemental technology are ultra-condensation technology, cycle technology, technology of low costly accessory, integrated control technology of systemic element in aspect. Among others, importance of ultra-condensation technology and cycle technology was analyzed highly.

It was analyzed that technology of Europe was the most excellent in the area of Solar Thermal Electric Power. When technical standard of Europe is called 100, American technology is 75, Japanese technology is 50, technology of our country is 25. Therefore, it was analyzed that the technological gap was big.

It was analyzed that technical standard of Europe was excellent in the area such as condensation technology, cycle technology, technology of low costly accessory, integrated control technology of systemic element.

Table 2 Technical standard evaluation of Solar Thermal Electric Power

| Country | Technology standard |
|---|---|
| The United States | 75 |
| Japan | 50 |
| Europe | 100 |
| Korea | 25 |

### *C. Development technology of Wind Power Generation System*

Wind Power Generation is technology getting electricity from mechanical energy, which is converted by turning rotor, using aerodynamic characteristic of kinetic energy to have pneumatic fluidity.

Technology related to Wind Power Generation is already in the stage of customization. Therefore, it is trend to be devoted into cheapness and largeness of aerogenerator and expansion of diffusion than elemental technology development.

Technical development is promoted by American NREL, GE Wind Energy, Japanese Kyoto Univ., MHI. Technical development is promoted by German DEWI and Enercon, Danish RISO and Vestas, NEG Micon, Dutch ECN in Europe. In the country, technical development is promoted by Korea Institute of Energy Research (KIER), Pohang University of science and Technology, UNISON co., Ltd, HYOSUNG.

The main comparative items of Wind Power Generation System are capacity(KVA), design technology, control, monitoring technology in aspect of systemic technology. Among others, KVA was analyzed with importance of the highest.

Items of main valuation are a wing, a generator, a structure, a trouble inspection and control technology in aspect of an elemental technology. Among others, importance of a wing, a trouble inspection and control technology were analyzed highly.

It was analyzed that technology of Europe was the most excellent in the area of Wind Power Generation System. When technical standard of Europe is called 100, American technology is 83, Japanese technology is 73, technology of our country is 61.

Technology of Europe is almost excellent in all sections of this area. It was analyzed that technical standard of Europe was equal to the United States in an architecture design section.

Table 3 Technical standard evaluation of a Wind Power Generation system

| Country | Technology standard |
|---|---|
| The United States | 83 |
| Japan | 73 |
| Europe | 100 |
| Korea | 61 |

### *D. Biomass technology*

Resources of Biomass are recyclable, and are taken notice of as the local energy how wide area is distributed. However, using and developing biomass energy have a lot of problems. It is necessary to work around with the problems in order to judge how Biomass is important as local energy.

Technical development is promoted by American EPRI, Canadian Dynamotive Inc., Japanese Forest & Forest Products Research Inst. In Europe, technical development is promoted by Finnish VTT, Norwegian NOBIO, German government operation assistance programs.

In our country, technical development is promoted by the Korea Electric Power Research Institute and Korea Forest Service, Korea Institute of Energy Research(KIER), etc.

Biomass technology can be divided with combustion technology of Biomass and manufacturing technology of bio energy.

The main evaluation items of elemental technology of Biomass combustion are technology of the fuel chip and faradization, technology of a combustion equipment improvement, technology of Biomass combustion characteristic evaluation, technology of Biomass cutting mechanization. Among others, technological importance of Biomass combustion characteristic evaluation and a combustion equipment improvement was analyzed highly.

The main evaluation items of bio energy production technology are bio energy liquefaction technology, bio energy gasification technology, catalyst developing technology, and technology of developing public decision system. Among others, importance of liquefaction and gasification technology were analyzed highly.

It was analyzed that technology of United States and Europe were the most excellent in Biomass technology, and are maintaining equal technical standard. When technical standard of Europe is called 100, American technology is 97, Japanese technology is 76, technology of our country is 20. We could see that the technological gap between Korea with advanced countries is big.

In aspect of detailed technical field, United States and Europe are showing equal technical standard in most elemental technology. However, it is analyzed that Europe is some excellent than the United States in a chip of fuel and faradization technology, technology of a combustion equipment improvement, technology of Biomass cutting mechanization among technology of Biomass combustion.

Table 4 Technical standard evaluation of Biomass

| Country | Technology standard |
|---|---|
| The United States | 97 |
| Japan | 76 |
| Europe | 100 |
| Korea | 20 |

## III. CONCLUSION

For domestic technical standard of the future energy, only the Wind Power Generation technology was analyzed with a level of approximately 60-80% in comparison with advanced countries. Other fields of future energy, technology level of our country appeared under approximately 60% of level of advanced countries.

Generally European and Japanese technology were analyzed as advanced technology for the future energy field. Technology of Europe was evaluated that it takes advantage in the area of sustainable energy production technology such as Wind Power Generation system, Biomass technology, and Solar Thermal Electric power.

It is evaluated that Japan takes advantage in the area of solar photovoltatics technology, and the United States takes advantage in the field of Fuel cell.

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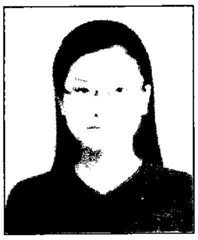

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