Not Yet Renewed

Challenges in Renewable Energy Transition in South Korea 2020

SFOC Solutions for Our Climate
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Solutions for Our Climate

Supported by:

This publication was produced with the financial support of the European Union's Partnership Instrument.
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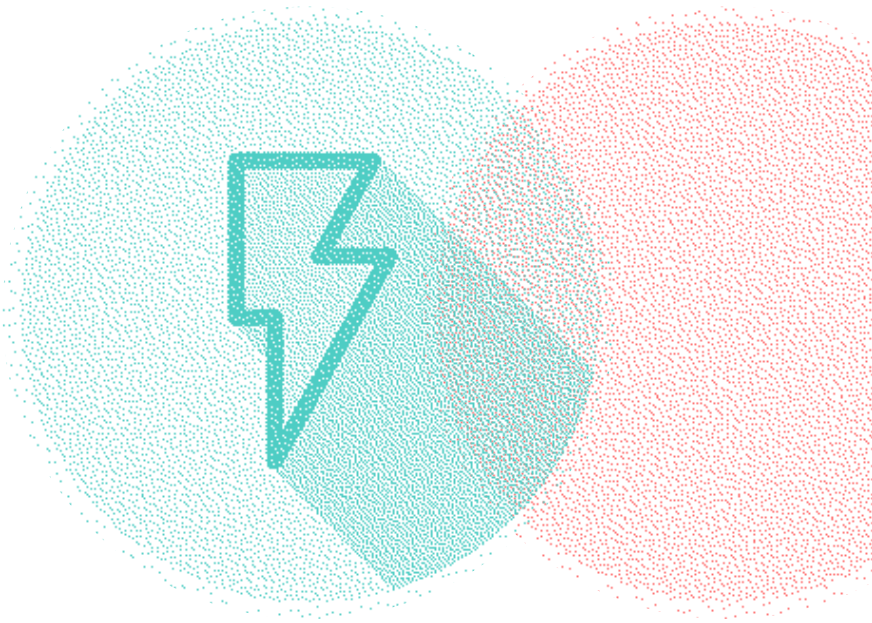

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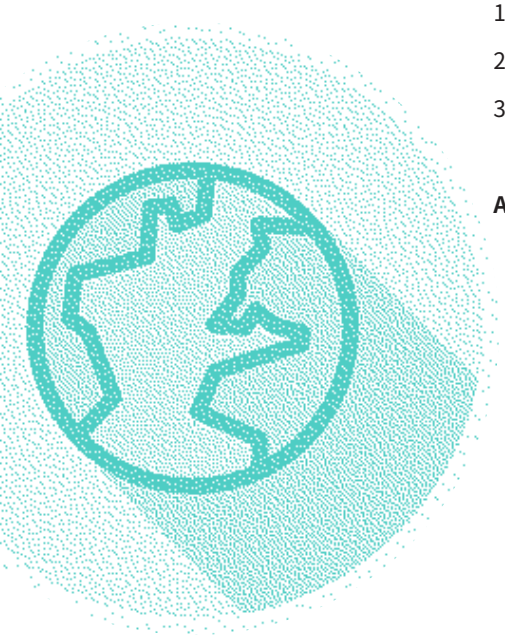

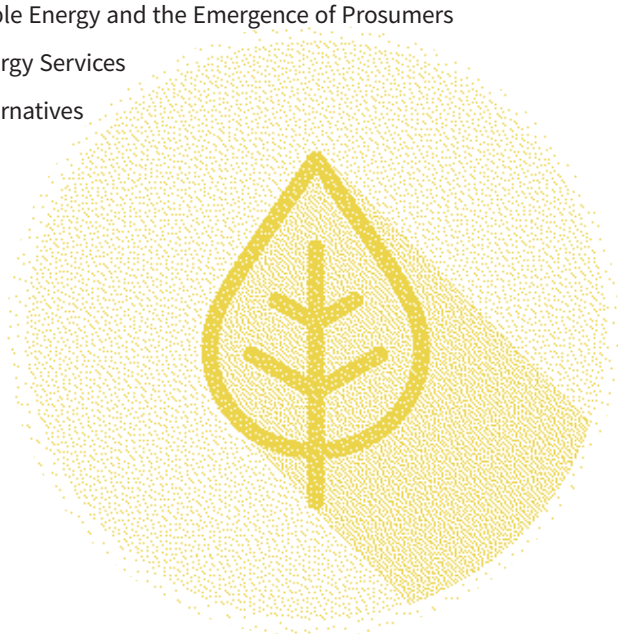

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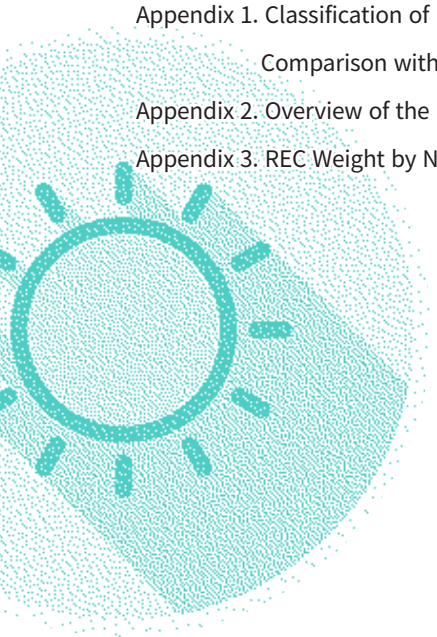
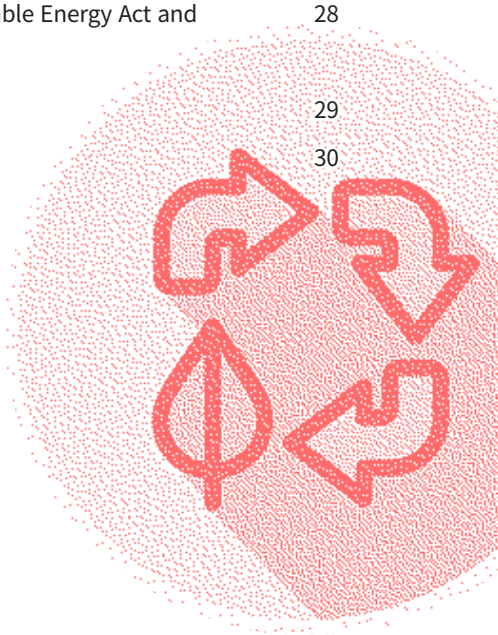




Background

1. Current Status of Renewable Energy Supply

Solar and Wind Only Account for 1.9% of Total Power Generation

The Republic of Korea (hereinafter "Korea") is among the world's top 10 greenhouse gas ("GHG") emitting countries in terms of total emissions. National greenhouse gas emissions have increased at an annual average rate of 3.3% since 1990 and have already exceeded 700 million tons (CO_2eq) since 2017. In 2016, Korea produced approximately 649.6 million tons of GHG emissions. In 2009, the Korean government set a mitigation target of 543 million tons of GHG emissions for 2020, but actual 2020 emissions are expected to exceed this target by more than 30%.[1]

Most of Korea's GHG emissions come from the energy sector (87.1%),[2] and especially because almost 40% of all GHG emissions come from the power generation sector, the supply of renewable energy to replace fossil fuels in the power sector is urgent and important. However, in 2018, solar photovoltaics (PV) and wind accounted for only 1.9% of total electricity generation,[3] and even Korea's unique category of "new and renewable energy", which is to be described later, altogether constitutes only 6.2% of power generation (Figure 1).

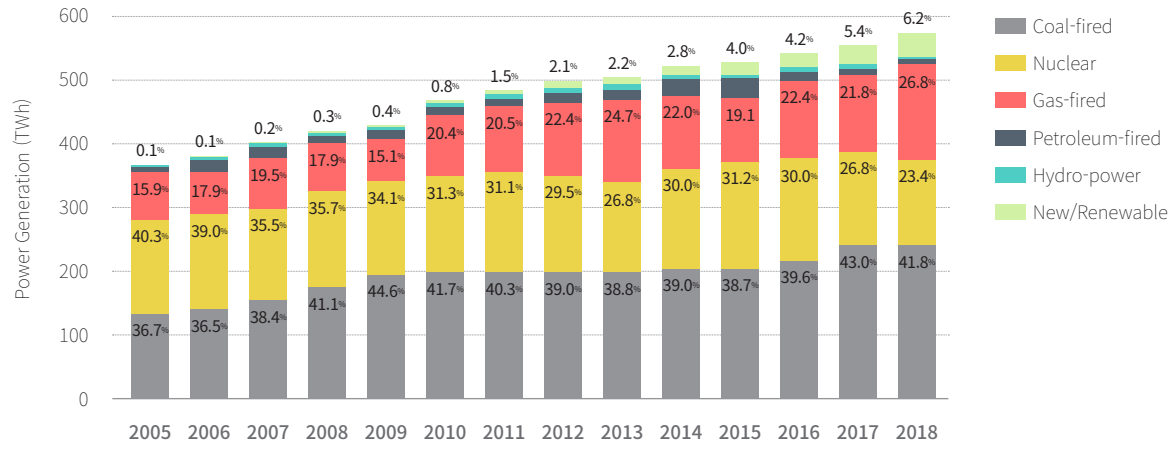
Korea's Classification Standards for Renewable Energy

It must first be mentioned that the law regulating renewable energy in Korea[4] treats "new energy", which includes fuel cells and integrated gasification combined cycle (IGCC), as a similar concept to renewable energy. Thus, most of Korea's renewable energy statistics refer to "new and renewable energy", a category which also contains new, but not necessarily renewable, energy types.

In addition, waste energy, such as from industrial waste incineration, which is not recognized as renewable energy by International Energy Agency (IEA) standards, is categorized as renewable in Korea (see Appendix 1 for a comparison between IEA and Korea's standards).

This concept and category of "new and renewable energy" unique to Korea has long been considered problematic. Recently, the pertinent law's article defining renewable

Figure 1. Changes in Power Generation (TWh) and Share of Generation by Source (%)



Source: Korea Electric Power Corporation Power Statistics Bulletin

1. Relevant Ministries of the Republic of Korea,"2nd Basic Plan for Climate Change Response", Oct 2019, 10.
2. Greenhouse Gas Inventory and Research Center, 2018 National Inventory Report, Dec 2018, 5.
3. This figure was calculated by including only the amount of electricity traded through the wholesale market and PPAs with KEPCO. Source: Korea Electric Power Corporation, 2019 KEPCO Statistics, May 2019.
4. Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy. Hereinafter abbreviated as the "New and Renewable Energy Act".

Table 1. Range of New and Renewable Energy According to the New and Renewable Energy Act

Category	Energy Source	Details
Renewable Energy	Solar	Solar PV, solar thermal
	Wind	
	Hydropower	
	Marine energy	
	Geothermal energy	
	Bioenergy	Biogas, landfill gas, biodiesel, wood chips, coal briquet, forest fuel, wood pellets, waste wood, black liquor, solid fuel from sewage sludge, Bio-SRF, bio heavy oil
	Waste energy	Waste gas, industrial waste, municipal waste, cement kiln fuel, SRF, refined fuel oil
	Other renewables	
New Energy	Hydrogen energy	
	Fuel cell	
	Energy from liquified or gasified coal and gasified vacuum residue	Integrated gasification combined cycle (IGCC)
	Other new energy	

energy was amended, and since October 2019, "waste energy from non-renewable waste" has been excluded from the waste energy category under renewable energies.[5]

Waste-Centred Renewable Energy Supply

As of 2018, power generation from solar PV and wind only accounted for 20% of generation from new and renewable energy in 2017 (Table 2). Waste energy and bioenergy represent an overwhelming share of new and renewable energy, accounting for approximately 46% and 18% (in terms of power generation), respectively. Waste gas, Solid Refuse Fuel (SRF), and municipal waste in descending order, constitute the highest shares of waste energy, and wood pellets represent the highest share of bioenergy at approximately 52%.[6]

Renewables in Korea, Possibilities and Potential

However, Korea's solar PV and wind potential is substantial. Research results from the Korea Environment Institute estimate the country's wind energy potential at 59.4 GW (onshore 15.0 GW/34.5 TWh, offshore 44.4 GW/127.7 TWh) and solar PV potential at 102 GW (138.6 TWh).[7] The Korea Energy Economics Institute has released analysis results finding market potential for solar PV to be 318 GW (411 TWh) or 90% of current power generation.[8]

5. However, as the amendment does not apply to those who supply renewable energy generated from non-renewable waste in accordance with previous regulations as pursuant to Article 2 of the amended Act or those who have already received approval for construction as pursuant to Article 61, Paragraph 1 of the Electric Utility Act, the share of waste energy in Korea's "legal" renewable energy is not expected to decrease significantly for the time being.
6. Korea Energy Agency, New & Renewable Energy Center, 2018 New & Renewable Energy Supply Statistics, Nov 2019.
7. Korea Environment Institute, Climate Environment Policy Research for March 2014, "Alternatives to Fossil Fuels' Environmental Impact and Competitiveness Assessment (II): A Focus on Renewable Energy Power Sources", Mar 2014.
8. 411TWh excluding land costs, market potential with land costs is 380TWh. Source: Korea Energy Economics Institute, Basic Research Report October 2018, "Analysis on Solar PV's Market Potential and Implementation Costs Considering Competitiveness by Region", Oct 2018, 59. <Table3-4>, Oct 2018. The Korea Energy Agency's New & Renewable Energy Center's "2018 New & Renewable Energy White Paper" estimates the solar PV market potential to be 321 GW, and the Korea Energy Economics Institute also obtained similar results. The Korea Environment Institute's solar PV potential estimates is a conservative evaluation as this puts considerable weight on Korea's special topographical factors. The Korea Energy Economics Institute performed an economic analysis based on the technological potential of solar PV for each grid in Korea. This shows that topographical constraints and siting conflicts could significantly affect potential.

Table 2. New and Renewable Power Generation (Unit: TWh, %: Share of Total Generation from New and Renewables)

Category	2016	2017	2018
Total power generation from new/renewable energy	40.7	46.6	52.7
Renewable energy	39.2	43.9	49.3
Solar PV (%)	5.1 (12.6)	7.1 (15.1)	9.2 (17.5)
Wind (%)	1.7 (4.1)	2.2 (4.7)	2.5 (4.7)
Hydropower (%)	2.9 (7.0)	2.8 (6.0)	3.4 (6.4)
Maritime (%)	0.5 (1.2)	0.5 (1.0)	0.5 (0.9)
Biomass (%)	6.2 (15.3)	7.5 (16.0)	9.4 (17.8)
Waste (%)	22.8 (56.0)	23.9 (51.2)	24.4 (46.2)
New energy	1.5	2.8	3.5
Fuel cell (%)	1.1 (2.8)	1.5 (3.2)	1.8 (3.3)
Integrated gasification combined cycle (IGCC) (%)	0.4 (0.9)	1.3 (2.8)	1.7 (3.2)

Source: Korea Energy Agency, New & Renewable Energy Center

In addition, solar PV's competitiveness is rapidly improving with the increase in solar PV system installations. If land prices are not taken into consideration, it is forecasted that the levelized cost of energy (LCOE) from solar PV generation will fall from KRW 121/kWh in 2018 to less than 100 won/kWh in 2023, achieving grid parity[9] below wholesale electricity prices.[10] This means that if solar PV and wind power generation are expanded through efficient policy measures and active investment, GHG emissions can be reduced cost-effectively.

2. Progress of Renewable Energy Policies

Renewable Energy Supply Targets

By establishing the Basic Plan for the Development and Supply of Alternative Energy in 1997, Korea set a target to supply 2% of energy demand from renewable energy by 2006. In the plan established in 2003, the target was raised to 5% by 2011, but actual supply remained at 2%. In 2008, the Korean government adopted a "Green Growth" policy and established the First Energy Master Plan, setting a target of supplying 11% of primary energy from new and renewable energy by 2030. Since then, the above target has been adjusted to be achieved by 2035 (accounting for 13.4% of electricity generation).

The current administration, which took office in 2017, adjusted the share of renewable energy generation of electricity generation by 2030 to 20% and announced the Renewable Energy 3020 Implementation Plan (Table 3), which focuses on the 48.7 GW expansion of solar PV and wind facilities.

How much the long-term renewable energy supply target should be raised by 2040 was the main subject of debate during the process of establishing the Third Energy Master

9. The average price in 2018 was KRW 95/kWh. Source: Korea Power Exchange, SMP (By Year), Accessed May 2019, https://www.kpx.or.kr/www/contents.do?key=414.
10. Heo Ga-young, National Assembly Budget Office, Industry Trends December 2018, "Analysis on the Competitiveness of solar PV power generation", Dec 2018.

Table 3. 3020 Renewable Energy Facility Supply Target (Unit: GW)

Category	2017	2030	Total Increase	Annual Average Increase
Solar PV	5.7	36.5	30.8	2.6
Wind	1.2	17.7	16.5	1.4
Other (waste, biomass, hydropower)	8.2	9.6	1.4	0.1
Overall	15.1	63.8	48.7	4.1

Source: Ministry of Trade, Industry and Energy, 3020 Renewable Energy Implementation Plan, 2017

Plan, which was confirmed in June 2019. The Plan's public-private working group had an opinion that the share of renewable energy generation should be 40% or more in 2040, but the final supply target was eventually set at 30~35%.

Support Schemes for Renewables

Initial support for renewable energy began with the implementation of a feed-in tariff (FIT) in 2002. Under this system, renewable energy producers could receive a subsidy equal to the difference between the wholesale electricity price and a guaranteed price assured by the government for 20 years. Such subsidies were funded by the Electrical Industry Foundation Fund (New and Renewable Energy Act, Article 17, Paragraph 2).[11]

In 2010, the Korean government decided to abolish the FIT system and introduced a renewable portfolio standard (RPS).[12] According to the RPS system, electricity generation businesses with a power generation capacity of 500 MW or more are obligated to supply at least a certain percentage of their total power generation from new and renewable energy. Mandatory suppliers must either construct

Table 4. Mandatory Renewable Supply Share by Year According to the New and Renewable Energy Act

Year	Share (%)	Year	Share (%)
2012	2.0	2018	5.0
2013	2.5	2019	6.0
2014	3.0	2020	7.0
2015	3.0	2021	8.0
2016	3.5	2022	9.0
2017	4.0	2023 and thereafter	10.0

11. The Electrical Industry Foundation Fund, which is funded by a percentage (currently 3.7%) of electricity bills, amounts to KRW 2.3 trillion, of which a portion goes to funding the supply of new and renewable energy (KRW 500 billion) and financing new and renewable energy (KRW 170 billion) (Ministry of Trade, Industry, and Commerce, 2018 Budget and Operational Plans for Electricity Industry Foundation Fund, Jan 2018).
12. From 2001 to 2017, a total of KRW 3.2 trillion was spent on FIT subsidies, and until 2030, an additional KRW 2.4 trillion is expected to be spent(Song Dae-ho, New and Renewable Energy Act, a Review Report on a Part of the Revision, Sep 2017, 18).

renewable energy facilities themselves or purchase renewable energy certificates (RECs)[13] in the marketplace to fulfil mandatory supply (New and Renewable Energy Act, Article 12, Paragraphs 5-10).

Currently, mandatory RPS supply is set by year, starting from 2% of total power generation in 2012 and reaching 10% in 2023 and thereafter (Table 4). The current government announced it would gradually raise the mandatory supply share to 28% by 2030 in its five-year plan for the administration in 2017.[14] However, the government has yet to present concrete plans.

Korea's RPS is currently receiving criticism for operating against its intended purpose of promoting the transition to renewables in the power generation sector.[15] In addition, unlike under the FIT system which guarantees fixed profits, under the RPS, renewable energy businesses are compensated for electricity sales based on system marginal prices (SMP) and REC prices. Hence, volatility in SMP and REC prices has led to projects' financial uncertainty, making it difficult to raise financing.

To overcome such financing issues, starting from 2017, for solar PV only,[16] bidding for some capacity under the RPS scheme has been conducted, but generation businesses are required to enter into long-term purchase agreements of around 20 years at a fixed price comprised of the system marginal price (SMP) and REC price (i.e., a "fixed price contract" system). In particular, in 2018, to guarantee stable profits for small-scale solar PV businesses, the decision was made to reintroduce the FIT system for five years. As a result, small-scale solar PV producers of 30 kW or less and solar PV stations operated by farmers, fishers, and

Table 5. Summary of Renewable Energy Financing Conditions Analysis Based on Market Environment and Policies

Period	Market Environment		Financing Conditions		Result
	Oil Prices	PV Construction Costs	Support Policy	Project Cash Flow	
~ 2012	High	KRW 6 billion/MW	FIT	Fixed price for 15~20 years (KRW 370.7~606.6/kWh)[17]	Easy to finance
2012 ~ 2016	In decline	In decline	RPS	Volatile SMP + Volatile REC price	Difficult to finance
After 2017	Low	KRW 2 billion/MW	RPS (+FIT)	Part of the RPS capacity with a guaranteed price on solar PV generation for 20 years (KRW 159/kWh), introduction of FIT for small-scale solar	Easy to finance

Source: SFOC Analysis

Table 6. International Comparison of Solar PV LCOE in the First Half of 2017

Category	India	Australia	Germany	China	Thailand	Korea
LCOE (USD/MWh)	68	71	57	76	107	125
Korea=100	54	57	46	61	86	100

Sources: Korea Energy Economics Institute, Policy Issue Paper 18-10, "Introduction of an Auction System for the Improvement of the New and Renewable Energy RPS System", 2018; Korea's cost is from the Korea Energy Economics Institute, Basic Research Report 18-27, "Analysis of New & Renewable Energy Policy Changes and Market Analysis", 2018.

13. REC is a certification that proves that new/renewable energy, from the construction of the station to power generation, was supplied. The power unit of MWh is multiplied by a constant 'weighted value' for each generation source (REC = MWh × weighted value).
14. Government of the Republic of Korea, Five-year Plan for the Management of State Affairs, 2017, 72.
15. Park Si-won, Environmental Law Research Volume 39, No.3, "Current Status of Renewable Energy Legal Policies and Improvements", 2017, 87.
16. The bidding process takes place every half year. Bidding had started from a volume of 250MW during the 1st half of 2017, which expanded to 350MW from the second half of 2018.
17. Ministry of Knowledge Economy (which has since been split into the Ministry of Trade, Industry and Energy and Ministry of Science, ICT and Future Planning) Notice 2010-176, "Price Guidelines for Electricity Generated from New and Renewable Energy", Table 1-2.

livestock producers or cooperatives of less than 100 kW are able to generate stable profits at a fixed price for 20 years.[18]

However, the LCOE of Korea's renewable energy remains relatively high (Table 6), requiring transparent and efficient renewable energy support policies.

3. Key Issues Impeding the Expansion of Renewables to be Discussed in This Report

The Korean government is making efforts to set ambitious renewable energy supply targets and establish a detailed implementation plan. Interest in renewable projects centred on solar PV is high, with solar PV power supply reaching a record high of 3.13 GW in 2019. However, some say that the RPS system, which was introduced to reduce renewable subsidies, has failed to induce a reduction in the unit cost of renewables. Additionally, it is known that a considerable number of renewable energy facilities are not being connected to the grid in a timely manner and are waiting for grid access due to insufficient substations or distribution lines. There are also various concerns being raised about grid management challenges and issues created by the increase in volatile renewable energy.

Meanwhile, for the past few years, the biggest problem that has hampered the expansion of renewables has been conflicts in the local community arising in the process of solar PV and wind project development due to damage to mountainous districts and impacts on the living environment. As a result, there is an increasing number of local governments autonomously establishing ordinances and rules restricting the sites for solar PV and wind power. Renewable energy producers have been citing obstacles facing the advancement of their projects, including permitting difficulties from delays in grid connection, various kinds of siting regulations, and resident complaints. Underlying such confusion and conflict over renewable energy are issues related to a vertically integrated power industry structure and a power market which favour fossil fuels and hinder the entry of innovative technologies and ideas.

This report examines the current status and important issues related to four different areas including (1) grid management and policy, (2) land policy and public acceptance, (3) power market and pricing, and (4) demand-side flexibility and innovative energy solutions and explores policy alternatives to sensibly overcome the above factors impeding renewable expansion in Korea and accelerate the transition towards a renewable energy-based society.

18. Ministry of Trade, Industry and Energy, "Full-scale Implementation of a Korea-specific FIT for small-scale solar PV producers" (Press Release), Jul 12,2018.

Issue 1: Grid Management and Policy

1. Delays in Grid Access Due to Lack of Grid Infrastructure and Conservative Operating Practices

Policy on Grid Connections for Renewable Energy

The majority of renewable energy facilities in Korea are small-scale facilities that can connect directly to the distribution system. The Ministry of Trade, Industry and Energy (hereinafter "MOTIE") and KEPCO have taken a series of measures to expand grid connection among small-scale renewable producers. In 2015, the range for low-voltage grid connection was increased from the existing under-100-kW requirement to under 500kW to alleviate the cost burden of accessing the grid.[19] At the end of 2016, it was announced that access to the grid would be unconditionally guaranteed for small-scale producers of 1MW or less and that necessary costs for power facility construction would be covered by KEPCO.[20] In addition, while the connection capacity per transformer is temporarily increased, sharing of grid information including spare capacity for substation access and circuit breakers has been initiated to attract renewable power stations to regions with spare grid capacity.[21]

Current Situation of Grid Connection Delays

However, after the guaranteed access policy for producers of 1MW or less was announced at the end of 2016, by the first half of 2018, grid access applications from renewables surged in the short term to 8GW.[22] A considerable number of applicants for grid access are not able to connect immediately to the grid and are facing long wait periods.

From October 2016 to the end of December 2018, grid access applications for all operators of solar PV generation businesses in Korea with 1 MW or less totalled 12.7GW (60,427cases). Of these, those who have successfully connected to the grid and started commercial operations account for 3,370MW (19,428 cases), representing only 25.9% of the total. The remaining standby supply is 6,250MW (26,700 cases) or 49% of the total. Two thirds of this supply (4,442MW) is expected to connect to the grid within one year after reinforcement of distribution lines and transformers, but a total of 1,808MW in facilities must wait at least two years until substation construction is completed.[23]

Challenges of Expanding the Distribution Network – Connection Regulations, Lack of Grid Infrastructure, etc.

The causes for such connection delays are largely the conservatively operated connection standards and the long time required to expand grid infrastructure.

First, KEPCO's standards for connecting distributed generation to the distribution network (hereinafter "connection standards") do not consider the actual usage rate for renewable energy and are operating on accumulated connection capacity (per transformer and substation) standards based on the maximum value of generation. Currently, because KEPCO cannot perform its role of controlling renewable energy as a distribution system operator, it regards renewables to be an uncontrollable power supply and is, thus, operating strict connection standards. This phenomenon is due to the unique structure of Korea's power industry, in which KEPCO is unable to acquire the status of neutral operator in its distribution sector. To address this, social discussion on various aspects is required.

Also, while it is necessary to expand distribution network infrastructure, distribution facilities are perceived as unpleasant, and thus, require a considerable amount of time to receive consent from the local community and obtain permits. According to KEPCO, the standard construction time for a substation is 72 months (six years).[24]

In addition, as confirmation of detailed planning for renewable power stations' locations, capacity, or grid connection points is not possible, it is difficult to make active investment plans because of the risk of sunk costs occurring due to errors in transmission and substation

19. Ministry of Trade, Industry and Energy, "Spur of Business Revitalization as Renewable Producers, such as Livestock Farmers, See Drastic Drop in Grid Access Costs"(Press Release), Mar 31, 2015.
20. Ministry of Trade, Industry and Energy, "Grid Access Guarantee for Small-scale Renewables of 1MW or Less" (Press Release), Oct 21, 2016.
21. Korea Electric Power Company, "Distributed Generation Connection Information", http://home.kepco.co.kr/kepco/CO/H/A/COHAPP001/COHAPP001.do?menuCd=FN040607.
22. Kim Hong-kyoon, "Increasing Grid Capacity for the Expansion of Renewable Energy"(KEPCO Grid Planning Commissioner DiscussionMaterial from National Assembly Debate on Renewable Energy), Aug 13, 2018, 63.
23. E2 News, "6250MW of 1-MW-and-less Solar Awaiting Grid Access", May 26, 2019, http://www.e2news.com/news/articleView.html?idxno=210788.
24. Yoo Joon-sang, ENewsToday, "Solar PV Stuck at Grid Connection…Renewable Energy 3020 Implementation Plan at a 'Red Light'" Mar 14, 2019,http://www.enewstoday.co.kr/news/articleView.html?idxno=1280408.

facility planning.[25] It has also been pointed out that KEPCO, which is in charge of investments into expansion of the distribution network, is not able to secure new financing for distribution infrastructure investments and lacks incentives to actively invest in new distribution network.

2. Tackling Uncertainty and Variability of Renewables and Securing Grid Instability

Renewable energy, including solar PV and wind, is often characterized by uncertainty and variability. In other words, it is difficult to predict actual generation (uncertainty), and because output varies over time (variability), the problem of responding to these changes arises. While these characteristics can affect renewable energy in all regions and countries, there are concerns that it might be more difficult to address them given the characteristics of Korea's power market and composition of power facilities.

Limitations of the Current Power Market System

Since its official launch in 2001, Korea's power market has been operated as a cost-based pool (CBP) market based on variable costs. The system marginal price (SMP) is determined by the equilibrium point between the electricity demand curve predicted the day before and the supply curve of the participating bidder power stations. While electricity generation businesses and electricity sellers are obligated to participate in the power market (Electric Utility Act, Article 31), small-scale new and renewable energy producers of 1 MW or less have no such obligations. In addition, electricity sellers must prioritize the purchase of power produced by renewable energy facilities (Electric Utility Act Article 41, Paragraph 4, Subparagraph 3).

Therefore, renewable energy producers are either signing power purchase agreements (PPAs) with KEPCO (for projects with a capacity of 1 MW or less) or selling power produced even without any separate dispatch orders through the Korea Power Exchange (for those with more than 1 MW). In the case of solar PV, as the installation of small-scale facilities increase, the share of power that is sold on the Korea Power Exchange is decreasing year by year, with only approximately 35% of overall capacity being sold on the exchange, while the remaining 65% is sold to KEPCO directly or consumed by the producer.[26]

Additionally, because Korea's power market only has a day-ahead market, and there is no real-time market, the time difference between the point of bid submission and point of actual power generation is large, so the prediction errors made in that timeframe can only be large. In the case of renewables, the producer does not participate in the bidding process and the power is purchased in the power market on a priority basis. As there are no incentives or penalties related to forecasting, there is no market system that can increase renewable energy's predictability.

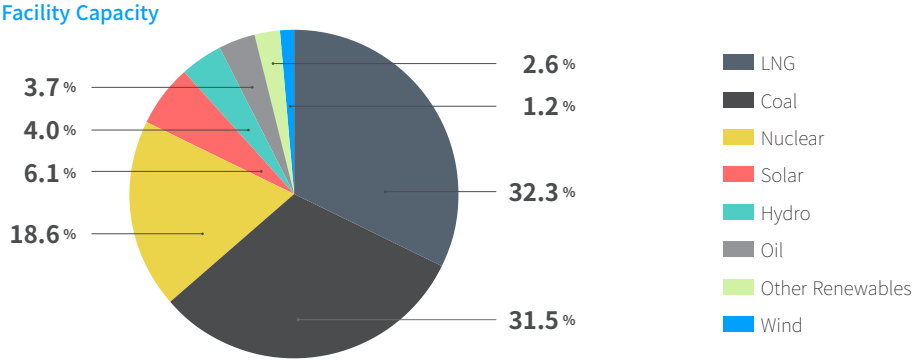
There have been emerging views that to overcome such uncertainty and stop cost increases from forecasting gaps, a real-time market and bidding market for renewable producers, as well as an incentive system to increase predictability, need to be introduced. The establishment of a real-time market has even been mentioned as a major task in the Third Energy Master Plan announced June 2019.

Solutions for Overcoming Variability and Renewable Energy Target Controversies

If the share of renewable energy facilities increases, the procurement of flexible power that can quickly reject excess power when renewable energy output is high and quickly run when renewable energy output is low is needed. Such flexible resources often include gas power, pumped-storage power, and ESS. However, in the current power facility composition, non-flexible nuclear and coal power account for 18.6% and 31.5% respectively, and the total facility capacity of non-flexible power sources

25. Kim Hong-kyoon, 64.
26. Values are calculated by dividing the "market participation capacity" announced by the Korea Power Exchange and the "cumulative installed capacity" announced by the Korea Energy Agency. "Market participation capacity" refers to the facility capacity of power stations that are making transactions in the power market. As it does not include PPAs with KEPCO, it does not mean Korea's new and renewable energy facilities' capacity (Electric Power Statistics Information System, "Market Participation Capacity", http://epsis.kpx.or.kr/epsisnew/selectEkmaRegGcpGrid.do?menuId=050801). "Cumulative installed capacity" reflects the capacity including construction, increase, decrease, and cancellation. Because it reflects cancelled capacity, this value can be less than the market participation capacity counted by the Korea Power Exchange (Korea Energy Agency, New & Renewable Energy Center, New & Renewable Energy Policy Division Manager).

Figure 2. Power Generation Facility Capacity by Power Source (2018)



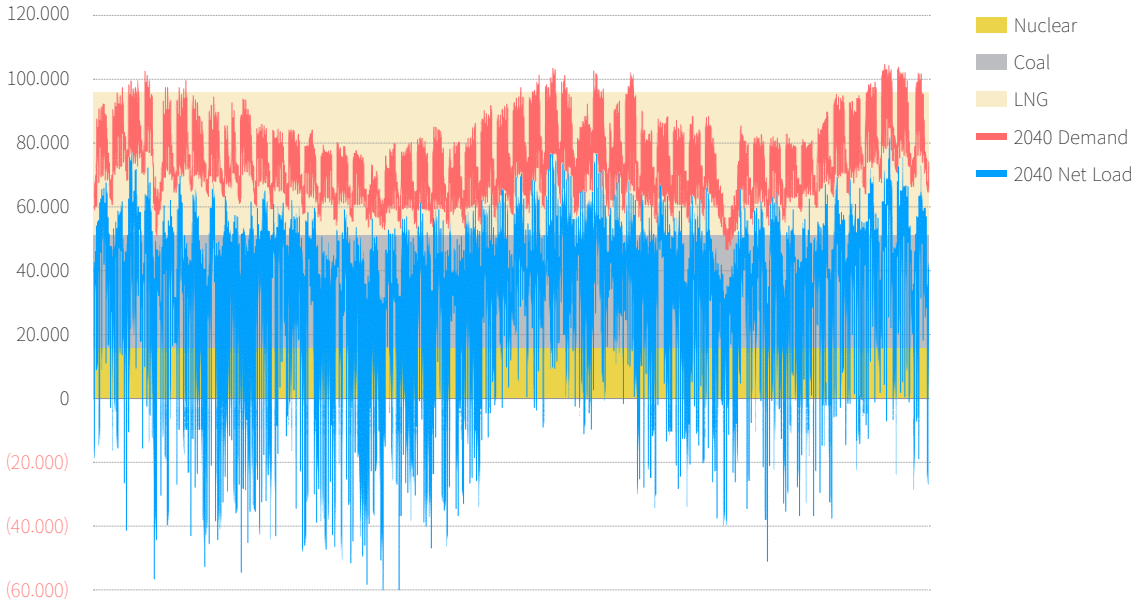
Source: KEPCO Statistics 2019 (No. 88)

Table 7. Predicted Output Constraints for Various Scenarios of Renewable Power Generation Presented by an Expert Task Force

Renewable Energy Share of Total Power Generation in 2040	25%	30%	35%	40%
Output Constraints Ratio (annual)	1.0%	4.4%	11.0%	21.5%

Source: Third Energy Master Plan

Figure 3. Power Generation in a 40%-Renewables Scenario in 2040 as Presented by an Expert Task Force[27]



reaches 50.1%. It is known that the nuclear generation of France's PWR has load follow operation capabilities. Korea's nuclear generators, however, are known to lack such capabilities.[28]

As a result of this lack of physical flexibility in the power grid's power facility composition, an opinion submitted by an expert task force to the 2018 public-private working group for the establishment of the Third Energy Master Plan included the argument that the 2040 renewable energy share target should be 35% or less because "if the share of renewable energy exceeds 35%, the cost of output control and back-up facilities (batteries, gas turbines, etc.) surges when output from renewable energy sources fluctuates".

When the expert task force suggested an upper limit of 35% of total power generation for the 2040 renewable energy target, it was argued that net load fluctuation patterns (blue) that exclude renewable energy generation could collide with the non-flexible nuclear power load (yellow) as can be seen in the figure above, and that a significant amount of curtailment would be needed to bring the net load down to under zero.

To address such problems, the share of flexible generation in the current pool of power generation facilities should be increased, and the introduction of new technologies and facilities that can respond to variability, including batteries, should be expanded. In addition, it is necessary to establish a rational legal system for limiting renewable energy output.

3. Discussion on Policy Alternatives

Korea maintained a vertically integrated monopoly structure in which the government-owned Korea Electric Power Corporation (KEPCO) monopolized generation, transmission, distribution, and electricity sales for a long time, and around 2000, it tried to restructure its power industry. Restructuring of the power industry was to be phased in through three stages: generation competition, wholesale competition, and retail competition.[29] But in 2001, after the breakup of KEPCO's generation division and establishment of generation subsidiaries, as well as the formation of the Korea Power Exchange (KPX), subsequent restructuring was tentatively halted in 2003 due to a lack of public consensus.

Accordingly, in the transmission and distribution sector, all transmission and distribution facilities are wholly owned by KEPCO, while KPX, newly established in 2001, performs the role of grid operator. In other words, KPX serves as both the market operator (MO) and transmission system operator (TSO).

As an exception, for transmission or distribution lines with less than 154kV, KEPCO fulfills the directives of KPX and manages its own facilities (Electric Utility Act, Article 45; Enforcement Decree of the Act, Article 25), but currently, such roles are performed only in non-routine situations, such as when malfunctions arise. Thus, there is no separate distribution system operator (DSO) that manages grid operations. In this situation, the following policy alternatives are being discussed to resolve grid connection delays, uncertainty, and variability issues caused by the expansion of renewable energy.

Plans to Reduce Grid Connection Delays

As MOTIE promotes the construction of new substations as the main solution for grid connection delays, the Ministry has also announced that it will maximize the capacity that can access existing substations such as through the addition of banks and invest KRW 900 billion between 2017 to 2021 in expanding the renewable grid, including reinforcement of the distribution network.[30] The 8th Long-term Transmission and Substation Facilities Expansion Plan presented plans to build and reinforce transmission and substation facilities in areas with a high concentration

27. Park Jong-Bae, "Tasks and Strategies for Addressing the Expansion of Renewables" (Presentation Material), Feb 26, 2019, 9.
28. Jeon Young-hwan, E2News, "[Column] Increasing Receptiveness of New & Renewable Energy and Nuclear Power Generation's Technological Limitations", Feb 12, 2018, http://www.e2news.com/news/articleView.html?idxno=106156.
29. Ministry of Commerce, Industry and Energy, Power Industry Restructuring Basic Plan, Jan1999, 5-6.
30. Ministry of Trade, Industry and Energy, "Industry Minister Ju Hyeong-hwan, on-site inspection of electric power facilities before the Korea New Year holiday - investment of 900 billion won for new renewable power grid connection by 2021," Jan 26, 2017.

of renewable generation applications to increase grid capacity in accordance with the expansion of renewables. The 8th Basic Plan for Electricity Supply and Demand also suggests a short-term plan for grid reinforcement by establishing new distribution lines and transformers along with measures to introduce distribution lines dedicated for renewable energy (70 kV) in the mid to long term and preemptively reinforce transmission and substation facilities in areas where renewables are expected to be concentrated.[31] In addition, a pilot project in the South Jeolla region is underway to build a local renewable energy monitoring, operation, and prediction system.[32]

There are views that we need to consider not only physical solutions such as the construction of additional distribution network and facilities but also nationwide introduction of active distribution infrastructure and restructuring toward a distribution-oriented decentralized operating system. There is also the opinion that we need to expand small-scale power communities, such as microgrids that use energy storage systems (ESS)[33] and hydrogen fuel cells.

Transition of Grid Management and the Market System

In the 8th Basic Plan for Electricity Supply and Demand, the Korean government presented measures to secure flexible back-up facilities that can quickly adjust output as a means to address renewable energy's variability, build a "comprehensive renewable energy control system" to strengthen forecasting of future power generation and capabilities for control in the case of sudden changes in output, as well as overhaul the auxiliary service operation system and review the introduction of a real-time market for the compensation of flexible facilities.[34]

The public-private working group for the Third Energy Master Plan also recommended the construction of next-generation grid infrastructure, such as Advanced Distribution Management System (ADMS) and Supervisory Control and Data Acquisition (SCADA). It also recommended ways to improve the power market, such as increasing the accuracy of forecasting renewable power generation and supplying power to match forecasted demand through futures markets and real-time markets.[35]

31. Ministry of Trade, Industry and Energy, 8th Basic Plan for Electricity Supply and Demand, Dec 29, 2017, 57.
32. Kim Hong-kyoon, 68.
33. Dueto battery industry promotion policies and high levels of RPS subsidies provided for ESS connected to solar PV and wind, Korea has world-class ESS battery infrastructure (4,534MWh[1,568MW] as of the end of 2018), but its contribution to grid operations is low, and recently, there are increasing instances of suspension of orders or operation of ESS due to problems such as fires.
34. Ministry of Trade, Industry and Energy, 8th Basic Plan of Long-term Electricity Supply and Demand, Dec 29, 2017, 53-54.
35. Ahn Jae-kyun, Korea Energy Economics Institute, Measures to Strengthen Power Grid Flexibility in Preparation for Expansion of New & Renewable Energy Supply, 2017.

Issue 2: Land Policy and Public Acceptance

1. Strengthening of Regulations Due to Siting Conflicts

Since the annual installed capacity of solar PV in Korea surpassed 1 GW for the first time in 2015, solar PV generation has recently been rapidly expanding, with annual installed capacity exceeding 3GW in 2019. However, as concerns over increasing solar PV installations in mountainous districts and some cases of wind power projects in mountainous districts with good conservation status, such as Baekdu Range, grow, conflicts with local residents have intensified. Because of this, tightening of siting regulations for renewable energy facilities has recently been on the rise.

Regulations on Solar PV in Mountainous Districts

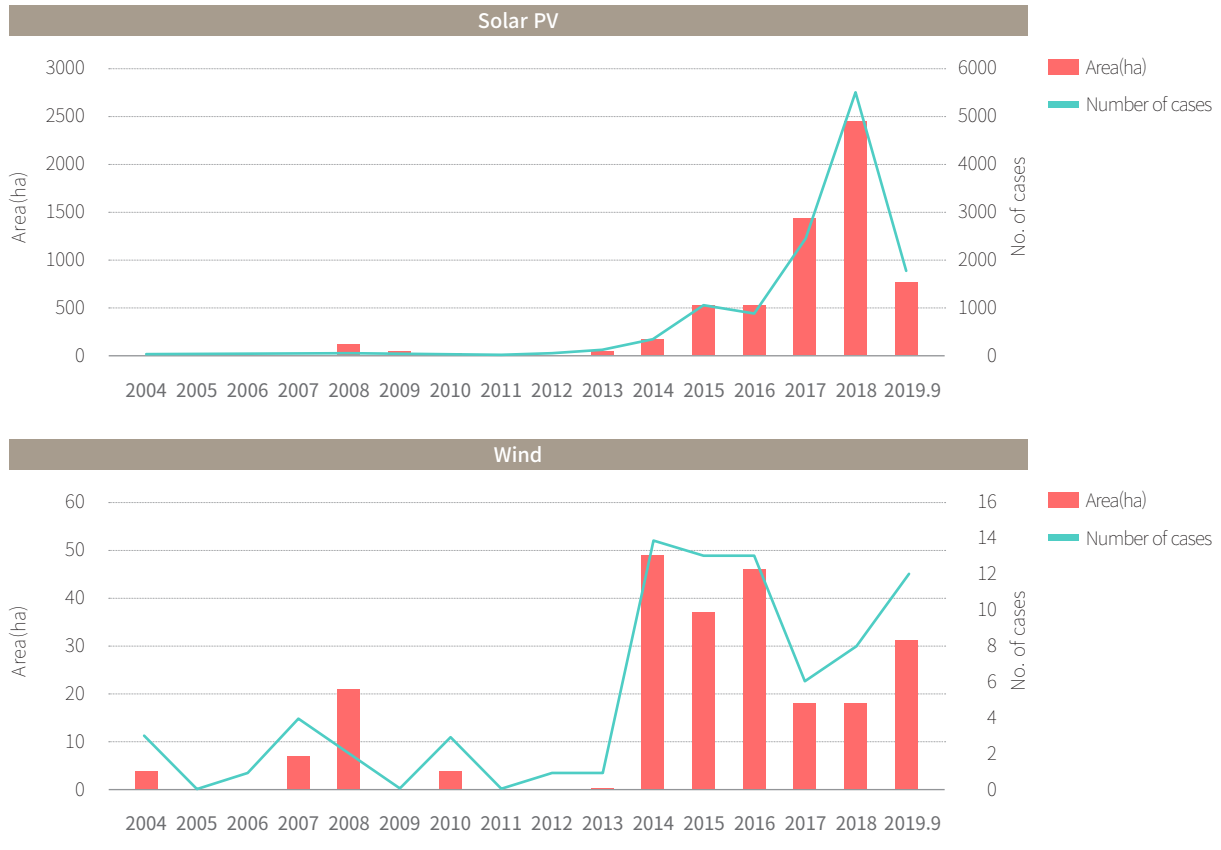
Regulations on solar PV in mountainous districts are a representative example. Because they require the cutting down of trees, which are carbon sinks, solar PV installations in mountainous districts have been judged as running contrary to the purpose of supplying renewable energy.

Because of this, in 2018, MOTIE took measures to minimize solar PV installations in mountainous districts, such as reducing the REC weight for solar PV installed on forest land from 1 to 0.7. The Ministry of Environment, in July 2018, also enacted the "Guidelines for Consultation on Environmental Assessment of Solar PV Projects on Land", which strengthened site evaluation criteria, such as specifying areas to be avoided and areas requiring careful review when assessing environmental impacts. As a result, the area of mountainous districts available for the installation of renewable energy facilities has recently been rapidly decreasing (Figure 5).

Regulations in Agricultural Promotion Areas

To prevent the problems of solar PV in mountainous districts, it is important to expand areas permitting solar

Figure 4. Permits for Mountainous District Conversion for Solar PV and Wind Facilities by Number of Cases and Land Area



Source: Data submitted by the Korea Forest Service to the National Assembly

PV generation on flatland, which has rich solar potential and allows easy installation of stations. However, much of the flatland that is suitable for solar PV generation is categorized as "agricultural promotion areas".[36] The installation of solar PV facilities is difficult due to regulations in the Farmland Act that strictly limit activities unrelated to agriculture in such areas.

With the establishment of the "Renewable Energy 3020 Implementation Plan", there have been ongoing discussions on expanding solar PV generation projects in rural areas, including temporary permission to use land within agricultural promotion areas, reclaimed land in particular, for solar PV purposes. In 2018, a pilot project was conducted for the introduction of an agro-solar PV model that can combine farming and solar PV generation in agricultural protection areas outside of agricultural promotion areas, and its effects were verified.[37] An amendment to the Farmland Act based on such cases, which would temporarily allow the installation of farming-type solar PV facilities in agricultural promotion areas for up to 20 years, has been proposed and is pending in the National Assembly.[38]

Issues with Local Governments' Development Activities Permits

To install wind and solar PV facilities, an electric utility business license must be obtained according to the Electric Utility Act, and permission for development activities must be acquired for the area in which the generation facility will be installed according to the National Land Planning and Utilization Act (hereinafter referred to as the"National Land Planning Act") (refer to Appendix 2 for the licensing process of renewable energy facilities). The Ministry of Land, Infrastructure and Transport, through the Operating Guidelines for Permissions for Development Activities, allows the heads of local governments to prepare city or county planning ordinances and autonomously operate the development activities permitting system. On this basis, local governments have introduced regulations on the distances from features such as roads, residential areas, tourist areas, farmland, and cultural assets, in addition to diverse regulations including those on perimeter fences, screen filters, shields, buffer zone requests, slope, hosting of information sessions for residents and securement of community consent.[39]

The most problematic of these regulations are those on separation distance. The majority of local governments specify a separation distance in which the solar PV facilities must be between 100 m to 1,000 m away from roads or residential areas. It is not only difficult to find land that meets these conditions within Korea's small national territory but also confusing for electric utility businesses which face separation distances and conditions that differ by local government jurisdiction.

For this reason, in March 2017, MOTIE established and distributed the "Solar PV Facilities Siting Guidelines", which set the basic principle of not specifying or operating separation distances and allows a maximum separation distance of 100 m only in cases where objective necessity is recognized.[40] Despite the distribution of such guidelines, many local governments still have separation distance regulations of at least 100 m.[41]

2. Project Delays Due to Decline in Public Acceptance

The Spread of Negative Perceptions of Solar PV

With the expansion of solar PV supply, there has also been an increase in false or exaggerated information on the harmfulness of solar PV generation, including on heavy metals, electromagnetic waves, glare, increase in surrounding temperatures and health effects. The Korean government has made efforts to correct these claims, but there are still instances of projects facing difficulties due to

36. As of 2016, the total area of Korea's Agricultural Promotion Areas is 99,004,000 ha (applies to approximately 10% of Korea's total territory), of which approximately 78.5% is being used as farmland. Only acts related to agricultural production and farmland improvement are permitted within Agricultural Promotion Areas (Chae Gwang-seok, Kim Hong-sang, Seong Jae-hun, Kim Bu-yeong, Korea Rural Economic Institute, "A Study on Enhancing the Agriculture Promotion Areas Designation and Operation System for Systematic Agricultural Land Management", Oct 2018, 39).
37. Ministry of Agriculture, Food and Rural Affairs, "2019 Ministry of Agriculture, Food and Rural Affairs Activity Report" (Press Release), Dec 18, 2018, 7.
38. Bill on an amendment to the Farmland Act; bill chief authored by National Assembly Member Park Jeong (Bill No. 14411)
39. Han Jae-gak, Lee Jeong-pil, Kwon Seung-moon, Lee Young-ran, Son Eun-suk, Energy & Climate Policy Institute, "Study on Resolving Conflicts Related to Renewable Energy Supply (II)", 2016, 52-54; as the first local autonomous entity to establish such criteria, South Jeolla Province, as part of its detailed guidelines on the permit for developmental activities, enacted the "South Jeolla Province Solar PV Project Permit Authorization Guidelines". South and North Chungcheong Provinces advised the preparation of guidelines for cities and counties under the provinces on permits for development activities for solar PV facilities. During 2016, there were 14 local governments that prepared guidelines in South and North Chungcheong Provinces alone.
40. Ministry of Trade, Industry and Energy, Solar PV Facilities Siting Guidelines, Mar 2017, 2-4.
41. When the guidelines were circulated in March 2017, 54 local governments had regulations on separation distances, but in 2018, after the guidelines were distributed, that number increased to 94. According to a survey conducted by the Korea Energy Agency in the first half of 2019, 117 local governments maintain separation distance regulations, with cases of separation distances of up to 2,000 m.

concerns over the harmfulness of solar PV generation. There has been opposition to floating solar PV projects due to concerns about heavy metals from solar PV panels polluting the water and harms resulting from electromagnetic waves (e.g., solar power project on Seokmun Lake in South Chungcheong Province), as well as suspension of a solar PV project in a parking lot due to resistance from the community over the harmfulness of solar PV panels (e.g., parking lot of Seoul Grand Park in Gwacheon, a city of Gyeonggi Province).

Due to such public opposition to solar PV generation, there are also cases emerging in which heads of local governments have rejected applications for permission for development activities based on discretionarily judged requirements. Judiciary control is not easy in such instances, because the court views the permissions for development activities as discretionary acts and loosely reviews their rationality.[42]

Development of Onshore Wind and Concerns over Environmental Damage

While mountainous districts, such as Baekdudaegan and Nakdong Range, have good wind conditions, most of their forests are dense, and there are also many protected areas, such as the Baekdudaegan Protected Area and national and public parks. This has led to significant concern over the destruction of conserved mountainous districts and ecosystems with the development of large-scale wind complexes in such areas.[43]

With regard to this, the Ministry of Environment proposed the "Onshore Wind Power Guidelines" in 2012, which regulates installation of wind power generators in Baekdudaegan and the surrounding areas of its ridges, surrounding areas of residential areas, and the sites of power generation facilities and within 50㎡ to the left and right of roads with areas with a slope of at least 20 degrees. In response to criticism that such guidelines run contrary to renewable energy expansion policies, the guidelines were considerably relaxed relative to the original plan in October 2014, including the possibility of considering wind power projects in areas that include first-grade zones according to ecological and natural maps.[44]

However, recently, due to the rise in complaints and concerns following the expansion of renewable energy installations, there have been increasing instances of projects being delayed for long periods or shelved in the environmental impact assessment process. In August 2019, to resolve such environmental assessment issues, a plan for promoting onshore wind was prepared, and a siting map for the objective judgment on where onshore wind siting is possible is being developed, but it is unknown whether onshore wind can be promoted through these efforts.

Delay in Offshore Wind Projects

Offshore wind power is relatively free from the controversies over environmental damage facing onshore wind and can have large-scale facilities by making use of excellent wind resources. However, offshore wind projects continue to face difficulties in their implementation as they run against strong opposition from local communities, fisherfolk in particular.

For example, the Southwest Offshore Wind Power Project was planned as a large-scale project installing a 2 GW offshore wind power generation complex in the coastal waters of Buan and Gochang to be completed by 2018, but only by 2017 was it possible to start building its 60 MW testbed. The project's demonstration site was narrowly completed at the end of 2019.[45] The proposed Ulsan Southeast Coast Offshore Wind Project, which had plans to install 28 units of 7 MW wind turbines on Ulsan's Gangdong Coast, applied for an electricity generation business license in 2017, but due to community opposition, was unable to obtain this license until September 2018.[46] The fisherfolk are concerned with damage to the ocean habitat due to noise or vibrations, the effects of the magnetic field from

42. When trees are moved for the installation of solar PV facilities, the permit application can be rejected based on concerns of damage to the natural landscape and occurrence of landslide disaster (Uijongbu District Court Decision 2017 Correction 11324, Apr 17, 2018), and in the case of installation on farmland, there have been cases of rejections based on the groundsthat the installation does not harmonize with the local environment or landscape (North Chungcheong Province Administrative Court, Oct 20, 2016 Decision, Case No. 2016-232). (Lee So-young, Korea's Energy Transition: Perspectives and Issues, "Issues Related to Permits for Development Activities", 2019, 209-213).
43. Ahn Se-woong, Lee Hee-sun, Korea Environment Institute, Analysis and Countermeasures for the Environmental and Social Problems from Solar PV and Wind Complexes' Development, Volume 10, Issue 3, 2011, 9.
44. Lee Jeong-pil, Energy & Climate Policy Institute, ENERZINE FOCUS, Issue 72, "How do we resolve renewable energy conflicts –a review of environmental technology, public participatory, and profit-sharing approaches", 2016, 5.
45. Cho Seong-gu, Korea Energy News,"Fair Winds for Offshore Wind Power Testbed Project in Southwestern Sea", Jun 17, 2019; Korea Offshore Wind Power Homepage, http://www.kowp.co.kr/data/news.asp, Accessed Jan 13, 2020.
46. Kim Sang-a, Ulsan Maeil,"SK E&C, Gangdong 'Southeastern Sea Offshore Wind Power Project' Passes Review and Takes First Steps", Oct 3, 2018.

the power lines on spawn, and the subsequent decrease in income due to the reduction in their catches.

In such a situation, there was high anticipation that with the introduction of a maritime spatial planning system, through a systematic and ex-ante planning system, energy development zones would be designated in advance and there would be an opportunity to increase public acceptance. However, according to the current status of the designation of maritime zones, there are increasing concerns that by avoiding areas with fishing rights, no zones will be designated for energy development, and this would act as new siting regulations in the future.

3. Discussion on Policy Alternatives

While the problems with siting regulations and permitting process for renewable energy have long been pointed out, they are not being solved, and as highlighted earlier, regulations are instead being strengthened recently. Accordingly, for the expansion of renewable energy supply, alternatives including a planned siting system that focuses on the building of a large-scale renewable energy complex led by the national or local governments, the institutionalization of public participation, and resident-led renewable energy projects which go beyond mere profit-sharing are being discussed.

Strengthening Pre-Planning through the "Planned Siting System"

Of particular interest in the "Renewable Energy 3020 Implementation Plan" presented in December 2017 was the introduction of a "planned siting system" to stop reckless development. According to its initial design, the planning siting system refers to a site planning procedure in which a municipality identifies potential sites by inviting neighbourhood participation and when the community's acceptance has been confirmed, such as through the agreement of the community representative, a private renewable energy producer to be located in that area is publicly procured.[47] It is expected that the new system's introduction would systematically increase renewable energy generation by alleviating difficulties in site selection, which were often considered obstacles to the spread of renewable energy while dispelling local residents' concerns over the indiscriminate introduction of renewable energy facilities. Despite these plans, relevant laws have not been revised yet.[48]

For the successful implementation of such system, the role of local governments, which have authority over utility business licenses as well as permissions for development activities for generation projects of 3 MW or less, the majority of which are renewable energy facilities, should be concretely specified in addition to specific policy means, such as incentives for participating in a planned siting system. Additionally, there are views that Korea, to strengthen its prior planning, should refer to cases like Germany, which uses policy means for space planning, including city management planning and land use planning, and also requires the inclusion of renewable energy facility plans when planning cities.[49]

Institutionalization of Public Participation

To increase public acceptance for renewable energy projects, there was a revision to the REC scheme to give preferential treatment to resident-participatory model power stations starting from January 2017. For solar PV power stations with a capacity of at least 1 MW and wind power stations of at least 3 MW in capacity, if the participation rate from local residents is 10% (20%) of the equity capital and 2% (4%) of the total equity, an additional 10% (20%) of the REC weighted value is added. In addition, when bidding for the SMP+REC fixed price, extra points will be awarded to power stations with resident participation. In 2018, in the case of solar PV stations, the threshold was lowered to 500 kW or higher, and the types of participation expanded from the equity investment type to include bond and fund types.

However, it is not easy to spread the public participatory REC incentive model in the case of wind power, in which 10% of the capital and 2% of operating expenses both reach

47. Ministry of Trade, Industry and Energy, Renewable Energy 3020 Implementation Plan, Dec 2017, 4-10.
48. An amendment bill chief authored by National Assembly Member Eoh Kiyku in February 2018 tried to abolish local governments' separation distance regulations and realize a planned siting system, but this bill is still pending in its pertinent committee.
49. Lee Chang-hoon, Cho Ji-hye, Yoon Jeong-ho, Korea Environment Institute Environmental and Economic Competitiveness Assessment of Alternatives to Fossil Fuels (II): with a Focus on Renewable Energy Generation Sources, 2014, 106-107.

hundreds of millions of won, making it difficult for the local community to make those investments.[50] In addition, such preferential REC weight is inconsistent with the trend of declining renewable energy generation costs worldwide, and there continues to be criticisms that this model is still far from the ideal of building a distributed energy system through communities' voluntary interest and participation.

Recently, there have been efforts to institutionally ensure the sharing of relevant information and the community's participation in the decision-making process before deciding to pursue a renewable energy project. In addition, there are views that there needs to be a framework for renewable energy producers and the local community to communicate and negotiate,[51] as well as detailed means and methods in the New and Renewable Energy Act on how to mediate and resolve on-site siting conflicts.[52]

Profit-sharing Schemes and Resident-led Power Generation Models

Devising and then institutionalizing a way for local residents together with renewable energy producers to own and enjoy the profits made from sunlight and wind is often referred to as a policy alternative that raises public acceptance and contributes to the decentralized energy system pursued by renewable energy. Currently, there are diverse profit-sharing plans, such as citizen funds and people's power stations, in which the majority of citizens participate in, as well as community cooperatives, town corporate bodies, and local public energy enterprises led by local governments, that are being discussed.

The most pioneering region in terms of profit-sharing schemes is Jeju Province. In Jeju, wind resources are considered shared resources in the development process of wind power generation complexes. The logic behind the so-called "public concept of wind power," in which usage fees for wind resources must be paid to Jeju provincial residents, thus returning development gains to the community, was thus developed. Accordingly, an ordinance has been enacted requiring the donation of a fixed share of sales or net profit to the province for all onshore wind power projects. A policy under which offshore wind is to be pursued by Korea's first local public energy enterprise founded with investments in kind was established.[53] In May 2018, Sinan County of South Jeolla Province became the first local government after Jeju Province to enact an ordinance that would require the sharing of profits of renewable energy development between utility businesses and the community through local residents' equity participation.[54] However, there are negative views on introducing additional profit-sharing arrangements since compensation schemes, such as the construction of community power generation facilities, establishment of funds, have already been implemented in the existing power generation project process.

In that regard, the energy cooperative model driven by the local community, which has successfully taken root in Germany and other European countries, is mentioned as an ideal business model that increases public acceptance beyond profit-sharing schemes. Such models can grow through a combination of unprecedented policy support from the government and local residents with a special perception of the environment and energy, and a combination of financial services.[55] In the German case, the number of energy cooperatives increased from 272 in 2010 to 855 in 2017.[56]

Even in Korea, energy self-sufficient villages, such as Seongdaegol[57] have established themselves as successful people-led models in urban areas. New models like the Seoul Citizens Sunshine Cooperative, an energy cooperative with membership participation, through which citizens can cooperate with public institutions (e.g. schools and government offices), cheaply lease spaces for renewable energy facilities and share their profits, are emerging. Expectations are high that vitalizing energy cooperatives in rural areas can be an alternative used to raise public acceptance and resolve farmers' income issues in the future.

50. Jeong Sung-sam, Lee Seung-hoon, Korea Energy Economics Institute, "Study on Building a Profit-Sharing System for Improving Acceptance of New and Renewable Energy", 2018, 12-13.
51. Lee Jeong-pil, Environment Law Center, 10th Environmental Law Forum,"Analysis of Renewable Energy Conflicts and Recommendations for Renewable Energy Guidelines", Jul 2, 2018.
52. Lee So-young, ibid, 217.
53. Kim Dong-ju, Exploitation of Nature and Wind Power Generation, Environmental Sociology Research, ECO, Volume 19, Issue 1, 2015, 251.
54. Sinan County, Ordinance on the Sharing Development Profits of Sinan County's New and Renewable Energy, 2018.
55. Lee Cheol-yong, Kim Min-ji, Korea Energy Economics Institute, Issue Diagnosis, "Case Studies and Improvement Measures of Public-Participatory Renewable Energy Projects", 2015
56. Sascha Görlitz, German Cooperative and Raiffeisen Confederation, "The Role of Energy Cooperatives in the German Energy Transition", Jul 2018.
57. Money Today, "'Seongdaegol Village' Opens the Sustainability of Energy Self-Sufficient Villages", Oct 8, 2018.

Issue 3: Power Market and Pricing

1. Limitations of Renewable Energy Expansion Policy through RPS

For the expansion of renewable energy supply, Korea introduced a FIT system from 2002, but this system was changed to an RPS system in 2012. Under the RPS system, electricity generation businesses with 500 MW or more in generation facilities are required to supply a minimum fixed ratio of total generation from renewable sources. As of 2019, obligated suppliers are KEPCO's six power generation subsidiaries, two public institutions, and 14 private companies, reaching a total of 22 entities.[58] The current percentage of mandatory supply from renewables in 2020 is 7% and is targeted to reach 10% by 2023.

Electric utility generation businesses that are subject to RPS can construct new and renewable energy generation stations themselves (self-financing) or meet their supply obligations through the purchase of a renewable energy certificate (REC) (external financing) from the REC market. The REC market can be divided into the spot market and contract market (self-contract, selection contract) (see Table 8). The spot market opens twice a week under the supervision of the Korea Power Exchange, and prices are decided when sales contracts are concluded according to REC demand and supply. Relatively large renewable facilities of 500 kW or more participate in the self-contracts conducted by electricity generation businesses. Selection contracts are conducted by the Korea Energy Agency and take place through a bidding competition at a fixed price. Such REC sales become an additional source of income for renewable energy producers (REC weights can be found in Appendix 3).

Uncertainty of Market Prices and REC Costs

Because revenue for renewable energy producers is decided by the variable SMP and REC under the RPS system, the system's drawback is that the financial uncertainty for renewable energy producers increases more than it does under the FIT system. Renewable prices

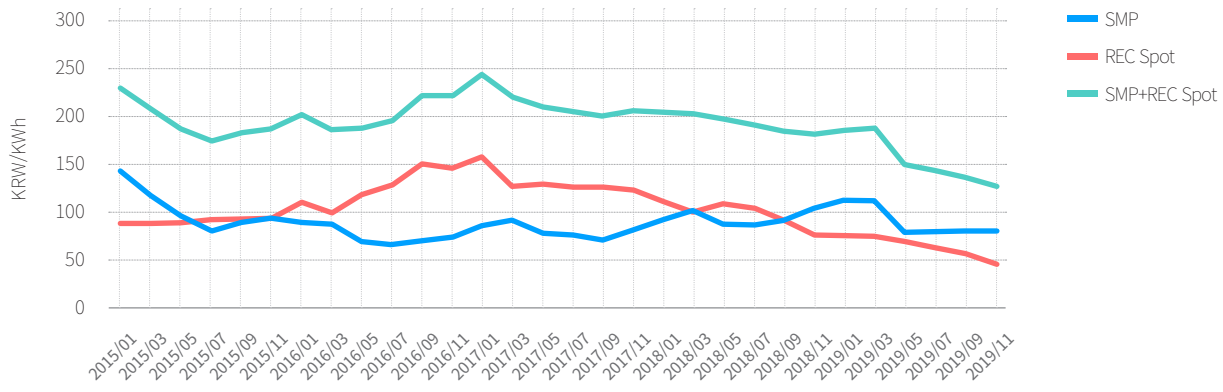
Table 8. RPS Obligations and Fulfilment by Year

Category		2012	2013	2014	2015	2016	2017
Required Supply (thousands of RECs)[a]		6,420	10,897	12,905	13,839	16,970	18,974
Fulfilled Supply (thousands of RECs)	Self-construction	1,727	2,930	5,486	6,161	7,061	7,031
		(41.6%)	(40.0%)	(54.4%)	(49.4%)	(46.0%)	(39.9%)
	Self-contract	2,124	3,664	3,322	3,383	4,674	5,629
		(51.1%)	(50.0%)	(33.0%)	(27.1%)	(30.4%)	(31.9%)
	Selection contract	120	220	507	937	1,277	2,238
		(2.9%)	(3.0%)	(5.0%)	(7.5%)	(8.3%)	(12.7%)
	Spot	184	511	763	1,993	2,343	2,728
		(4.4%)	(7.0%)	(7.6%)	(16.0%)	(15.3%)	(15.5%)
	Total fulfilled supply	4,154	7,325	10,078	12,474	15,355	17,625
Fulfilment Rate (%)		64.7%	67.2%	78.1%	90.2%	90.6%	92.9%
Fulfilment Cost (hundred million KRW)[b]		1,476	4,150	6,591	10,421	13,010	15,650
Average Cost of Obligations	KRW 1,000/REC or KRW 1/kWh	35.5	56.6	65.4	83.5	85.1	88.8

a) Required supply is the sum of the required supply per year and the previous year's delayed fulfilment supply
b) Fulfilment costs are cited from the National Assembly Research Service (Park Yeon-su, National Assembly Research Service, "RPS Improvements and Tasks", 2018)

58 Ministry of Trade, Industry and Energy, "Announcement on 2019 Mandatory Supply by Supplier", Jan 31, 2019, 1.

Figure 5. Trends in Price Changes of SMP (Combined SMP) and REC Spot (for Solar PV)



Source: SMP – Electric Power Statistics Information System, REC Price – KPX New & Renewable Energy One-Stop Project Information Portal.

have varied depending on SMP and REC prices, and this impedes stable cash flow, which is often the basis for decisions to invest in renewable energy and is a cause of hindering the market entry of new producers.[59]

To overcome such issues, for a portion of RPS solar PV capacity, MOTIE required electricity generation businesses subject to RPS to enter into long-term purchase agreements of around 20 years at a fixed price derived from adding up the SMP and REC, starting from 2017. In addition, to support small-scale solar PV producers, a FIT system to be run for five years was temporarily introduced in July 2018,[60] and by the end of 2018, a total of 3,056 facilities accounting for 227 MW (of which agro-livestock farmers and fishers accounted for 76.2%) applied for participation.[61]

Recently, due to an increase in renewable energy facilities, small-scale producers' REC supply is increasing, causing the REC price to fall. Thus, securing REC revenue through the spot market has become difficult. Accordingly, competition in the fixed-price contract market through the Korea Energy Agency is intensifying.[62] Producers are thus facing difficulties in establishing long-term plans as the REC price's range of fluctuation has increased due to the policy and market changes under the current RPS structure.

Market Inefficiencies from Giving REC Supply Obligations to Power Generating Companies

Under the existing RPS system, power generating companies are participating in the market as consumers with obligations to secure RECs, while simultaneously playing the role of REC suppliers by constructing renewable energy facilities. As for the obligation fulfilment costs for obligatory suppliers, the Korea Power Exchange calculates the standard REC price and according to that price, covers those costs, and KEPCO pays the final corresponding expenses. Therefore, they have strong motivation to simply secure RECs at a moderate price to fulfill their supply obligations rather than trying to secure RECs at the cheapest prices.[63] Fulfilment costs have been increasing each year, reaching KRW 1.565 trillion in 2017, and average fulfilment costs have continued to increase (Table 8).

59. Korea Energy Agency, "Weekly Issue Energy Briefing No. 145", Aug 26, 2016, 3-4.
60. In 2018, the FIT system allowed on a semi-annual basis for general businesses (with less than 30kW) and cooperatives or farmers and fishers (with less than 100kW) to have SMP+REC contracts at a fixed rate for 20 years with the highest average successful bid price set as the purchase price (Guidelines for managing and operating the obligation to supply renewable energy and the obligation to mix fuels, Article 10-2, Implemented May 16, 2019).
61. Woo Jae-hak, National Assembly RPS Market Diagnosis Debate Presentation Material, "RPS Outcomes and Policy Directions for the Future Support of Renewable Energy Supply" (New & Renewable Energy Center RPS Department Head), Mar 7, 2019, 21.
62. Kim Ye-ji, Electric Times, "REC Falling with No End in Sight…Government Working to Prepare Countermeasure", Nov 5, 2018.
63. Lee Seok-ho, Cho Seong-min, Korea Energy Economics Institute, "Introduction of an Auctioning System for the Improvement of the New & Renewable Energy RPS System", Policy Issue Paper 18-10, April 30, 2018, 19-20.

2. Insufficient Support for Renewable Energy Projects

Granting of Subsidies for Non-Renewable Energy

While the expansion of solar PV and wind generation in Korea has been driven by the RPS system, the same system is also subsidizing fossil fuels. The current RPS system targets both new energy and renewable energy sources as recognized by the New and Renewable Energy Act. Thus, non-renewable energy sources, including IGCC (which is merely the more efficient use of fossil fuels), fuel cells, non-renewable waste energy, and imported wood pellets (bioenergy), account for roughly half of issued RECs (Table 9). An amendment to separate new energy, such as IGCC and fuel cells, from renewables was proposed in 2019 and is pending in the National Assembly, but whether it will pass remains unclear.[64]

Insufficient Subsidies for Solar PV and Wind

Meanwhile, subsidies for solar PV and wind are insufficient. In the early stages of RPS implementation, to protect the promotion of the solar PV market, which has relatively high generation costs, MOTIE required separate supply obligations for solar PV. However, as the cost of solar PV generation fell, there were criticisms that this separation was instead hindering solar PV generation. Thus, starting in 2016, the solar PV and non-solar PV markets were operated together. Since then, it has been difficult to find any dedicated measures to fostering solar PV and wind. This is apparent in the weighted values applied when issuing RECs. When solar PV and wind are linked to ESS, they can receive a high weighted value, but when they are not, their weighted value is lower than that of fuel cell, tide, and biomass energy.

Issues with the REC Decision-making Process

This system is maintained due to an unreasonable and opaque REC decision-making process. According to regulations related to the New and Renewable Energy Act, MOTIE must consider a variety of elements, such as effects on the environment, technology development and promotion of industry, generation costs, energy potential, effects on greenhouse gas emissions reductions, effects on stability of power supply, public acceptance, and the minister must decide and announce these weighted values (New and Renewable Energy Act, Article 12, Paragraph 7, Subparagraph 3; Enforcement Decree of theAct, Article 18, Paragraph 9). However, it is known that in reality, consideration of generation costs is the biggest factor. Consideration of generation costs accounted for 70% of the weighted value in the first revision process in 2015 and 54% in the second revision in 2018.[65]

In particular, in June 2018, as MOTIE finalized an amendment

Table 9. Current Status of RECs Issued by Sector (Unit: REC)

Year	Solar PV	Wind	Hydropower	Fuel Cells	Bioenergy	Waste	IGCC	Total
2012	118,110	99,569	1,457,600	134,131	196,022	123,502	-	2,128,934
2013	646,562	241,411	1,706,906	807,865	1,037,430	195,561	-	4,635,735
2014	1,742,651	347,388	1,094,873	1,758,103	4,035,496	324,973	-	9,303,484
2015	3,469,276	566,064	952,180	2,078,698	4,963,190	389,596	-	12,419,004
2016	4,713.031	977,621	1,182,648	2,170,092	5,855,361	467,915	68,753	15,435,421
2017	6,705,068	1,639,088	1,234,982	2,826,404	7,607,324	567,421	223,877	20,804,164
2018	9,864,195	1,965,596	1,418,243	3,413,541	9,392,164	580,064	259,961	26,893,764
2018 (%)	36.7	7.3	5.3	12.7	34.9	2.2	1.0	100

Source: MOTIE data submitted to the National Assembly

64. Bill on a partial amendment to the New & Renewable Energy Act; bill chief authored by National Assembly Member Kim Sung-whan (Bill No. 20564)
65. Samjong KPMG, data from public hearing on improvements to the RPS system, May 18, 2018.

to part of the RPS mandate, there was criticism that there was a problem with the REC weight adjustment process. It was pointed out that the reasons for revising the weights and process were not transparently disclosed to the public and that the Ministry conducted bureaucratic decision-making, failing to consider the field conditions by excessively relying on a certain accounting firm's analysis. Additionally, disputes about the fairness of REC weights by energy source have cropped up, including maintenance of the status quo for weights where large companies are involved, such as fuel cells or ESS, and various grace conditions in the case of biomass weights.[66]

3. Discussion on Policy Alternatives

Securing Transparent Subsidy Sources

The New and Renewable Energy Act stipulates that the government covers additional costs from entities' fulfilment of RPS obligations through the power market at an appropriate level of compensation, and that electricity sellers reflect those costs in electricity prices, recovering those costs through electricity bills (Enforcement Decree of the New and Renewable Energy Act, Article 18, Paragraph 11). However, because the costs of RPS fulfilment have not been separately disclosed in electricity bills so far, electricity seller KEPCO claims that it is bearing RPS fulfilment costs.[67] Referring to overseas examples, there are views that a special clause should be created that links RPS fulfilment costs to electricity prices and also suggests to utilize funds created by a special energy account for energy transition costs.[68]

Achieving Cost Competitiveness through the Introduction of a Competition-Based System

As discussed earlier, there are market inefficiencies regarding renewable energy generation obligations due to the fact that renewable suppliers and consumers are the same entities in Korea. A structure needs to be established in which entities subject to RPS do not simply settle for the stable procurement of RECs as consumers but induce reductions in generation costs and strengthen capacity for renewable energy generation as suppliers. As can be seen in the renewable energy supply obligations of other countries, it can be an alternative to impose these obligations on electricity sellers. This is because we can expect that the sellers will try to purchase renewable energy electricity inexpensively from power generating companies in order to minimize the increase in power retail charges. As a result, power generating companies will have an economic incentive to minimize the cost of supplying new and renewable energy.[69]

Renewable energy auctioning is also a policy alternative currently being considered by the Korean government.[70] Countries that have achieved quantitative growth in the development of renewable energy through FIT and RPS systems are increasingly introducing auctioning methods. The United Kingdom and Germany, for example, have introduced auctioning, thus, inducing competition between power generating companies with successful bidders entering into long-term fixed-price contracts. If entities subject to RPS can purchase RECs at a low price through such methods in Korea, RPS fulfilment costs can be reduced. In addition, if the possibility of finance raising from long-term contracts increases, we can expect the unit cost of generation to fall through power generating companies' active participation in investments. Currently, while there are diverse markets as suggested in Table 8 (spot, self-contract, fixed-price bidding contract) in which RECs are being transacted, a unified and systematized auctioning market must be made to expand the scope of auction applications.[71]

Expansion of Renewables Through Liberalization of the Power Market and RE100

As the RE100 movement, which aims to cover 100% of electricity required for company activities through

66. Lee Jae-wook, E2News, "REC Weight Adjustment Plan Exposed as Rags", Jun 11, 2018.
67. Joo Hye-rin, Newsway, "KEPCO, Emergency Management for the 2nd Consecutive Year…Looking at the KRW 2 Trillion Deficit", Feb 13, 2019.
68. Song Yoo-na, National Assembly Debate Facts & Figures, "Issues with the Moon Jae-in Administration's Renewable Energy 3020 Plan and Public Alternatives", Aug 13, 2018.
69. Lee Seok-ho, Cho Seong-min, ibid, 36.
70. MOTIE, with the intent of reducing renewable energy generation costs, has plans to amend relevant rules to expand competitive bidding centering on large-scale solar PV and conduct demonstration projects from the second half of 2020 (Ministry of Trade, Industry, and Energy, "Public Notice on the 2020 Implementation Plan for New and Renewable Energy Technology Development, Use, and Diffusion", Feb 27, 2020, 8).
71. Lee Seok-ho, Cho Seong-min, ibid, 34.

renewable energy, is spreading internationally, global companies have been purchasing renewable energy through self-generation (35.5%), purchase of renewable energy certificates (30.0%), PPA procurement (24.5%), green pricing (7.3%), and other methods (4.7%).[72] However, even if companies in Korea want to achieve RE100 targets, the country is not equipped with the systems and infrastructure needed to meet these goals. There are discussions of introducing additional alternatives, including the introduction of green pricing, to guarantee businesses the right to choose renewable energy.[73]

However, the green pricing being pushed by the current government is being criticized for the fact that even if consumers pay additional fees, they will still be using the same electricity as before and that it does not guarantee the actual expansion of renewable energy facilities. There is high demand to allow the establishment of power purchase agreements (PPAs) between renewable energy suppliers and electricity consumers in order to expand the demand and supply of renewable energy in a forward-looking manner. The Third Energy Master Plan includes plans to review such a proposal for renewable energy producers to sign PPAs with companies.[74] Discussions on the introduction of PPAs are expected to take place in the future.

72. Kim Ye-ji, Electricity Times, "To Achieve RE100, 'We need PPAs with Businesses, not KEPCO'", Mar 6, 2019.
73. Bill on a partial amendment to the Electric Utility Act, bill chief authored by National Assembly Member Lee Won-uk (Bill No.14135); bill on a partial amendment to the Electric Utility Act, bill chief authored by National Assembly Member Kim Sung-whan (Bill No. 21700)
74. Ministry of Trade, Industry and Energy, Third Energy Master Plan, 2019, 42.

Issue 4: Demand-side Flexibility / Innovative Energy Services

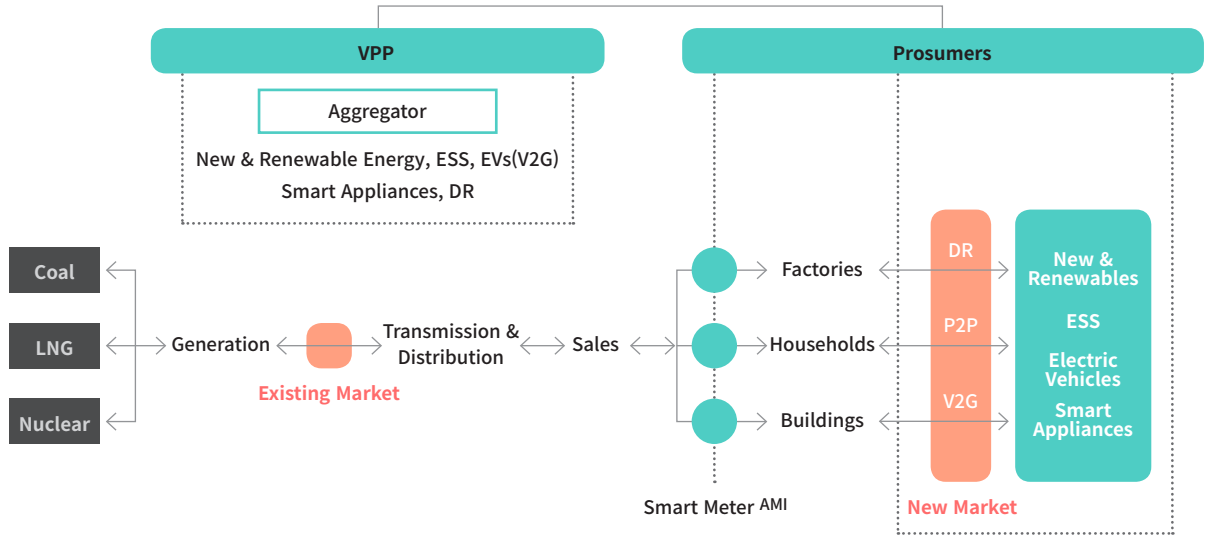
1. Expectations of Renewable Energy and the Emergence of Prosumers

In preparation for the entry of many small-scale producers into the power market with the expansion of renewable energy, efficient energy market operations using information and communications technology (ICT) is attracting attention. In the future, the power grid will change its operation method and market mechanism from the existing one-way operation method to a two-way or multidirectional operation method. The grid, which had previously focused only on supplying electricity produced from large-scale power stations over long distances through a transmission network in one direction, is transitioning into a role of a negotiating platform in which producers and consumers can mutually communicate.

The increase in distributed renewable energy signals the age of the energy prosumer, in which the distinction between energy consumer and producer disappears, and production and consumption are carried out simultaneously. In the age of the energy prosumer, various new business models will emerge, including net metering, which allows consumers to efficiently use surplus power, surplus power sales within the same distribution network (energy transactions between neighbours), peer-to-peer (P2P) transactions using the Internet, and an intermediary market for distributed energy resources.[75]

In addition, with the rise in the use of electric vehicles, the vehicle-to-grid (V2G) system, which connects electric vehicles' batteries to the grid, is receiving attention. V2G is a system that allows the sale of battery power to the grid or households during peak hours, and thus, power companies can reduce investments in surplus power facilities for peak hours, and electric vehicle owners can participate as prosumers and increase their income. The idea of contributing to supply stability in the wholesale power market through a virtual power plant, which enables such diverse renewable energy generators and batteries, V2G, P2P systems at the distribution level to be connected and managed by a central system using ICT, is also being discussed.

Figure 6. New Energy Sources and Supply-Demand System



Source: Startup4, May 23, 2018[76]

75. Lee Yoo-soo, Kim Ji-hyo, Korea Energy Economics Institute, "Research on System Improvement Measures for Catalyzing Energy Prosumers", Research Report, Nov 2016.
76. Jeong Man-ki, Startup4, "An Opportunity for New Energy Industries", May 23, 2018. http://www.startup4.co.kr/news/articleView.html?idxno=10691#0BOf.

2.Slow Growth of New Energy Services

Prosumers' Surplus Power Exchange Market (Net Metering, P2P)

Net metering is a power trading method that backfeeds power to KEPCO and deducts this from the used power rate. This method allows for the easy use of distributed resources without going through complex procedures. Surplus power after net metering can be rolled over and used. As part of the government's policy for the expansion of prosumers, permitted capacity allowed for net metering of small-scale distributed resource generators grew from 5 kW or less in 2005 to 10 kW in 2012, and eventually 1 MW in October 2016.[77] This was intended to incentivize the installation of renewable energy in large buildings, hospitals, and schools. The Renewable Energy 3020 Implementation Plan, for the expansion of prosumer businesses, includes plans to allow remaining power after net metering to be sold to KEPCO,[78] and currently, an amendment bill to the Electric Utility Act on this matter has been proposed and is pending in the National Assembly.[79]

P2P (peer-to-peer) systems, in which power is shared between individuals, are systems which allow individuals to freely trade power online using the Internet, and its introduction is being delayed as well. In 2016, MOTIE permitted transactions between neighbours for small-scale solar PV facilities (10kW or less) through the establishment of guidelines on transactions for small-scale new and renewable energy-generated power and pursued a demonstration project. However, these transactions do not constitute actual P2P trading. In the same distribution network, KEPCO fulfills the intermediary role for transactions and calculates the electricity rate. Afterwards, the guidelines were revised to expand the scope of allowed trading to cover solar PV facilities of 1,000 kW or less, but this has not actually stimulated trading.[80]

At present, the progressive stage system was reduced to three stages, and with renewable energy generation costs higher than electricity prices, there is insufficient motivation for individuals to trade with each other.[81]

Power Intermediaries and Virtual Power Plants (VPP)

Power intermediaries aggregate small-scale renewable energy power stations and manage their surplus energy efficiently in a joint manner. In Korea, in 2016, the introduction of a system for small-scale power intermediaries was announced as a promotion measure for new energy industries. The amendment to the relevant Act was realized only in June 2018, and in December of the same year, lower statute arrangements, such as enforcement decrees, were established.[82] Thus, the power produced by renewable energy of 1 MW or less, energy storage devices, and electric vehicles can be aggregated by the power intermediary and traded on the power market. In addition, it appears that virtual power plant models, which aggregate many distributed energy resources and build a system, will be able to be commercialized in the near future.[83] When such projects become active, small-scale power resources can be efficiently managed, allowing power grid stability to increase. However, as no rules compensating efficiency improvements have been established, actual business performance is low, with only eight of 40 businesses that have been registered as intermediary operators having entered into deals during 2019.[84]

Demand Response Market

Demand Response (DR) responds to inducements such as incentives for reducing consumers' consumption and a pricing system that differs depending on the time of day. DR has the effect of transferring maximum load through the suppression of maximum demand with users changing their level of consumption from regular consumption patterns.

77. Ministry of Trade, Industry and Energy, "Solar PV Capacity that Can Receive Electricity Bill Reductions Expanded to 1,000 kW (Press Release), Sep 10, 2016.
78. In 2017, the Seoul region had 37 MW of power facility capacity engaging in power intermediary trading, and the leftover power after intermediary trading from these facilities reached 3,737 MWh. This intermediary trading accumulates more household generation than consumption, and in the current system, consumption is subtracted from the monthly aggregated amount; Lee Yoo-soo, Kim Ji-hyo, Korea Energy Economics Institute, "Research on System Improvement Measures for Catalyzing Energy Prosumers"(Research Report), Nov 2016.
79. Bill on a partial amendment to the Electric Utility Act chief authored by National Assembly Member Lee Hoon (Bill No.16569).
80. Kim Min-kyeong, Lee Yoon-hye, ibid, 14.
81. Lee Yoo-soo, Kim Ji-hyo, ibid, 4.
82. Ministry of Trade, Industry and Energy, "Small-scale Power Intermediary Project Implementation to Begin in Earnest" (Press Release), Dec 12, 2018.
83. Woori Finance Research Center, "Future Development Directions of Small-scale Power Intermediary Markets", Apr 5, 2019.
84. Lee Kyung-min, Electronic Times, "Small-scale Intermediary Operators Are Actually 'Open Without Any Business'", Dec 9, 2019.

In Korea, from 1995, according to the Energy Use Rationalization Act, a system of 'Energy Suppliers' Demand Management' (Article 9) has been operated, and from 2014, a DR market allowing trading of saved resources has been operated. The demand response market can be divided into the economic DR (rate-saving DR) and the reliability DR (peak reduction DR) markets.[85] Rate-saving DR (economic DR), which relies on voluntary participation, allows bidding on day-ahead prices for demand reduction capacity, and the successful bidders receive payment for their reductions. Peak reduction DR (reliability DR) occurs when there are orders for demand reduction. Since the establishment of the market in 2014, the distributed resources market's capacity has increased approximately 2.8 times to 4.2 GW, and by the first half of 2018, through demand response trading, a total of 899 GWh in power was curtailed.[86]

However, with usage performance falling by half in 2017 compared to 2016, expansion of the DR market is in a faltering situation. Conditions for recognition of demand resources are quite difficult to meet. Thus, there are many problems related to the market not actually being activated. Even with significant potential capacity, it is difficult to enter the demand response market, and even in cases of registered demand resources, due to political issues, the market is not used even during peak power use hours. In addition, there are criticisms that because the costs expended for the demand response market are too high, benefits from the avoidance of electricity production are exceeded.

Recently, for the stimulation of demand management, there have been ongoing attempts to introduce a "citizens' DR" in which small-scale power consumers, such as shops, residences, and buildings, can participate. Approximately 45,000 households participated in the "citizens' DR" pilot project that was conducted from June to December of 2018 and carried out demand-response transactions for smart air conditioning equipment with peak management functions.[87]

5.3. Discussion on Policy Alternatives

In 2013, the Korean government first established its Smart Grid Implementation Plan and started to build the foundations for the introduction of new energy services, including the dissemination of advanced metering infrastructure (AMI). In August 2018, the government presented the Second Smart Grid Implementation Plan (2018-2022),[88] announcing an investment of KRW 2.5 trillion over five years and plans to enhance the national power system, develop technology for the expansion of diverse future power services (seasonal-hourly rates, business models based on big data, and implementation of power brokerage businesses), and build a smart-grid experience complex.

However, in Korea, with factors including a structure in which KEPCO has a monopoly over information on power use and low electricity prices, it is difficult to anticipate private-sector investments and experimentation in innovative additional services. Consumers can only passively accept power services from a monopolistic company, and there are no incentives for prosumerisation through the installation of renewable energy facilities. Thus, the introduction of an electricity rate system that is tied to production costs and changes depending on the power supply, transparency of data on power usage needed for the development of additional services, and of course, liberalization of the power retail market are being discussed as policy alternatives.

85. Economic DR, which participates in the power market as an equal to the generator and by operating by winning bids through price competition with generation fuel costs, has a lowering effect on SMP. Reliability DR, when the power markets' reserve power is reduced through the worsening of a supply situation, instead of running an expensive generator, demand response registered in advance will get reduction orders. Procurement of grid operation reliability and avoidance of new investments into future peak generators through the securing of reserve power are among the main aims of reliability DR; Jeong Yeon-jae, Kim Nam-il, Korea Energy Economics Institute, "Analysis on Effects of Participating in the Demand Response Market", 2015, 12.
86. Korea Energy Agency, "Demand Response Market: Current Operation Status and Insights", Feb 2018, 2.
87. Ministry of Trade, Industry and Energy, "Now You Can Sell the Electricity Saved at Home –Conducting Small-scale Demand Response (People's DR) Pilot Project"(Press Release), May 25, 2018, 2.
88. Ministry of Trade, Industry and Energy, "Second Smart Grid Implementation Plan (2018~2022)", 2018, 1-7.

Appendix 1. Classification of New and Renewable Energy According to the New and Renewable Energy Act and Comparison with IEA Definition

Category	Energy Source	Details	Korea	IEA
New Energy	Hydrogen energy		○	×
	Fuel cell		○	×
	Energy from liquified or gasified coal and gasified vacuum residue		○	×
	Other new energy		○	
Renewable Energy	Solar	Solar PV, solar thermal	○	○
	Wind		○	○
	Hydropower		○	○
	Marine energy		○	○
	Geothermal energy		○	Partly*
	Bioenergy	Biogas, biodiesel, black liquor, Bio-SRF, etc.	○	○
	Waste energy	Waste gas	○	×
		Industrial waste	○	×
		Municipal waste	○	Partly**
		Cement kiln fuel	○	×
		SRF	○	×
		Refined fuel oil	○	×
	Other renewables	Wastewater heat energy	○	×
		ESS	○	×

*Geothermal power generation only is included.
** Recyclable waste only is included.

Source: Cho Sung-min, Korea Energy Economics Institute, Comparative study of the classification criteria of the renewable energy – with a focus on the comparison with the IEA standard, Sep 28, 2018, 13

Appendix 2. Overview of the Licensing Procedures for Renewable Energy Facilities

Phase	Solar PV	Wind
1. Siting review	- Review of installation requirements - Review of grid connection - Consultation with landowners	- Review of wind conditions and installation requirements - Review of grid connection - Consultation with land (or fishing ground) owner - Installation of a wind vane device and resource measurement *In the case of offshore wind, review of energy development areas needed
2. Review of project feasibility	- Micro-siting - Feasibility analysis	- Micro-siting - Feasibility analysis
3. Utility business license	- Finalization of business plan and basic design	- Finalization of business plan and basic design - Local government and consultation related to public acceptance
4. Application for grid connection	- In the case of projects of 1 MW or less, PPA registration and application to use electricity facilities for transmission and conclusion of contract	- Application to use electricity facilities for transmission and conclusion of contract
5. Design of generation complex	- Finalization of machinery and structural specifications, structural evaluation - Detailed design	- Access roads and detailed designs related to installation of generator
6. Authorization	- When regulations require it, small-scale environmental impact assessment, advance review of influence on natural disasters - Permit for development activities and other authorizations (permission for using farmland/ mountainous districts)	- Environmental impact assessment - Permit for development activities and other authorizations *In the case of onshore wind power, permits to use mountainous districts, consultation on use of sites according to the State Forest Administration and Management Act *In the case of offshore wind power, an evaluation on radio wave impacts on the military (Ministry of National Defense), consultation on use of sea zone (Ministry of Oceans and Fisheries), safety inspection of offshore transportation (Ministry of Oceans and Fisheries), permit to use public waters (Ministry of Land, Infrastructure and Transport)
7. Construction of generation complex	- Engineering/electrical construction, structure production and installation - Completion inspection (local government) - Inspection of electrical installation (Korea Electrical Safety Corporation) - Confirmation for REC application (Korea Energy Agency)	- Installation and entry of generator, establishment of management road - Transmission routes and construction of substations - Completion inspection (local government) - Inspection of electrical installation (Korea Electrical Safety Corporation) - Confirmation for REC application (Korea Energy Agency)
8. Completion and commencement of operations	- Power station completion and commencement of commercial operations - Monitoring and follow-up environmental impact inspection (only for certain applicable businesses)	

Source: Korea Wind Energy Industry Association (http://www.kweia.or.kr/), Korea Solar System (http://koreasolarsys.co.kr/)

Appendix 3. REC Weight by New and Renewable Energy Source

Category	REC Weight	Energy and Criteria	
		Installation Type	Detailed Criteria
Solar PV	1.2	In the case of installation at a general site	Less than 100 kw
	1.0		Starting from 100 kW
	0.7		Over 3,000 kW
	0.7	In the case of installation in forest land	-
	1.5	In the case of using an existing structure (e.g. building)	3,000 kW and less
	1.0		Over 3,000 kW
	1.5	In the case of installation on a floating surface	
	1.0	In the case of trading power on private generation facilities	
	5.0	ESS facility (connected to a solar PV facility)	’18, ’19
	4.0		’20
Other New/Renewable Energy	0.25	IGCC, by-product gas, waste energy, Bio-SRF	
	0.5	Landfill gas, wood pellet, wood chip	
	1.0	Hydropower, onshore wind power, tidal power (with tide embankment), other bioenergy (e.g., bio heavy oil, biogas), in the case of trading power using private generation facilities	
	1.0~2.5	Geothermal, tidal power (without tide embankment)	Fixed type
			Floating type
	1.5	Hydrothermal, unused forest biomass multi-fuel facility	
	2.0	Fuel cells, tidal power, unused forest biomass (only applicable to bioenergy-only facilities)	
	2.0	Offshore wind power	Connection distance of 5 km and less
	2.5		Connection distance of more than 5 km and less than 10 km
	3.0		Connection distance of more than 10 km and less than 15 km
	3.5		Connection distance of more than 15 km
	4.5	ESS Facility (connected to wind power facility)	’18, ’19
	4.0		’20

Ministry of Trade, Industry and Energy, Partial Amendment to the Ministry of Trade, Industry and Energy Notice No. 2019-41, Mar 15, 2019.[89]

89. Ministry of Trade, Industry and Energy, Partial Amendment to the Ministry of Trade, Industry and Energy Notice No. 2019-41, Mar 15, 2019.

Not Yet Renewed

Challenges in Renewable Energy Transition in South Korea 2020

Publication date

March 2020

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