Journal of Energy Challenges and Mechanics
http://www.nscj.co.uk/JECM/
ISSN 2056-9386
Volume 3 (2016) issue 1, article 1

# The trend of ICT-based renewable energy in South Korea with a focus on cases of application of micro grids

# 侧重于韩国微电网中应用案例的基于信息通信技术之可再生能源趋势

Suhyeon Han[1*], Eunjin Jun[1], Yuri Yoon[1], Chulho Park[1]

[1]*Future Strategy Division, Green Technology Center, Seoul 100-705, South Korea*

*sue@gtck.re.kr*

Accepted for publication on 16 October 2015

*Abstract* – **Although the need and demand for switching to renewable energy continue to increase, adoption of renewable energy is difficult owing to disadvantages such as unstable power supply and a rather low efficiency. In this study, a new business model was examined to overcome such disadvantages through Korea's renewable energy policy and cases analysis. The future industrial application of renewable energy depends on an ICT-combined convergence and compound power system, rather than on regular energy source support. Hence, demand response systems along with energy storage systems (*ESS*s) and energy management systems (*EMS*s) would be more emphasized for the efficient use of energy.**

*Keywords*— **Green energy, Renewable energy policy, Energy policy, Smart grid, ESS, EMS, ICT**

## I. INTRODUCTION

Various policies and systems for responding to climate changes and energy resource depletion have been enhanced upon worldwide.

South Korea has declared "Low Carbon Green Growth" as its national vision and has put its efforts into establishing a legal and systematic foundation for the vision through the Five-Year Plan for Green Growth [1], the Framework Act on Green Growth [2], the Presidential Committee on Green Growth and executing emissions trading.

Furthermore, Korea succeeded in internationally capitalizing a green brand and achieved fruitful results, including the launch of an international institute, Global Green Growth Institute (GGGI), and successfully invited the Green Climate Fund (GCF) to Korea. In particular, with the investment principle that 2% of the GDP is invested in green technologies, Korea took initiatives to invest in such technologies and improved its level of technologies by encouraging investment in research and development (R&D) on core green technologies.

President Park Geun-hye attended the 22nd **World Energy Congress 2013, Daegu, Korea** and announced her plans: "Korea will reduce energy consumption by utilizing information and communication technologies (ICT), such as energy storage systems (ESSs) and energy management systems (EMSs), and build a trading system with which the saved energy can be traded in the Korea Power Exchange"; these plans will show the way to resolving the world energy trilemma that Korea and the world are facing and will contribute to the world energy market.

From these viewpoints, the main aim of this paper is to investigate the problems that renewable energy faces and efforts to overcome these problems, then review the policies and a business model related to Korea's renewable energy.

## II. TRENDS IN RENEWABLE ENERGY

The need and demand for switching from fossil fuel to $CO_2$ reducing renewable energy continue to increase coping with climate changes.

Even in this global economic crisis, R&D investments for technological development of renewable energy and in particular, the government R&D investments continues to increase; as a result, renewable energy technologies have advanced.

However, there still remains various constraints.

1) High developmental unit cost compared to that of the existing fossil fuels, owing to the high initial investment costs, hinders the commercialization of renewable energy.

2) Moreover, the installation of renewable energy faces certain constraints (the quality of wind, the amount of sunlight, etc.), and even in the areas where the installation is practical, it conflicts with residents, making installations difficult. For example, residents express an extreme opposition because fishing is impossible where a marine wind power plant is built. With regard to biogas plants, residents consider it an unpleasant facility because the plant is based on livestock and food wastes.

3) The unstable supply of natural energy resources such as sunlight and wind, lowers the utilization rates of renewable energy facilities, thereby interfering with its commercialization and industrialization.

4) The industrial characteristic of renewable energy is of great importance in the installation, maintenance, and repair; in addition, the renewable energy industry also experiences the lack of the service.

While the necessity of the industrial development of renewable energy is recognized, the implementation of industrial development is difficult because of the above problems.

To overcome the barriers in the use of renewable energy, for example, unstable power supply and low efficiency, there is a need for the convergent use of various energy sources, thus creating a new business model.

Without governmental support, after all, the grid parity of renewable energy is very challenging; therefore, for invigorating renewable energy, a powerful drive led by the government is essential more than anything else from the viewpoint of policies and systems.

## III. RENEWABLE ENERGY POLICY IN KOREA

Since the declaration of its vision on green growth, Korea has established Five-Year Plan for Green Growth (July 2009) as a national strategy and action plan for the purpose of increasing the effectiveness of the policy. Korea has proposed national mid-long term emissions reduction targets and introduced an emission-trading system, vehicle emissions standards, etc.

Furthermore, Korea also legislated the Framework Act on Low Carbon Green Growth[2] and developed 27 core green technologies through R&D measures and strategies for commercializing the core green technologies[3] (May 2009). Fundamental studies were encouraged on these 27 core green technologies by allocating aggressive R&D budgets.

In recent years, with the establishment of "developmental strategies for new energy industries and core technologies in response to climate changes," Korea announced its plans to invest 430 billion KRW ($400 million) in the development of core technologies for coping with climate changes and that by 2020, the current technology level of 81% compared to those of advanced countries, will be increased to 93%.

As shown in <Figure 1>, in 2013, the total national R&D investment amount was 16 trillion KRW; the amount invested in green technologies was 3 trillion KRW (17.9%) and that in the 27 core green technologies was 2.3 trillion KRW, which makes up 76.2% of the entire R&D investment amount in green technologies. For the last six years, the average annual increase rate of the R&D investment in green technologies was 15.8%, which is higher than that of the national R&D investment (9.0%).[4]

(in 100 million KRW)

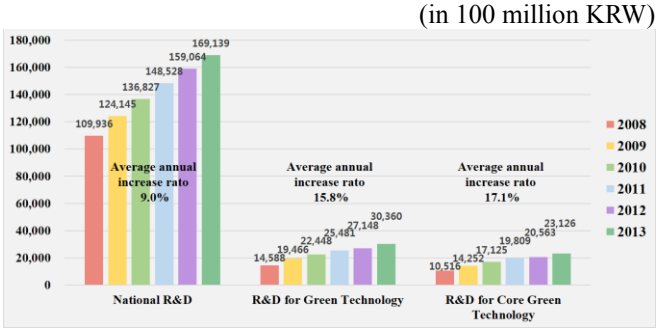


Fig.1, Green Technology R&D Expenditure from 2008 to 2013

The plans that are directly related to renewable energy are as follows:

### 3.1. The Fourth Master Plan on Renewable Energy (2014-2035, MOTIE[1]) [5]

This plan suggested to increase the supply target for renewable energy over 11% by 2035. It is aiming for the creation of a renewable energy market to enable shifting the current government-led actions to a private-government partnership, and achieving sustainable growth by expanding to the international markets.

With regard to the outlook of the target per energy source, current focus on waste energy will be shifted to solar and wind. In addition, the renewable energy market will be expanded from electric energy including hydro/thermal energies by enforcing the Renewable Fuel Standard (RFS) and the Renewable Heat Obligation (RHO).

For sub-tasks, in addition, eco-friendly technologies are

[1] Ministry of Trade, Industry and Energy (MOTIE): A central administrative body in Korea; it governs affairs related to commerce, trade, industry, trade, trade negotiation and general management , mediation on trade negotiation, foreign investments, the R&D policies of industrial technology, and energy and underground resources.

applied to existing unwanted facilities including incineration plants and landfills for energy supply, and a project demonstrating an "eco-friendly energy town" will be revealed to provide benefits to the residents. Also, the island where has been 100% diesel-power system will be provided with self-sufficient micro grid system.

### 3.2. The Second National Master Plan for Energy (2014.1 MOTIE) [6]

As energy policies are complicated and conflicts among interested parties become sharp, private sector-led participation is essential in establishing a policy. This plan was the first open-process national plan that wholly reflected the recommendations of the private working group.

Its main points include, as shown in <Figure 2>, a shift from the current supply-managing policy to a demand-managing policy; adjustments to energy tax rates with a goal of cutting the power demand to 15% by 2035; system improvement on electricity rates; and building an ICT demand management system.

In addition, with the goal of supplying at least 15% of energy through a decentralized generation by 2035 instead of centralized generation by utilizing fossil fuels, its energy types will be diversified into renewable energy, home generators, and so on. Then, small- and mid-size enterprises will have increasing opportunities to participate in the power generation market.

In other words, this plan entails an operational shift from supplier-oriented facility to user-participating facility.

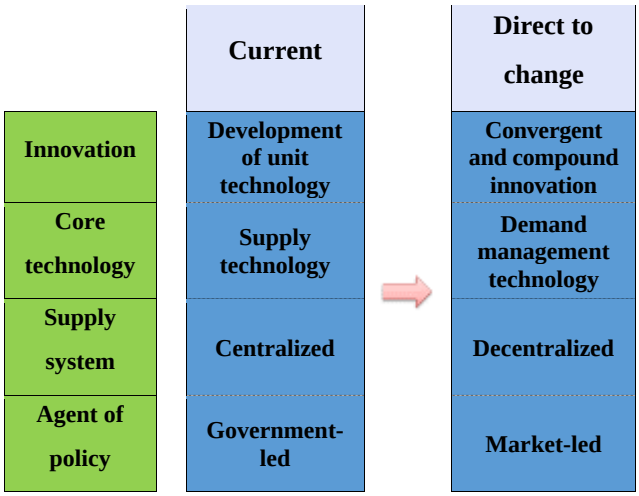


Fig.2, Directions of changes on the energy technology paradigm

### 3.3. The Third Energy Technology Development Plan (2014-2023) [7]

The Energy Technology Development Plan is the highest level technology development plan that covers the National Master Plan for Energy, the use of related energy, the development of renewable technology, emissions reduction, etc.

With the policy goals such as strengthening the competence of the energy industry, it was proposed to respond to climate changes through innovation and enhance the productivity of technology development, as shown in <Figure 3>, through a technology development program "Energy Innovation Architecture 2025" and core promotional strategies.

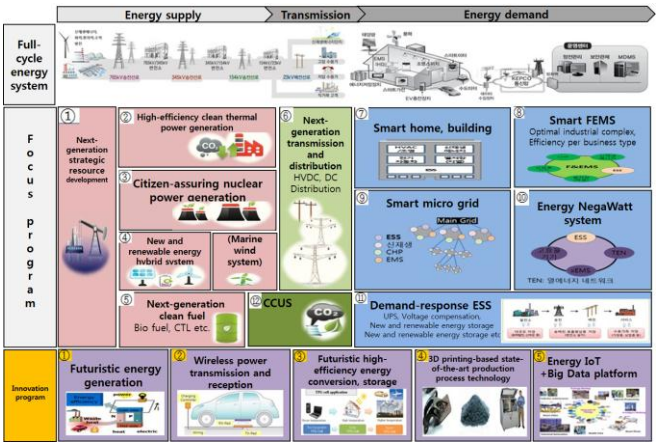


Fig.3, Concept of the program, Energy Innovation Architecture 2025

With regard to the energy supply technology part of the sub-programs, there is a renewable energy hybrid system combined with a compound generation and storage facility to provide optimal solutions that are suitable for various conditions and geographical characteristics, and this system will be applied in domestic island areas.

With regard to the energy demand management technology, the program offers a solution for an operating system solution that combines and manages decentralized resources. It also loads, connects the solution to the power network, and builds an independent operation system—a smart micro grid.

Furthermore, based on information and communications technology (ICT), the main focus of the energy NegaWatt system technology will be on the development of the energy solution services to secure the stability of energy demand and supply through combining energy sources, including ESSs, EMS, TENs (thermal energy networks), and decentralized development resource.

## IV. CASE

For activating renewable energy industry, Korean government puts extra efforts to create a foundation based on ICT convergence for shared growth among energy sources, instead of supporting sources per energy. The government is seeking and generating a business model based on the foundation.

A "micro grid (MG) system" is an independent decentralized small-scale power supply system, unlike the existing wide-area power supply system. This system generates, stores, and supplies power throughout the day to

areas where power supply is constrained by using renewable energy facilities.

This concept is considered to be a rather new technology which IT is employed to store generated electric energy when the demand is low and to supply it when the demand is high.

In other words, it is an eco-friendly power system that converges and compounds various renewable energy generation sources and energy storage systems.

Now, among the proven projects, a "self-sufficient micro grid demonstration project" and the case of a building an "energy independent island" will be examined.

### 4.1. Gasado's self-sufficient micro grid demonstration project

Gasado is a small Korean southwestern island located in Jeollanam-do. It has a population of 303 in 165 households. This island had been 100% diesel-power dependent, but with the completion of four wind power plants and eight solar power plants along with a 3MWh ESS in 2014, its power capacity has been supplemented with 320 kW of solar power and 400 kW of wind power.

This small island suffered from chronic power shortage due to its existing diesel power plants capacity of only 300 kW; it was transformed into a state-of-the-art energy village by conversion of its power supply into hybrid power supply with a combination of wind, solar power plants and an ESS.

Some problems encountered with the project have been addressed through an optimal combination of decentralized powers with a 100% renewable energy site designing. As a result, problems such as high-capacity power transmission and distribution facilities, high costs of power transmission due to the existing long-distance power supply and the increase in power losses could be addressed.

Hense, this project is considered to have maximized the efficient use of energy through energy storage systems (ESSs), energy management systems (EMSs), demand responses (DRs), and etc., in addition to resolving the problem of unstable power generation of new and renewable energy.

### 4.2. Ulleungdo, an eco-friendly energy independent island

Against the background of the technological development with regard to the renewable energy power sources being proved by the results achieved in Gapado of Jejudo and Gasado of Jeollanam-do, the eco-friendly energy independent island plan on Ulleungdo was realized.

For the first time in Asia, Ulleungdo joined ISLENET[2] (2011) and emerged on the international stage as a green island.

Even though Ulleungdo has the largest power system among land power systems and independent island areas, most of its power generation capacity of 13,000 kW is derived from the thermal power plants that use diesel power generators.

According to <Figure 4>, during the first stage (2015–2017) of the project, 30% of the current diesel-oriented power generation will be substituted with an ICT(ESS+EMS)-combined eco-friendly energy supply by giving up one diesel power plant a year. There are plans to build facilities for hydro-electric power (0.696 MW), solar power (1 MW), wind power (8 MW) and a 21 MWh ESS. In the second stage, facilities for geothermal power (4 MW) and fuel batteries (23 MW) will be added, expanding to a total of 36.5 MWh ESS facilities.

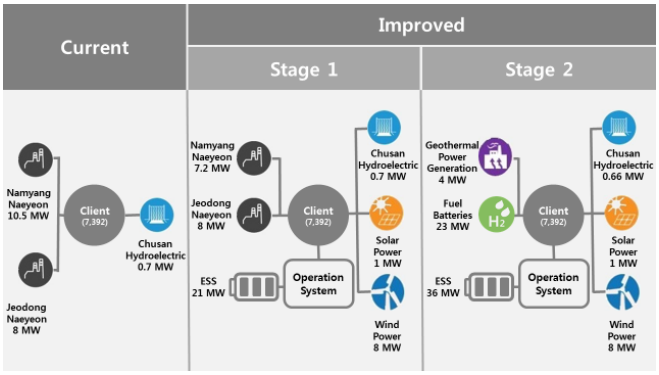


Fig.4, Mix per renewable energy source of the eco-friendly energy independent island project [8]

The Ministry of Trade, Industry and Energy expects that the execution of the first stage itself will reduce the $CO_2$emission of Ulleungdo by 4,771 tons and that the completion of the second stage will reduce the $CO_2$ emission by 13,683 tons.

## V. CONCLUSION

Renewable energy has already contributed to lowering the imported energy dependency substantially and meeting the rapidly growing power demand, yet it is becoming more important to determine the direction of its policy.

Renewable energy, in terms of policy, requires an emphasis in national level. Korea has shown interest and made investments by strengthening national polices. Although its R&D investment per technology has improved the levels of renewable energy, Korea still faces various problems from the viewpoint of activating related industries.

Korea made efforts to realize green growth through various national policies, thus renewable energy sector gradually

[2] ISLENET is a European islands' self-governing bodies' network (ISLENET: European Island Network on Energy & Environment) on sustainable energy supply and environment management, which 52 islands from thirteen countries joined.

through R&D, demonstrations and projects.

In particular, while Korea works toward to establishing a powerful government-led national plan, at the same time it also reflects the recommendations of the private working group at its best. Korea has encouraged participation of the private sectors and has promoted market-led measures for commercializing renewable energy.

Thus, breaking away from conventional government-led actions that would simply increase and expand the proportion of the supply of renewable energy sources with regulations and systems, Korea has planned of building eco-friendly energy towns or self-sufficient micro grid projects. Also, it has created a business model that allows participation of private sectors, thereby, the project can be transformed into a market-led one.

In Gasado and Ulleungdo, innovative micro grid systems where ICT and renewable energy sources were converged and compounded were built. In addition, these cases provide good example of changes from a centralized supply system to an independent decentralized power system, creating an environment where potential local renewable energy sources are fully utilized to generate necessary power without an external connection, and in which stable use of energy is possible by building ESS and DR systems.

Although there still exists problems that need to be resolved before commercializing the suggested cases, they are expected to contribute to the global energy market, especially by leading participations from the private sectors among global energy cooperation.

## References

[1] Presidential Committee on Green Growth. “National Strategy and five-year Implementation Plan (2009-2013).” Government report, Seoul. 2009

[2] Basic Act on Low Carbon Green Growth and Related Legislation. 2010

[3] Presidential Committee on Green Growth. “Commercialization Strategy for Core Green Technologies.” Government report, Seoul. 2009

[4] Green Technology Centre Korea. “National Green Technology R&D Analysis.” report, Seoul. 2013

[5] Ministry of Trade, Industry and Energy. “The Fourth National Master Plan for New and Renewable Energy.” Government report, Seoul. September 2014

[6] Ministry of Trade, Industry and Energy. “The Second National Master Plan for Energy.” Government report, Seoul. January 2014

[7] Ministry of Trade, Industry and Energy. “The Third Development Plan for Energy Technology.” Government report, Seoul. December 2014

[8] Mun Seung-il, “Operational planning of an independent Micorgrid”, Discussions in the third private/government energy new project conference, 2014.12, http://www.energynewbiz.or.kr/society/working/236?&pageIndex=1