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South Korea's PPA System: Status and Opportunities for Renewable Energy Development

Research Report March 2024

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Executive Summary

This report outlines a comprehensive approach to overhauling corporate renewable Power Purchase Agreements (PPAs) in South Korea. It advises that, by adopting methods that align with international standards and practices, businesses will be encouraged to use more renewable electricity. This is expected to foster a supportive environment for sustainable and long-term growth through renewable energy (RE) usage.



The proposed measures aim to facilitate more active and beneficial corporate RE procurement through regulatory adjustments, market restructuring, and supportive policies.

The report specifically addresses the details of Korea's current renewable energy PPA system. Various issues that hinder the widespread adoption of corporate renewable energy uptake through PPAs in South Korea, which is a part of the corporate renewable energy scheme (K-RE100) introduced in January 2021, are also analyzed. Countries around the world are proactively using PPAs, allowing businesses to bypass the conventional power markets and directly purchase electricity from energy producers. As a result, businesses can cut costs, improve the stability of energy prices and support the development of renewable energy infrastructure. On the contrary, Korea's PPA scheme faces unique challenges primarily stemming from regulatory, financial, and market structure issues. This report focuses on three key obstacles: high ancillary costs, overlapping network usage fees, and opaque pricing policies. These barriers intertwine and collectively create a complex and unattractive environment for businesses interested in adopting RE solutions.

In addition, the report recaps the structure of the domestic electricity market as a significant hindrance to the adoption of the renewable energy PPA scheme. As competitive and dynamic PPA markets are activated in North America and Europe, energy markets are liberalized. On the other hand, in Korea, market flexibility and innovation are limited by the monopolistic presence of the Korea Electric Power Corporation (KEPCO). Such a unilateral structure makes it difficult for renewable electricity providers to supply energy in a stable and cost-efficient manner, which in turn creates an unfavorable atmosphere across the RE market. This poses a significant issue to businesses considering transitioning to renewable electricity through PPAs. In light of this, the report suggests a market reform to align Korea's renewable energy policies to successful foreign cases. The measures for the overhaul include regulatory adjustments to foster more competitive markets, structural reforms to reduce unnecessary costs, and incentives to make renewables more attractive and economically viable for companies.

Lastly, the report analyzes the effects of policy incentives that support the use of renewables through overseas examples. Countries with dynamic PPA markets provide incentives, including tax benefits, subsidies, and price guarantees, to incentivize the private sector's participation. Such incentives not only make financial cases for renewable electricity more compelling but also ensure that businesses secure stable and predictable energy prices, a pivotal point of consideration for long-term planning and investment.



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01

Overview of the Current Status and Issues of South Korea's Renewable Energy PPA Scheme

1.1 Literature Review and Research Objective

Since the inception of the 'Korean RE100 (K-RE100)' scheme in January 2021, numerous studies have been undertaken to promote corporate renewable electricity procurement in South Korea, aiming to expand the utilization of renewable energy in the country. (Solutions for Our Climate, 2021)[1] pointed at high ancillary costs, overlapping net usage fees, and opaque fee policies as the key factors hindering the activation of 'trilateral PPA (Power Purchase Agreement) systems' and suggested the government make longstanding efforts to stabilize the auxiliary costs. (Korea Power Exchange, 2022)[2] addressed a similar topic, analyzing the problems inherent in the settlement formulas in electricity market operation rules and offering solutions. (Solutions for Our Climate, 2022)[3] comprehensively covered all means of RE100 compliance, which are hindering companies from selecting adequate compliance methods, and set forth improvement directions from the aspects of accessibility, additional renewable energy, cost efficiency, transparency, and power market structure and governance. (Corporate Renewable Energy Foundation, 2022[4]) generally covered the concept of PPA, global PPA status, issues in domestic PPA systems, Korean power market and electricity tariff structures, transmission and distribution charges, and policy proposals to improve the PPA system. The research contents covered in the said previous studies and those in this report exhibit specific differences as detailed below.

This report first explains the structural differences between North American and European power markets, which are used to lay out the general concept of PPAs. It examines the domestic renewable energy PPA system, which has different classification criteria of typical PPAs, and analyzes the problems of Korean electricity market and electricity fee determination structure. Furthermore, it studies new examples of renewable energy PPA incentive policies being implemented overseas to increase the share of renewables, with a focus on introducing new systems such as energy banking models, in addition to network usage fee discounts or exemptions covered in existing research. Lastly, the report reiterates the aspects of domestic PPAs pointed out in previous research that have not yet been improved, with an aim to present directions to improve the market-structural issues regarding 'direct PPAs' and long-term enhancements in the Korean power market.

1 Solutions for Our Climate, "RE100 Scheme Left Stranded, with Focus on High Network cost and Unreasonable Guidance on Trilateral PPAs," December 2021

2 Korea Power Exchange, "Research on Power Transaction Standards and Settlement Scheme of PPA Purchasers to Promote Renewables," February 2022

3 Solutions for Our Climate, "Accelerating Corporate Renewable Electricity Procurement in Korea," June 2022

4 Corporate Renewable Energy Foundation, "Research and Policy Recommendation Project to Improve PPA System," August 2022

1.2 Status of South Korea's Renewable Energy PPA Scheme

Among the various available means to comply with RE100, PPAs, which guarantee long-term supply at stable prices, are increasingly being used globally to procure renewable energy. Against such backdrop, an amendment to the Electric Utility Act was proposed in July 2020 to enable direct transactions of renewable energy. The revised proposal includes provisions to allow renewable power suppliers to directly supply power to consumers, without having to go through the power market. Meanwhile, in most overseas power markets, PPA contracts are classified into physical or virtual PPAs depending on whether the market takes a mandatory (gross pool) or optional (net pool) approach. This adds diversity to and encourages flexibility in renewable energy procurement methods.

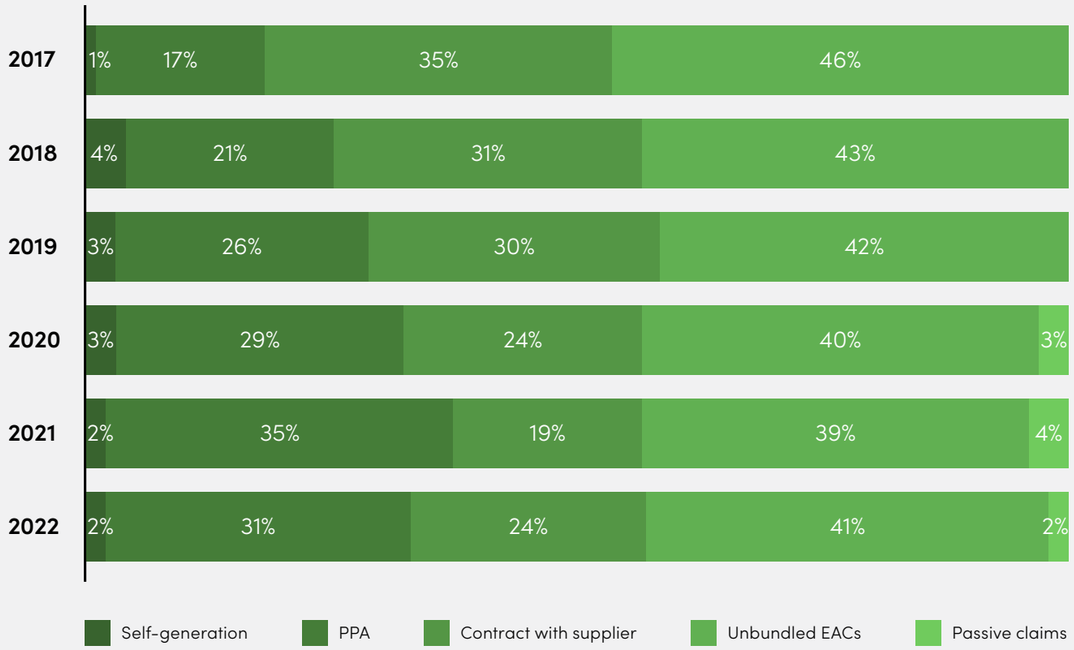


Figure 1 Global RE100 Procurement Type Mix, 2017-2022 Reported Data from RE100 Members (Source: RE100 2023 Annual Disclosure Report)



Power Market Structure and Types of PPA Contracts

In mandatory pool-type power markets, primarily operating across North America, all generation sources must bid their power into the market. Generators sell power based on market prices and may enter into virtual PPAs (VPPAs) to manage the price volatility risks. Virtual PPAs are financial contracts between generators and buyers that do not involve the physical transaction of actual electricity. VPPAs help the generators secure the stability to sell electricity at a specific price and assist the buyers with an opportunity to purchase power at a stable price over the long term. Since the price differences are settled financially, the physical flow of actual electricity is rendered irrelevant to the agreement. The below scenario illustrates this case:

1. 'A' and 'B' sign an agreement to trade 10kWh at the price of 100KRW per kWh.
2. The regular pool market price is set at 150KRW/kWh. As a result, 'A' generates 11kWh, and 'B' consumes 12kWh.
3. As a result, 'A' receives 1,650KRW (11kWh×150KRW/kWh) from the market settlement.
4. As a result, 'B' pays 1,800KRW (12kWh×150KRW/kWh) to the market.
5. The settlement and payment of the above steps 3 and 4 are made in the mandatory regular pool market, irrelevant to the mutual agreement.
6. 'A' and 'B' exchange differences between the market price and the mutually agreed price for the agreement 'to trade 10kWh at the price of 100KRW per kWh.'
7. In this case, the market price of 150KRW/kWh is 50KRW higher than the mutually agreed price of 100KRW/kWh. 'A' sells electricity at a more expensive price than the agreement, and 'B' buys electricity at a more expensive price than the agreement.
8. Therefore, after the regular market settlement, 'A' pays 'B' 500KRW (10kWh×[150KRW/kWh-100KRW/kWh]).

On the other hand, in optional pool-type power markets, often seen across European countries, generators that have entered into PPAs do not participate in the market but supply electricity directly to the PPA offtakers, thereby establishing physical PPAs. Physical PPAs entail the physical transaction of electricity between generators and buyers. Generators directly provide electricity to buyers per the agreement, and the buyers are guaranteed supply at stable prices over the long term. Let's take a look at the below scenario.

1. 'A' and 'B' sign an agreement to trade 10kWh at the price of 100KRW per kWh.
2. The regular pool market price is set at 150KRW/kWh. As a result, 'A' generates an additional 1kWh (total 11kWh), and 'B' consumes an additional 2kWh (total 12kWh).
3. As a result, 'A' receives 150KRW (1kWh×150KRW/kWh) from the market settlement.
4. As a result, 'B' pays 300KRW (2kWh×150KRW/kWh) to the market.
5. 'A' pays 'B' 1,000KRW (10kWh×100KRW/kWh), based on the mutual agreement which states the transaction price at 100KRW per kWh for a total of 10kWh.
6. The amount that 'A' and 'B' exchange are completely irrelevant to any market situation changes.



Meanwhile, the domestic power system exhibits somewhat different trends from American or European power markets owing to KEPCO's monopolization of electricity sales. Accordingly, Korea applies different classification criteria for PPAs, which distinguishes it from overseas markets where PPAs are categorized into physical or virtual ones depending on whether the wholesale power market is a mandatory or an optional pool. Currently, in Korea, if KEPCO is directly involved between the parties of a PPA contract, it is classified as a trilateral PPA. If KEPCO's involvement is relatively indirect, it is considered a direct PPA. This is because KEPCO acts as the sole sales operator and also the only transmission and distribution network operator in Korea. It is therefore virtually impossible to completely exclude KEPCO from even the private power transactions that take place outside the market.

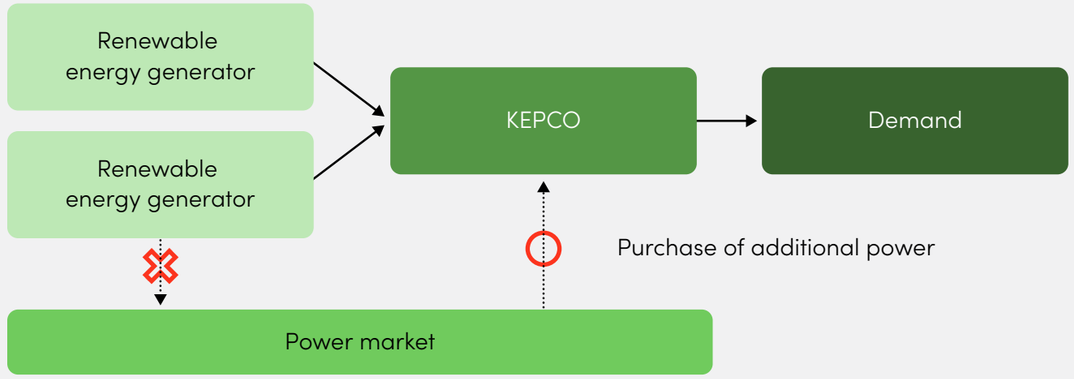


Figure 2 Structure of a Trilateral PPA

Overview of Trilateral PPAs

As illustrated in **Figure 2**, the characteristics of the domestic power system enable KEPCO to be a third-party entity to PPAs, to provide supplementary power supply at a time when the demand is higher than the renewable energy generation volume. Generators and electricity consumers enter into PPAs with KEPCO acting as an intermediary. With regards to this, in June 2021, the Ministry of Trade, Industry and Energy announced the "Guidelines for Third-Party Power Purchase Agreements on New and Renewable Energy Generation," ("the Notice") which stipulates how the power transactions should be carried out amongst third party entities of new and renewable energy sources. The Notice defines the eligible entities of third-party power trading, relevant procedures, and the calculation and payment of fees. Following the amendment of the Enforcement Decree of the Electric Utility Act, renewable energy generating facilities exceeding the capacity of 1MW are now able to conduct power transactions through third-party power trading. That is, the power generator and the electricity consumer reach an agreement, and the power generated is provided to KEPCO, which in turn supplies it to the consumer. In August 2023, with the partial amendment of the third-party Notice, the criteria for electricity consumers eligible to use the trilateral PPA system was changed to those with general or industrial high-voltage usage of 300kW or higher. The average unit price of trilateral PPA contracts is expected to be formed at around 'SMP (System Marginal Price)[5]+REC (Renewable Energy Certificate)' price levels, and will additionally encompass network usage fees, additional settlement payments, and power infrastructure fund payments.

5 SMP (System Marginal Price) refers to the price at which power generation companies sell electricity to Korea Electric Power Corporation (KEPCO), the largest electric utility in South Korea. Within the current power market structure of South Korea, KEPCO purchases electricity generated from power generation companies through Korea Power Exchange (KPX) and supplies it to consumers. In this process, KEPCO refers to this wholesale electricity price it pays to power generation companies per kilowatt-hour (kWh) of electricity as SMP.

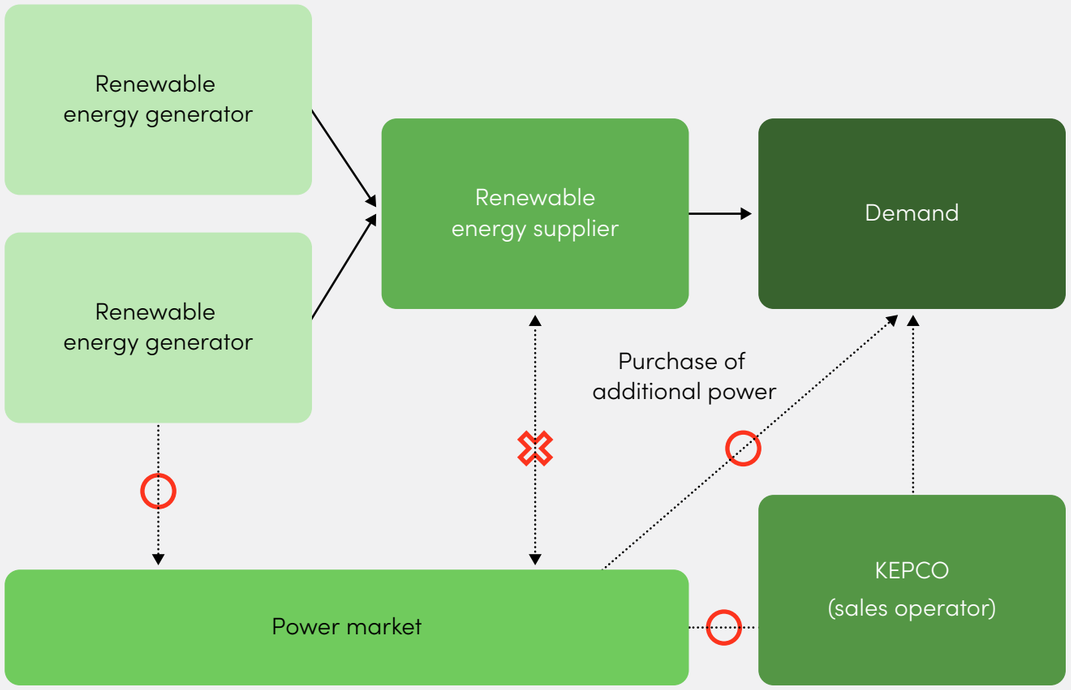


Figure 3 Structure of a Direct PPA

Overview of Direct PPAs

Direct PPAs, implemented in October 2021, allow power consumers to directly purchase the electricity produced from renewable energy suppliers bypassing KEPCO. In addition, with the amendment of the Enforcement Decree of the Electric Utility Act, RE electricity suppliers who have registered as renewable energy supply businesses are now able to directly offer electricity to consumers, without having to go through the power market. RE electricity supply businesses refer to businesses primarily aimed at supplying electricity produced from renewable energy sources to consumers. Per the Electric Utility Act, sales business entities are obliged to receive licenses by the Minister of Trade, Industry and Energy. However, practically, only KEPCO is acknowledged as a sales business entity. Therefore, businesses engaging in direct PPA transactions register as 'RE electricity supply businesses' instead of 'sales business entities' to bypass the opening of the electricity sales market. Consequently, as depicted in **Figure 3**, RE electricity supply businesses lack the legal status to directly participate in the power market, which prohibits them from providing supplementary supply to entities with a PPA demand. As such, demand-side enterprises are obliged to either receive supplementary supply from KEPCO (as in trilateral PPAs) or directly purchase power from the electricity market.

PPAs and Supplementary Supply in the Domestic Power Market

Supplementary supply refers to additional power provision in case the electricity produced by the supplier falls short. When RE sources participating in a PPA produce less electricity than what is demanded by consumers, the discrepancy is supplied through the power market to demand-side enterprises. Typically, such an imbalance incurs costs in terms of power system operation. PPA supplementary supply cases in overseas markets show that the supplementary provision of electricity is freely handled in energy and balancing markets, as RE generators, PPA suppliers (RE electricity supply businesses in the domestic context), and demand-side companies are all eligible to participate in the market. Furthermore, most demand-side enterprises aim to minimize complexities arising from the transition to RE100, including participation in the wholesale electricity market for supplementary supply. It is therefore common for supplying entities of PPAs to also serve the role as supplementary supply providers.

Conversely, in Korea, RE electricity supply businesses are not legally entitled to provide supplementary supply. For any additional electricity demand that exceeds the PPA-agreed volume, demand-side enterprises can only receive power from KEPCO or directly purchase it from the power market. With regards to supplementary supply via KEPCO, in December 2022, KEPCO proposed separate electricity fees for supplementary supply to customers participating in direct PPAs to the Electricity Regulatory Commission. However, this proposal received significant backlash from renewable energy related stakeholders as the basic tariffs were over 50% more expensive than existing levels and is currently indefinitely pending.

The other option for supplementary supply, directly purchasing power from the power market, was introduced in 2003 with the opening of the power market. However, no enterprise has participated in this system thus far, as KEPCO's SMP is relatively higher than KEPCO's retail electricity rate and also encompasses the market price volatility risks. The direct PPA system currently in place applies a disadvantageous settlement method to direct buyers, compared to other power buyers such as sales business entities (KEPCO) or district electric businesses.

As illustrated, under the current direct PPA structure in Korea, RE suppliers are unable to provide supplementary supply, which comprises an essential factor in power supply. Consequently, demand-side enterprises have no choice but to receive electricity from KEPCO, as they are subjected to discriminatory settlement methods while being compelled to participate directly in the market is the other option. This serves as a major roadblock for the PPA system to be more pronounced in Korea, while it is globally recognized as effective procurement method to reach RE100. Section 1.3 of this report covers the differentiated settlement methods for demand-side enterprises when they directly participate in the market for the purpose of supplementary supply. Section 1.4 will analyze the structural issues inherent in the domestic power market and electricity tariff determination that exacerbate the existing problems.





1.3 Regulatory Challenges in Direct Procurement of Supplementary Supply by RE100 Demand-Side Companies

As explained previously, currently, for domestic RE100 demand-side enterprises to engage in direct PPAs without involving KEPCO, they can take part in the wholesale power market as direct purchasers to procure supplementary supply. This section examines the discriminatory settlement regulations RE100 demand-side companies face in the wholesale power market from the perspectives of energy volume (generated electricity), capacity, and uplift payment settlements.

Impracticality in Distribution of Energy Payment Settlements

According to domestic power market regulations, participants in the wholesale power market include sales business entities, district electric businesses, and direct purchasers. The Korea Power Exchange receives settlement fees from these actors to pay power generators. Under the current operational rules, the settlement paid by each power purchaser is determined as follows:

1. Calculate settlement payments needed to be made by direct purchasers based on SMP (corresponds to (B) in **Figure 4**, (B) = SMP X effective purchased electricity volume).
2. Calculate the total settlement to be paid to generators (corresponds to (A) in **Figure 4**).
3. Deduct the settlement payments from direct purchasers from the total settlement to be paid to generators (corresponds to (C) in **Figure 4**).
4. Distribute the deducted amount of (3)-(C) based on the ratio of effective purchased electricity volume between the sales business and the district electric business.

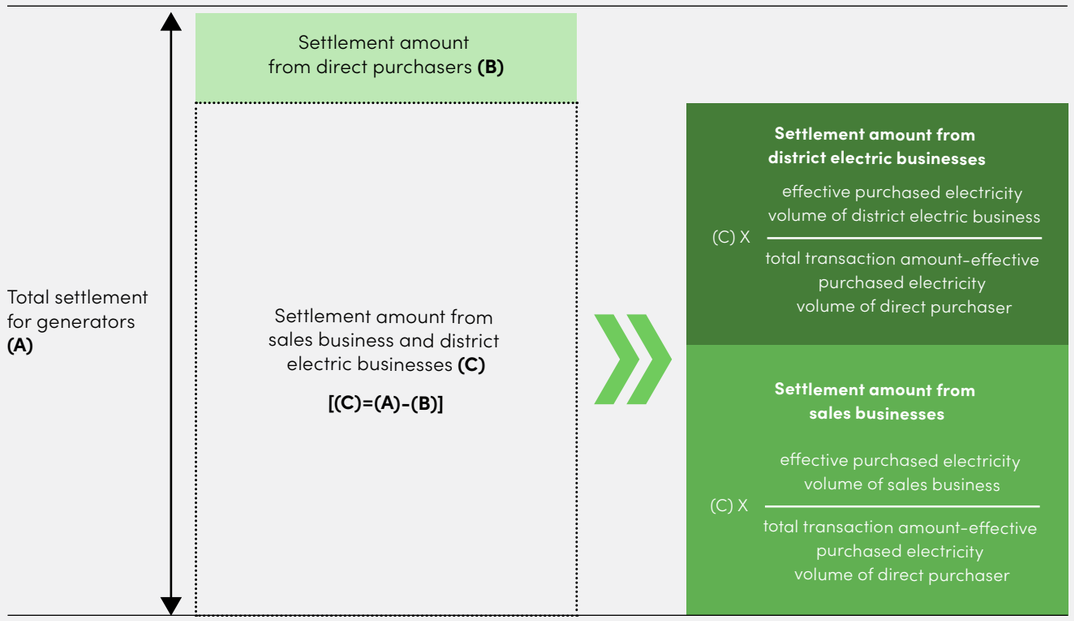


Figure 4 Settlement Formula of Energy Payment from Power Purchasers (Source: Korea Power Exchange, Guidebook on Settlement Rules)

Accordingly, sales businesses and district electric businesses makes energy payments at different prices rather than the SMP of the wholesale power market. As this price includes power generation settlements for settlement adjustment factors, among others, it is formed at a lower level than SMP. The below table shows the comparison between the energy settlement unit payments and the weighted average SMP figures applied to KEPCO, a sales business, and other district electric businesses over the past decade.



Table 1 Comparison Between Energy Settlements and Weighted Average SMPs

Year	Energy settlement unit price [KRW/kWh]	Weighted average SMP [KRW/kWh]	(SMP-unit price) difference [KRW/kWh]	(Unit price/SMP) ratio
2011	60.83	126.63	+65.80	48.04%
2012	69.47	160.83	+91.36	43.19%
2013	66.88	152.1	+85.22	43.97%
2014	69.33	142.26	+72.93	48.74%
2015	64.19	101.76	+37.57	63.08%
2016	62.06	77.06	+15.00	80.54%
2017	66.84	81.77	+14.93	81.74%
2018	76.34	95.16	+18.82	80.23%
2019	74.54	90.74	+16.20	82.15%
2020	63.85	68.87	+5.02	92.71%

As illustrated, it is structurally mandated for demand-side companies that have entered into PPAs to purchase electricity at a higher price than KEPCO. In addition to such price differences stemming from institutional causes, RE generators also hope to receive profits coming from RECs through PPAs. This imposes an additional burden on demand-side enterprises and eventually hinders the direct PPA system from being sufficiently activated to expand the use of renewables. The operation of such unfair settlement rate criteria is a structural issue in the domestic power industry, and it will be examined further in Section 1.4.

Impracticality in terms of Calculating Capacity Payment Settlements

As is the case for PJM (Pennsylvania New Jersey Maryland Interconnection) and NYISO (New York Independent System Operator) in North America, the domestic power market applies the Capacity Payment (CP) mechanism to compensate for fixed costs of power generator construction, which aims to prevent the sudden price fluctuations in the spot market during peak periods. Accordingly, all demand entities in the wholesale electricity market must pay the CP settlement for the generation facilities constructed for the entire grid, regardless of the respective energy amount they have individually purchased. The current power market operation rules apply the below criteria to calculate the capacity payment for direct buyers. Under this scheme, demand companies engaging in direct PPAs for renewables with fluctuations in output may bear a higher burden of CP settlements in comparison to other electricity buyers.

Calculating the power volume applicable to CP for direct buyers

The electricity volume applicable to CP is calculated based on the maximum power the buyer purchased from the power market in the transaction period of July, August, September of the last 12-months and the previous month of the purchase.

Figure 5 depicts the RE generation volume and demand of consumer enterprises that have entered into direct PPAs. Once the average corporate demand and RE generation volume are determined for different times of the day and the above calculation criteria is applied, the applicable power for demand enterprises is determined based on the timeslots where the RE generation is 0 (marked as 'a' in the Figure). As a result, demand enterprises are obliged to pay the CP settlement for a year based on the part 'a,' which could pose significant challenges once the implementation of CP for RE sources begins, which is currently underway.

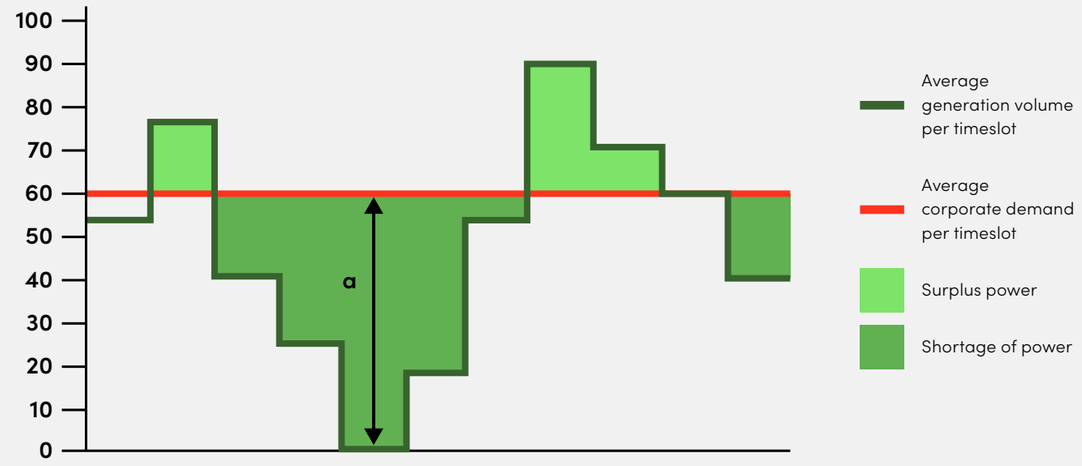


Figure 5 Variation in Hourly Supplementary Power Volume

If RE generation operators are eligible to receive CPs, they are anticipated to include the corresponding amount in the PPA contract terms with the demand-side companies. That is, RE operators will expect a new PPA price that includes the CP on top of the current levels of 'SMP+REC'. Meanwhile, from the demand side, after paying for the amount associated with the renewables, they are additionally required to settle the capacity payments all year round, calculated based on the demand during timeslots with low RE generation volumes in the wholesale electricity market. In other words, they would end up making overlapping payments for some of the CP settlements.

Sales businesses and district electric businesses exclude the CP paid by direct purchasers from the hourly CP and divide the remainder by the ratio of effective purchased volume to make the final payment. Therefore, the base power volume for the capacity settlement of sales businesses and district electric businesses is the same as the effective purchased power volume for each timeslot, which means they bear relatively a less burden. As more demand-side companies choose direct PPA as a means of implementing RE100 and more entities pay CPs through direct purchasing methods, issues around fairness could be further exacerbated, as the CP burden on sales businesses and district electric businesses is expected to decrease.





Impracticality in terms of Calculating Uplift Payment Settlements

All purchasers of electricity are obliged to pay uplift payments, which are costs involved in system operation. Demand-side companies engaging in direct PPAs must pay uplift payments for the power supplied in the form of supplementary supply. The settlement criteria for uplift payments may reference the settlement rules that currently apply to direct purchasers, as they do for CP payments. Under the electricity market operation rules, the uplift payment for direct purchasers is determined by multiplying the 'effective purchased power volume for the direct purchaser's transaction time' by the 'uplift payment unit price' that applies to direct purchasers. For this calculation, the uplift payment unit price is determined yearly by the Cost Assessment Committee[6] based on the previous year's figures. Meanwhile, sales businesses and district electric businesses make the payment by excluding the uplift payments paid by direct purchasers from the hourly total system operation costs and dividing it by the ratio of the effective purchased electricity volume, similar to energy or capacity payment settlements.

The problem with the current uplift payment calculation method for direct purchasers is that all direct purchasers are settled at the same rate, regardless of the actual impact of individual direct purchasers on the power grid. In contrast, sales businesses and district electric businesses settle their additional fees by dividing the hourly system operational costs by the power volume they have purchased during that specific timeslot. This means that the settlement calculation is precisely done based on the hourly impact of sales businesses and district electric businesses on the power system. However, for direct purchasers, the uplift payment unit price is calculated based on the previous year, and that amount is uniformly applied to the total purchased volume of the current year. Uplift payments are therefore allocated irrespective of the individual load usage patterns of each direct purchaser. Under such a scheme, the grid operation situation cannot be accurately and directly reflected to the individual direct purchasers. Not only that, effective market operation cannot be guaranteed in situations where the share of renewables increases, leading to higher costs involved in grid operation.

6 Per the regulations set forth in Article 2.1.1.2 of the KPX's Power Market Operation Rules, the Cost Assessment Committee is in place to conduct review of materials pertinent to generation costs and to serve the functions outlined in Article 2.2.1.4.



1.4 Analysis of Structural Issues in South Korea's Power Market and Electricity Tariff Determination

Market-Structural Issues of the Current Direct PPA Scheme

Renewable electricity suppliers under the direct PPA legislation are not legally entitled to directly participate in the wholesale power market. Accordingly, the settlement for the supplementary supply of direct PPAs, as covered in Section 1.3, assumes that all RE100 demand-side companies take part in the wholesale power market as direct buyers present in the existing market operation rules. This scenario incurs the inconvenience of RE100 companies having to engage in the complexities of the power market. This direct PPA scheme, apart from the fact that the role of renewable energy power suppliers is practically absent, has several other issues. Firstly, if surplus power occurs under a direct PPA, the KPX (Korea Power Exchange) must distinguish and settle between the PPA contracted portion and the additionally generated portion from the total calculated generation volume of individual RE generators. While there may not be significant volumes of surplus energy in the early stages of PPA implementation, a potential diversification of PPAs would pose a significant burden on the KPX's wholesale market operational tasks, as it would have to undertake these differentiated calculation tasks on a time-of-day basis. Such challenges will further exacerbate if the number of complex PPA contracts, including multiple-to-one contracts, increases. Similarly, market operational tasks of the KPX would face bottlenecks if there are more demand-side enterprises participating in the market as direct purchasers, which would be the same number as the current direct PPAs.

Another structural issue present in the Korean power market is that KEPCO, the monopoly sales operator, concurrently holds the status of a monopoly grid operator, as well. As such, RE providers who emerge as KEPCO's competitors have no other choice but to use KEPCO's power grid and pay the usage fees determined by KEPCO. Likewise, RE100 demand enterprises, by participating in direct PPAs, have no alternatives even if KEPCO were to raise its electricity tariffs. As such, the KEPCO-monopolized market structure has significant impacts on the electricity market operation rules. Section 1.3 noted differences in settlement calculations between direct purchasers and sales businesses. Fundamentally, such discrepancy arises because the domestic power market fails to practically meter the electricity used by KEPCO, which is a sales business.[7] Since there is no other sales operator than KEPCO present in the Korean market, there is no need to accurately calculate the electricity volume sold regionally, resulting in a lack of proper metering devices.

Electricity tariffs exclusive to direct PPAs

(unit: KRW/kWh, source: Korea Chamber of Commerce and Industry)

Electricity rate types	PPA-exclusive electricity rate (A)	Industrial electricity rate (B)	Difference (A-B)
Base rate	9980	6630	3350(50.5%)
Base load (rate for 22:00-08:00)	95.1	94.9	0.2(0.2%)
Medium load (rate for 11:00-12:00 and 13:00-18:00)	127.1	140.2	-13.1(-9.3%)
Peak load (rate for time periods excluding those for base and medium loads)	179.4	196.4	-17.0(-8.7%)

Table 2 Proposals of Electricity Tariffs Exclusive to Direct PPAs

7 KPX meters the combination of the electricity volume generated from each generator, excluding the power amount purchased by KEPCO from the wholesale electricity market. In essence, it cannot be measured as there is no metering device.

Structural Issues in Electricity Tariff Determination

In 2023, the role of PPA contracts to accelerate RE100 in Korea was extremely minimal. Most were either for showcasing purposes or involved only small-scale agreements through trilateral PPAs. While PPAs serve a pivotal role in implementing RE100 internationally, they have been poorly utilized domestically because, in a fundamental sense, renewable energy PPAs pose a much greater financial burden for demand-side companies. This preference has been exacerbated by the fact that the retail electricity rates may be lower than the wholesale power market prices that renewable energy operators expect to receive for selling their electricity. **Figure 6** illustrates the changes in wholesale and retail electricity fees from 2020 to 2022. Even when major countries including Germany and the UK faced a 200-300% surge in electricity fees because of the spiking international gas prices following the Ukraine-Russia war, changes in KEPCO's retail prices remained relatively stable. On the other hand, the wholesale power market, where multiple private entities are present, went through a wider range of price fluctuations. This made it challenging for the renewable energy sellers and buyers to settle at a certain price point. As of 2023, the industrial electricity rates in Korea for businesses consuming more than 300kW or higher range from 100KRW/kWh to 230KRW/kWh, and the sum of the SMP and REC prices range from 140KRW/kWh to 390KRW/kWh, varying significantly by the time of day.

Electricity wholesale base prices and retail prices

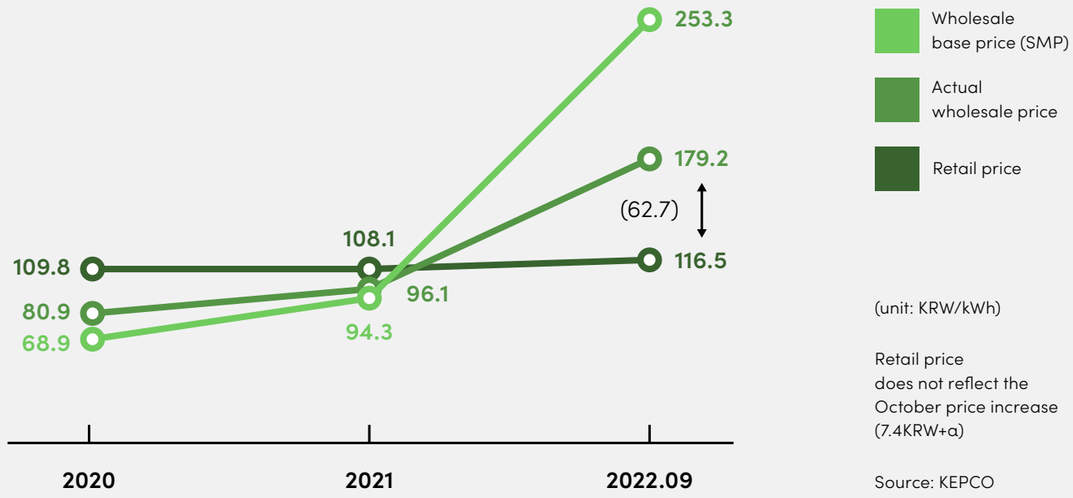


Figure 6 Comparison Between Korea's Wholesale and Retail Electricity Prices



The discrepancy between wholesale and retail electricity rates stems from the rate determination process based on the current flexible electricity billing system[8]. If implemented, the flexible electricity billing system would ideally follow the fluctuations of the wholesale and retail prices. However, the reality in Korea is different. Despite the 'nominal' flexible electricity billing system in place, domestic retail electricity rates remain at an unrealistically low level, failing to reflect the actual costs. The current mechanism follows the below procedures when KEPCO's electricity purchasing costs increase due to rising international gas prices, among other causes.

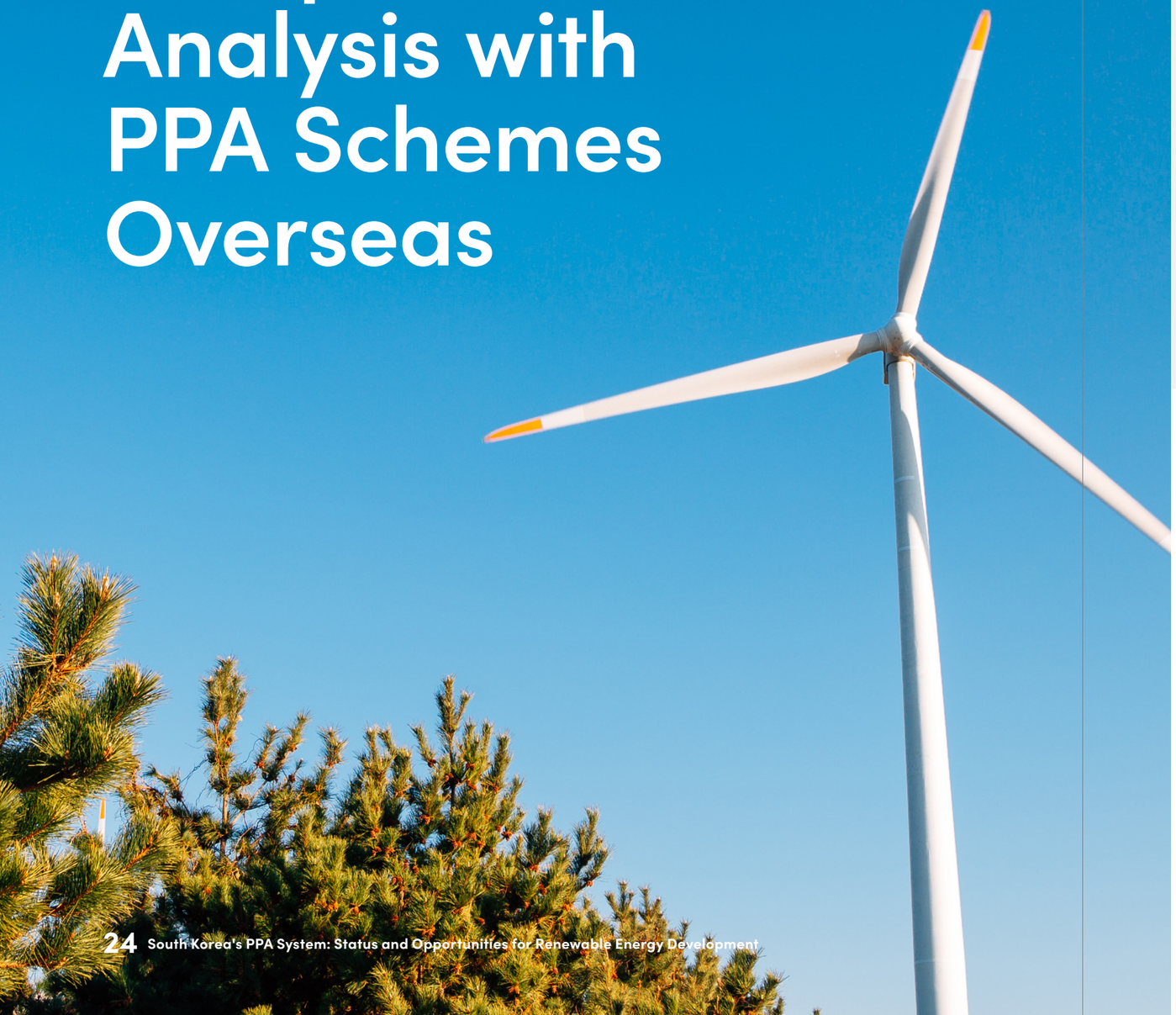
1. KEPCO submits a cost-based electricity rate adjustment proposal to the Ministry of Trade, Industry and Energy.
2. The Ministry of Trade, Industry and Energy consults the Ministry of Economy and Finance and makes the final decision after deliberation by the Electricity Regulatory Commission.

The key here is that the scope of the electricity fee increase may be adjusted or deferred for the sake of overall price management. However, the Korean government, ruling and opposition administrations alike, has continued to postpone electricity rate increases due to political risks, which resulted in the financial deterioration of the state-owned enterprise KEPCO. Such an approach distorts the power market over the long term, causing problems such as investment contraction and supply shortages. This may pose a bigger risk under the current situation where the use of renewable energy acts as a barrier to international trade related to carbon emissions. Not only that, such a response is merely a temporary measure that eventually uses up taxpayers' money to resolve KEPCO's financial issues. To address these challenges, the electricity rate determination mechanism should be revised to more accurately reflect the production costs, including a comprehensive overhaul of the flexible electricity billing system.

8 The flexible electricity billing system reflects the price fluctuations of fuels used for power generation in KEPCO's retail prices. The main purpose of this is to more transparently convey the changes in electricity production costs to consumers by reflecting the fuel price volatility in retail electricity tariffs in real time.

02

Comparative Analysis with PPA Schemes Overseas



2.1 Analysis of Participation Methods of RE Providers in Wholesale Power Markets

PJM[9] defines resources comprised of one or more distributed energy resources (DERs) for the purpose of participating in the power market as virtual power plants (VPPs). RE sources installed in the distribution network such as solar or wind power may participate in various wholesale electricity markets, including energy, reserve power, and capacity markets. Among ancillary services, renewable sources can participate in frequency regulation and reserve markets, except for the reactive power control market. That is, renewable energy sources, given that they meet the requirements for each product, are allowed to participate in various markets like conventional generators and receive settlements for the provided services.

Table 3 Necessary Telemetry Requirements for VPPs as Defined by PJM

Market type		Time unit for data telemetry	Accuracy
Capacity market		1 minute	±2%
Energy market	**Lower than 10MW**	Does not require real-time telemetry	±2%
	10MW or higher	1 minute	±2%
Frequency regulation		2/10 seconds	±2%
Reserve power		1 minute	±2%

The power market in the UK has virtual lead parties (VLPs), a concept equivalent to VPPs of PJM. VLPs refer to aggregators that bundle the consumer load or distributed generation output changes together for power to be sold at markets.

Like conventional generation sources, VLPs may participate in the balancing mechanism, as well as energy, ancillary services (frequency control, STOR[10]), and capacity markets. Germany also operates supply-side VPP systems based on DERs, and transactions are made in energy futures and spot markets.

9 PJM is one of the most representative organizations in the American power market, overseeing the power grid in 13 U.S. states and the District of Colombia. With the name derived from the states engaged in its early-day operation (Pennsylvania, New Jersey, Maryland), it manages the wholesale power market as well as transmission and distribution networks. Major wholesale markets run by PJM include energy market, capacity market, and ancillary services market. Capacity markets prepare for the peak load over the past three years, and ancillary services markets deal with various products (frequency control, reserve power) required to stably manage the power grid and maintain frequency control.

10 Stands for Short-Term Operating Reserve

Table 4 Renewable Energy VPP Market Participation in the Power Markets of North America and the UK

Country	Participation Status Overview	Markets Eligible for Participation		
		Energy	Capacity	Ancillary Services
US (PJM)	Electricity brokerage businesses directly participate in the power market like generation resources. Resources eligible for aggregation: RE, ESS, EV, DR, etc.	■	■ (resources participating in bidding)	■ (resources eligible for power dispatch orders)
UK	Electricity brokerage businesses enter into contracts with users or engage in the power market. Resources eligible for aggregation: RE, ESS, emergency generators, EV, DR, etc.	■	■ (resources participating in bidding)	■ (resources eligible for power dispatch orders)
Korea	Electricity brokerage businesses participate in intermediary transaction markets. Plans are underway for a renewable energy bidding market (Jeju Pilot Project).	■	□ (plans underway)	-

The above **Table 4** summarizes whether and how renewable energy VPPs can participate in markets in the US (PJM) and the UK. Renewables and aggregated resources of PJM and the UK can bid in various types of wholesale power markets and receive settlements. Renewable energy sources eligible for electric dispatch orders can also participate in ancillary service markets to receive payments like conventional generators. However, sources ineligible for provision orders can only participate as price takers in the energy market through self-scheduling. They cannot take part in capacity or ancillary service markets and therefore cannot receive payments, which is similar to the current status of renewable energy in the domestic power market. Korea is considering the introduction of a renewable energy bidding market as part of the Jeju Pilot Project, which will make renewable energy sources eligible for capacity settlements like any other generators.

Overview of ELCC (Effective Load Carrying Capacity)

(Domestic) Future plans

- **(1H 2023) Revise the power market operation rules and detailed operational regulations for cost assessment.**
  - (Current) Calculating the effective load carrying capacity of electric storage devices -> to be expanded to include solar, wind, and electric storage devices.
- **(March 2023) ELCC proposal for solar, wind, and electric storage devices to be applied from July 2023 to June 2024 will be notified.**
- **(end of 2023) Implementation of the renewable energy bidding system**
  - Schedule: revision of renewable energy bidding system rules (until June 2023), implementation of the system (scheduled for the end of 2023)
  - Details: provision of capacity settlements to effective load carrying capacity of VPP resources

Figure 7 Implementation and Reform Schedule of the Next-Generation Power Market (Source: KPX, Calculation Methods for ELCC of Electric Storage Devices and Renewable Energy)



2.2 Global Case Studies on Support Mechanisms to Stimulate PPA Schemes

This section outlines the various support mechanisms currently being operated overseas for renewable energy expansion. It primarily focuses on analyzing support measures closely related to PPAs between RE producers and demand enterprises, with an aim to provide insights for improving trilateral PPAs and direct PPAs in Korea.



US

The US does not have an exclusive system designated to renewable energy PPAs. However, RE operators are entitled to the same RE support policies even when providing power via PPAs. The below figure illustrates the estimation process for the levelized generation revenue of renewable energy projects, based on the PPA contract between Massachusetts electric distribution companies and a wind power generation company, Vinyard Wind LLC. Levelized generation revenue of RE projects can be estimated by considering PPA contract price, investment tax credit (ITC), capacity payment, and deflation. It should be noted that the incentive received from renewable energy support policies is included in the calculation under the 'Value of ITC' item, regardless of the PPA contract price. This means RE operators can sign PPA contracts at relatively lower prices because their financial incentive from the investment tax credit and PPA contracts do not overlap. As a result, the lowered PPA contract prices also incentivize demand-side companies to more proactively seek PPAs.

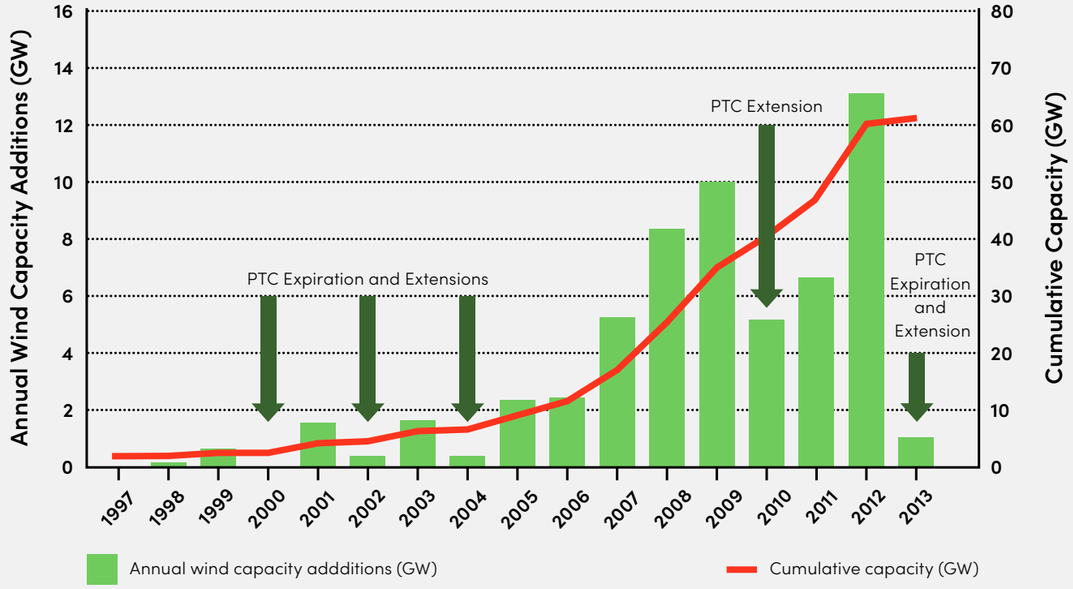
Step	Description	Estimate	Method	Source
0	First-year PPA price ($$_{nominal}$/MWh)	74 $$_{2022}$/MWh for facility 1 65 $$_{2023}$/MWh for facility 2	Reported	a, b
1	Revenue from electricity and REC sales ($$_{nominal}$/MWh)	89 $$_{2021}$/MWh for facility 1 79 $$_{2022}$/MWh for facility 2	Present value of future cash flow	a, b
2	Value of ITC ($$_{nominal}$/MWh)	105 $$_{2021}$/MWh for facility 1 94 $$_{2022}$/MWh for facility 2	Value of ITC in t=0	a, b
3	Revenue from sale of capacity ($$_{nominal}$/MWh)	112 $$_{2021}$/MWh for facility 1 101 $$_{2022}$/MWh for facility 2	Present value of future cash flow	a, b
4	Deflation to $2018 ($2018/MWh)	104 $/MWh for facility 1 92 $/MWh for facility 2	Discounting	N/A
5	Average between facility 1 and 2 ($/MWh)	$98/MWh	Averaging	N/A

[a] Massachusetts Department of Public Utilities (2018a)
[b] Massachusetts Department of Public Utilities (2018b)

Table 5 Estimation of Levelized Generation Revenue for Renewable Energy Projects (Source: NREL, The Vineyard Wind Power Purchase Agreement- Insights for Estimating Costs of U.S. Offshore Wind Projects)

The investment tax credit (ITC) and Renewable Electricity Production Tax Credit (PTC) are the two most noticeable policies provided at the federal level in the US to promote investment and generation of renewable energy. The ITC allows the deduction of a certain percentage of renewable energy investment costs from corporate taxes, while the PTC deducts a certain amount of corporate taxes per unit of renewable energy generation. Both policies are designed as temporary support measures, but their impact on renewable energy investment is primarily significant. The uncertainty surrounding the extension of the PTC has even led to a significant downturn in onshore wind projects across the country in a certain year. **Figure 8** illustrates how the installation capacity of wind power significantly fluctuates every time the PTC system expires and extends. As such, any changes to renewable energy support policies may have a great impact on investment sentiments. It is therefore necessary for Korean policymakers to take a long-term perspective and pre-emptively analyze the various potential impacts when designing RE100 support policies.





Historical wind deployment variability and the production tax credit

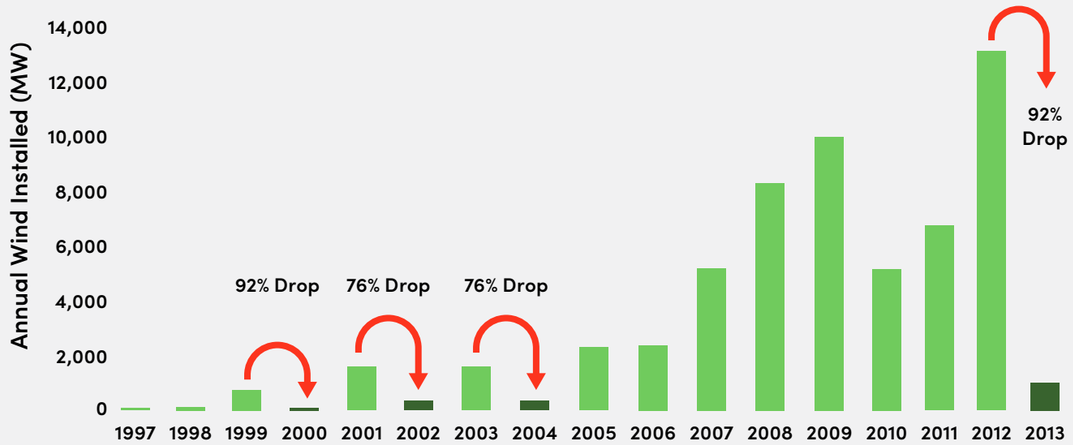


Figure 8 The Impact of PTC's Expiration and Extension on Wind Power Generation Installation Facilities (Source: Department of Energy, American Wind Energy Association)



Mexico

Mexico, with an objective to expand the use of renewables, has applied a separate transmission fee ('wheeling fee') for PPAs between renewable energy generators and demand-side entities. Since the enactment of the RE Act in 2008, the MW-mile method was used to calculate transmission fees for traditional resources, and the postage stamp method for renewable energy sources. This is because using the postage stamp method for calculation is more effective in promoting the distribution of renewables.

The postage stamp method calculates the transmission costs based on the volume of the power transmission, without reflecting the physical and electric distance factors between the generation and demand-side of PPAs. Since the fee is calculated irrespective of the power flow or transmission congestion, it is easier to estimate the future transmission costs. Meanwhile, the MW-mile method calculates the transmission fees using functions that reflect the maximum power flow, maximum power loss, load factor, and the length of transmission networks.

Looking at geographic locations of major operating power plants in Mexico, there is a distant gap between regions that are rich in renewable resources and the areas with high power demand. If the MW-mile transmission calculation method is identically applied to renewable PPAs, the relatively high transmission costs and uncertainties surrounding future costs may have hindered new investments in renewable energy sources.

In addition to applying differentiated transmission and distribution fees, Mexico also implements the energy banking model to support renewable energy. There can be instances where renewable energy generation exceeds or falls short of the demand from PPA customers, as illustrated in **Figure 9**. In Mexico, renewable energy providers can store or withdraw excess energy in or from the state-owned energy bank in the state of Mexico. The storage only entails financial settlements and does not involve the physical storage of energy in large-scale batteries. If surplus energy remains at the end of the year, it can be sold at 85% of the market price or carried over to the next year. The use of renewables is encouraged nationwide, as all renewable energy sources stipulated in the Energy Regulatory Commission are eligible to use the energy bank free of charge.

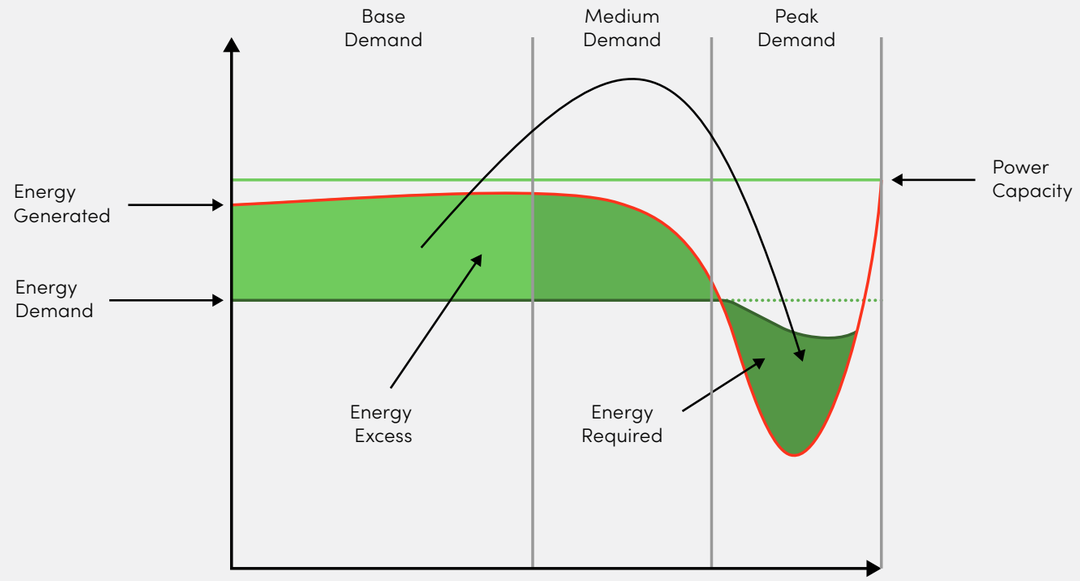


Figure 9 Concept of the Energy Banking Model (Source: NREL, Wheeling and Banking Strategies for Optimal Renewable Energy Deployment: International Experiences)

India

India also adopts policies to offer discounts for transmission and distribution fees to expand the use of renewable sources. In India, transmission and distribution fees are determined based on the capacity utilization factor. The utilization rates of conventional generation resources are about 80-90% and those of renewable resources are 19-26.5%. If the same fee structure is applied, renewable sources end up paying 4 to 5 times higher transmission fees. To avoid this, India's Central Electricity Regulatory Commission (CERC) announced in 2010 regulations exempting inter-state transmission fees and loss charges for renewable energy sources.[11]

The geographical distribution status of solar power in India demonstrates a diverse distribution of generation resources across multiple regions. Support measures can be particularly helpful when renewable energy sources are located in one state but the demand-side company receiving the power is in another. Through the revision of relevant rules in 2015, CERC extended the exemption of network usage fees to June 30, 2017.[12] The central government announced the amended policies in 2016 and expanded the exemption of transmission fee and loss charges to also include wind power.[13]



11 Central Electricity Regulatory Commission (CERC). 2010. "The Central Electricity Regulatory Commission." No.L-1/44/2010-CERC

12 Central Electricity Regulatory Commission (CERC). 2015. "Statement of Reasons Order"

13 Ministry of New and Renewable Energy (MNRE). 2016. Amendment in Tariff Policy, Dated 28th January, 2016. Ministry of Power.



In addition to support measures provided by the central government, there are separate transmission and distribution fee systems individually offered by each state. **Table 6** illustrates that some states offer partial discounts to energy banking fees, whereas states like Karnataka exempts both the transmission and distribution fees as well as energy banking costs for solar power. The energy banking model used in India is identical to the one in Mexico.

Table 6 Discounted Prices for Transmission and Distribution Fees for Solar Power Generation (separate regulations exist for wind power) (Source: NREL, Wheeling and Banking Strategies for Optimal Renewable Energy Deployment: International Experiences)

State	Transmission fees	Transmission loss charges	Distribution fees	Distribution loss charges
Andhra Pradesh	Exempted	Applied	Exempted	Applied
Rajasthan	50% of conventional generation	Applied	Applied	Applied
Punjab	Exempted	Exempted	Exempted	2%



Taiwan

Similar to Korea, in Taiwan, network usage fees are included in the electricity rates charged to demand-side consumers. However, since 2017 when PPAs became feasible between renewable energy generators and users, network usage fees have been imposed on some supply-side entities, as well. Differentiated transmission and distribution fees are applied depending on the type of fuels used, aligned with the approaches for energy transition and green energy policies. The calculation of various settlements in transmission and distribution are based on the electricity carbon emission factor per Articles 9 and 10 of the Electricity Act. Discounts are offered for the transmission and distribution fees from renewable energy sources according to Article 10, Paragraph 4 of the same Act.

The grid usage fees comprise of the ancillary services, electric power dispatching, and wheeling services provided by the transmission and distribution operators of Taiwan as follows:

1. **Ancillary services:** These services ensure the safety and reliability of electricity supply, maintain the stability of the system and electricity quality. In addition, they prepare for contingencies by preserving reserve power and provide other services including black starts and voltage regulation.
2. **Electric power dispatching:** This involves activities such as generation plans, system balancing, real-time electric dispatching, and safety monitoring. It manages the loss of power transmitted through the grid.
3. **Wheeling:** This service involves the provision of electricity through transmission and distribution systems.

Table 7 outlines the transmission and distribution fees determined in the 2017 Electricity Tariff Examination Council meeting. It evidently shows the differentiated levels of tariffs imposed, which aligns with the energy transition policies and prioritizes green energy sources. The meeting materials note that the grid fees should oblige the spirit of 'User Pays' and encourage the direct supply or wheeling of renewable energy. Apart from financial incentives, such a strong governmental determination to support renewable sources must have been instrumental in large-scale renewable PPAs coming into play, including the one signed by the semiconductor manufacturer TSMC. As of 2023, for ancillary services, renewable energy with zero carbon emissions is subject to TWD 0.0207/kWh, while the average fee for all fuel types stands at TWD 0.0414/kWh. The power wheeling fees for power transmission show an even more distinct disparity between renewable energy and other fuel types. Renewables with zero carbon emissions are applied with TWD 0.0183/kWh and the average fee for all fuels is TWD 0.183/kWh, resulting in a tenfold difference in fees.

Table 7 Rates for Electricity Transmission and Distribution in Taiwan (Source: Taiwanese Ministry of Economic Affairs, Convened Meeting for the Review of Electricity Transmission and Distribution Tariffs)

Rates for Electricity Transmission and Distribution Unit: NTD/kWh

Item		Ancillary Service	Electric Power Dispatching	Wheeling (Power Transmission)	Wheeling (Power Distribution)
Average Rate		**0.0460**	**0.0802**	**0.2164**	**0.3375**
Rates for Various Fuels	**Renewable Energy (Zero carbon emission)**	0.0230	0.0040	0.0108	0.0169
	Renewable Energy (with Carbon Emissions) note 1	0.0692	0.1223	0.3299	0.5144
	Nuclear Energy	0.0230	0.0416	0.1123	0.1751
	Coal	0.0599	0.1060	0.2861	0.4462
	Fuel Oil	0.0557	0.0987	0.2662	0.4151
	Fuel Gas	0.0408	0.0728	0.1963	0.3062
	Pump-Storage Hydro Power	0.0230	0.0416	0.1123	0.1751

Note 1: Carbon emissions from renewable energy is due to the power generation by wastes such as garbage and waste tires.



A noticeable characteristic of Taiwan's support policies through discounts in transmission and distribution fees is that the scope of the discount differs according to the share of renewable energy generation. The incentives are greater during periods when the share of renewables in the power system is relatively low, and they grow gradually as the share increases, as outlined in **Table 8**. This is a reasonable approach that could be accepted by not only renewable energy providers but also by other power market players. Considering these regulations in designing domestic incentive policy programs could be beneficial.

Table 8 Discounts for Transmission and Distribution Fees According to Share of Renewables (exchange rate assumes 1TWD at 40KRW)

Share of renewable energy generation	Formula for base rate (discount rate)	Calculation (Average rate 2022 =0.653TWD/kWh)
<10%	10% average rate	0.653 x 10% = 0.065 (2.6KRW/kWh)
10% - 15%	30% average rate	0.653 x 30% = 0.195 (7.8 KRW /kWh)
15% - 20%	50% average rate	0.653 x 50% = 0.327 (13.08 KRW /kWh)
>20%	70% average rate	0.653 x 70% = 0.457 (18.28 KRW /kWh)

Comparison with Korea

Currently, in Korea, a support program for trilateral PPA network usage fees is being operated with the aim to activate the implementation of RE100. Funded by the Green Premium proceeds, electricity users that have signed trilateral PPAs receive support for the transmission and distribution fees to pay for the sales entity (KEPCO). The support is only provided to electricity businesses that meet the below requirements and is limited to the provision of network usage fees.[14]

One advantage of the domestic support system is that it covers the entire transmission and distribution fees, which is a greater level of incentive than overseas schemes. However, it has its limits as the support period is limited to a maximum of one year and large conglomerates are ineligible for receiving assistance.[15] It is necessary to extend the support period and expand the eligible target enterprises, thereby increasing investment incentives, expanding renewable energy generation, and accelerating the race toward carbon neutrality. Furthermore, it is stated that the current system may end prematurely if the network usage fee support budget is exhausted. Stable funding sources other than the Green Premium Fund are therefore required to guarantee long-term support feasibility.[16]

Conditions for Trilateral PPA Network Usage Fee Support Program [15]

Condition 1. Participation in K-RE100

Condition 2. Electricity users that have entered into trilateral PPAs including KEPCO (users of general or industrial electricity with contract volume exceeding 1,000kW)

Condition 3. SMEs or middle-market enterprises



14 Electricity Times, "Support Measures for Trilateral PPAs to Reach 3.6 billion KRW This Year," February 2022

15 The content of this report is based on information as of March 2024, and subsequent changes may occur.

16 The Green Premium scheme, which financially sources the network usage fee support projects, is facing skepticism due to its potential for greenwashing. Since the allocation of these funds is not transparently disclosed, fundamental questions are raised about the very utility of this system.

03

Policy Recommendations and Detailed Improvements of Regulations



3.1 Overview of KPX's Domestic Wholesale Power Market System Reform Plan

A review process is required to assess whether the proposed recommendations of this report align with the future direction of the domestic power market reform and if their utility can be maintained. The overall process of the Korean power market reform measures currently underway is structured into two phases, with details as the following:

Phase 1 power market reform: incorporation of SMP system constraints and revision of ancillary service settlements

1

Bidding system: unconstrained price generation plan → constraint-based operational generation plan[17]

- Abolition of the existing price generation plan.

2

Price scheme: maintenance of the system marginal price

- Change in the criteria for excluding price-determined generation units, as the bidding involves constraint-based generators.

3

Capacity value: introduction of a new settlement item for reserve capacity's opportunity costs (replacing the existing reserve power COFF[18]**)**

- Quarterly average of opportunity costs based on the difference between SMP and reserve supply generator fuel costs.

4

Control costs: adoption of the current direct cost settlement formula but with improvements based on performances

- Improvements in performance coefficients such as mileage weights for frequency control services.

17 Prior to Phase 1 power market reform, the domestic power market had separate plans for price generation and operational generation. When establishing price generation plans, SMP is calculated with the system constraints removed, which essentially nullifies the plans' utility as they do not reflect system constraints. Accordingly, a separate plan only for operational purposes was formulated for grid operation. This abnormal structure was initially maintained during the early stage of the power market introduction. It persisted for about 20 years due to the suspension of the structural reform, until it improved from around September 2022.

18 Refers to the compensation paid to power plants that were initially included in the generation plan but unable to generate electricity due to various operational constraints (system stability issues, forecasting errors, etc.). The compensation aims to reimburse the plants for the lost revenue opportunity and further incentivize them to ensure their non-operation does not adversely affect the stability and efficiency of the power system.

Phase 2 power market reform: introduction of real-time and ancillary service markets

1

Introduction of real-time energy market and double settlement

- Introduction of real-time energy markets to accurately reflect the system status after the announcements of the 'day-ahead markets' results.
- Real-time settlement deviations based on prices reflecting the real-time system conditions.

2

Introduction of reserve power markets

- Hourly calculation and settlement of opportunity costs of generation facilities that provide reserve electricity.
- For reserve capacity value settlements introduced in the Phase 1 reform, quarterly average opportunity costs are to be applied.
- Product type: frequency control reserve, primary, secondary, and tertiary reserve power.
- Market structure: consideration of a real-time ancillary service market (single market).
- Consideration of reserve power for system operation planning from the 'day-ahead markets' energy operation.

The ongoing overhaul of the domestic power market outlined above aims to be completed by 2025. This reform is notable in that the transaction prices are determined based on the real-time system conditions, establishing an incentivizing structure that provides greater benefits to market players that operate in line with the system conditions. Particularly noteworthy is newly establishing real-time and ancillary service markets, which are currently non-existent, which allow market participants to influence even the most detailed aspects of system operation. This reform strategy also aligns well with the directions set forth by advanced power markets overseas. This report has previously stated that relevant regulations should be revised to allow renewable energy electricity providers to directly engage in the market and handle supplementary supply and excess generation, with an aim to improve the PPA scheme over the long term. However, even after amending the PPA legislation and permitting electricity providers to participate in the power market, it is currently very challenging for them to handle supplementary supply and surplus generation under the market system. Therefore, the ongoing power market reform is a prerequisite for amendments to legislation to activate RE100 and encourage PPAs. Only after the market reform is fully complete, successfully creating an environment where market players can freely and fairly trade energy and various ancillary services, will PPAs become more common and make companies closer to achieving the RE100 objectives. Thus, the institutional reforms on PPAs proposed in this report will have better effects on the flow of the current power market reform and align with the policy direction.

3.2 Suggestion of a Short-Term Improvement Plan for South Korea's Renewable Energy PPA Scheme

A fundamental solution to various problems in the domestic electricity market, as illustrated in Sections 1.3 and 1.4, necessitates the handling of structural issues prominent in the market. However, this is expected to take a long time as there are various stakeholders involved and a need to collect public opinions. Taking this into consideration, this report outlines short-term advancement measures with detailed changes, while keeping the main skeleton of the current system.

Improvement Proposal for Unit Price Determination for Supplementary Supply through the Direct Purchase Scheme

Improvement Proposal for Energy Payment Unit Price Determination for Supplementary Supply Power

First, there is an option to apply settlement adjustment factors to demand-side companies participating in direct PPAs, as is the case for district electric businesses subject to the same rules as sales businesses. However, to this end, changing the calculation methods for settlement adjustment factors should be a prerequisite. It would be reasonable to apply a cost-based approach, similar to the calculation criteria for settlement adjustment factors for private coal-fired electricity generation. In this scenario, the same electricity settlement formula would be applied to direct PPA participants as to district electric businesses and sales entities. The settlement amount for power transactions for each trading hour would be totalled, and the proportion it represents in the entire power traded will be used for settlement.



Meanwhile, it is crucial to note that settlement adjustment factors are gradually sunsetting, following institutional reforms such as introducing real-time markets. There is a movement to transition to vesting contracts (VCs)[19] for baseload sources like nuclear power generation. If VCs are introduced, it becomes another option to include direct purchasers in VCs. Since district electric businesses have been contracting parties alongside sales businesses under the conventional VC scheme, this may be feasible. However, different from district electric businesses, the number of demand-side enterprises for direct RE PPAs would fluctuate annually, which requires a yearly renewable of VC contracts in this case. Therefore, in the medium to long term, it seems necessary for the Korea Hydro & Nuclear Power (KHNP) to first sign VCs with the Korea Power Exchange, and the KPX to then distribute the associated costs to all power buyers in the form of additional settlement funds. This approach enables the equitable distribution of costs traded at non-market prices (SMPs), including the coal-fired power generation volume quota under the government policy and nuclear VCs. But this also requires a redefinition of the legal status of the KPX to enable it to engage in such energy purchases.



Improvement Proposal for CP Determination for Supplementary Supply Power

The same method of universally applying identical criteria for power buyers can also be considered to improve the calculation of CPs. That is, the capacity settlements for each trading hour can be simply shared amongst direct purchasers, sales businesses, and district electric businesses in proportion to their respective effective purchased volume. However, this means that the KPX needs to calculate the electricity usage of demand-side companies that should be subject to capacity settlements, by comparing the power usage and renewable generation volume of direct PPA parties. In other words, the KPX has to conduct hourly checks on whether there is surplus power or supplementary supply is required, which could burden the organization when direct PPAs become more predominant in the future. In this regard, when capacity settlements are paid to RE generators going further, the settlement between the CP of RE generators and that of demand-side companies should ideally be handled outside the scope of their PPAs. This means renewable generators would receive settlements from the capacity market, regardless of their contracts with demand enterprises. Demand-side companies would pay the capacity settlements based solely on the physical volume of the electricity used, encompassing both surplus and excess energy. Indeed, PPA practices in advanced foreign countries involve separating traded items such as electricity volume, capacity, and tax benefits, with different trading items for each contract.

19 Authorized by the government or relevant regulatory authorities in the power market, vesting contracts are signed between specific power generators and power purchasers (mostly electricity market operators.) The primary purpose of this contract is to maintain price stability in the electricity market and prevent excessive price fluctuations.



Improvement Proposal for Uplift Payment Determination for Supplementary Supply Power

The issue of the current uplift payment calculation of direct purchasers lies in the fact that all direct purchasers are subjected to the same rate, not taking into consideration the actual impact each direct purchaser has on the power system. As illustrated previously in Section 1.3, such an approach undermines the efficiency of market operation, as sound operation cannot be ensured with increasing additional costs involved in operational procedures. Therefore, it is necessary to modify the uplift payment calculation method for direct purchasers to apply a formula based on their hourly electricity usage, as is the case for sales businesses and district electric entities. Another point of concern is whether the PPA contract volume will be included in the power used subject to uplift payments for direct purchasers engaging in direct PPAs. KEPCO, a sales business, currently performs PPA contracts and excludes the KEPCO PPA volume when paying uplift payments in the power market. Since uplifts are the costs used to stabilize and optimize the physical operation of the power grid, it is reasonable to impose costs based on the actual physical usage of grid-connected users. Therefore, amendments should be made to subject both direct purchasers and KEPCO to include the KEPCO PPA volume when making uplift payments.



3.3 Proposal of Wholesale Power Market Reform Directions to Ensure the Utility of the Renewable Energy PPA Scheme

Improvement Directions for Market-Structural Issues Relevant to Direct PPAs

As previously noted, renewable energy electricity supply businesses according to the direct PPA legislation are considered to lack the legal authority to directly engage in the wholesale power market. Accordingly, the settlement for the supplementary supply of direct PPAs is analyzed under the assumption that all demand enterprises take part in the wholesale electricity market as direct purchasers in accordance with the existing power market operating rules.

The current structure of direct PPAs, in addition to the fact that the role of renewable energy electricity supply businesses is practically non-existent, possesses various other issues. Firstly, in case surplus energy is generated from a direct PPA, the KPX needs to differentiate between the contracted amount and the excess power volume to make the settlement. Such surplus power could be minimal in the early days of PPA introduction, but as they become more diverse and widespread, the KPX will face the increased burden of distinguishing between contracted and excess generation

for multiple renewable energy suppliers, which could lead to a bottleneck in the organization's wholesale market operation. Such challenges will exacerbate if the number of complex PPAs involving multiple renewable generators (multiple-to-one) increases. Similarly, the KPX's operational burden will increase significantly if there are more demand-side companies engaging in the market as direct purchasers, in line with the number of current direct PPAs. This leads to the conclusion that newly granting the legal authority to RE electric supply businesses to participate in the wholesale power market is a way to guarantee the effective operation of the market, compared to a future scenario with more direct PPAs in operation. Therefore, considering solutions for expanding distributed resources and activating new energy businesses, it is necessary to devise mechanisms that involve energy supply businesses in handling excess and shortage of power. In the long run, the necessary direction for improving the direct PPA structure is illustrated in below **Figure 10**:

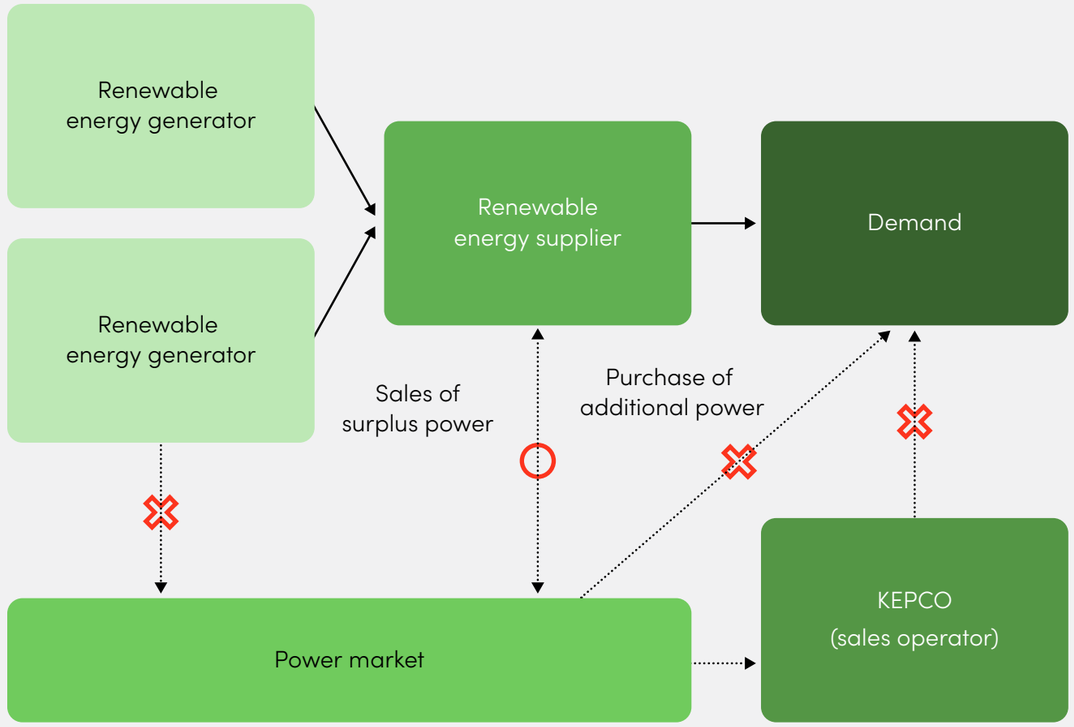


Figure 10 Long-term Direction to Improve Direct PPA Structure

The structure outline above refrains from the direct participation of multiple small-scale RE generators in the market, effectively preventing the overload of market operation duties by the KPX. Also, as renewable energy electricity supply businesses also assume the role of intermediary businesses, they become capable of managing individual renewable energy generation businesses. This setup promotes more transparent and simplified regulations and operations in the power market because renewable energy electricity supply businesses handle the purchase of shortage power and sales of surplus power arising from direct PPAs through the market. To implement these institutional improvements, modifications to the Electric Utility Act defining renewable energy electricity supply businesses are required.

Article 16-5 of the Electric Utility Act, Supply of Electricity by Entities Engaged in Renewable Energy Electricity Supply Business

1. An entity engaged in the renewable energy electricity supply business may supply electricity produced by using renewable energy to electricity consumers not via the electricity market.
2. Where an entity engaged in the renewable energy electricity supply business supplies electricity to electricity consumers pursuant to paragraph (1), it can enter into a contract after separately discussing each charge, other conditions of supply, etc.
3. Electricity supplied pursuant to paragraph (1) shall not be subject to the issuance of a certificate of supply of new and renewable energy under Article 12-7 (1) of the Act on the Promotion of the Development, Use and Diffusion of New and Renewable Energy.
4. Other matters necessary for supplying electricity under paragraph (1) shall be prescribed by the Ordinance of the Ministry of Trade, Industry and Energy.





Long-Term Improvement Directions for the Domestic Power Market

For an effective establishment of the direct PPA scheme, a pivotal means to achieve RE100, a more open attitude toward the participation of renewable energy electricity supply businesses in the domestic power market is required. As mentioned above, RE electricity supply businesses taking part in the power market as a direct entity providing supplementary supply effectively means that they will assume an equal position as KEPCO, which is currently the sole domestic sales entity. This ultimately signifies the sales opening of the Korean power market. In addition, if RE electricity supply businesses also handle the excess generation, on top of providing supplementary supply, it is implied that they will serve 'dual roles' (assuming business tasks unrelated to one's own), which is currently prohibited in the domestic market.

While topics like 'market sales opening' and 'dual roles' were naturally allowed in the overseas context following the opening of the vertically integrated power industry in the 1990s, relevant discussions have been lackluster in Korea, except partial efforts made after the structural reform began in the 2000s. Furthermore, the research team believes that 'sales separation,' which separately distinguishes the roles of KEPCO which is the sole seller and grid operator of Korea, is necessary to facilitate the use of PPAs. Why is it important to separate KEPCO's roles, which is seemingly unrelated to promoting the direct PPA scheme? To reiterate, for direct PPAs to be effectively activated, it is essential for RE electricity suppliers to directly handle surplus power generation and supplementary supply in the power market. These suppliers, conducting the role of supplementary supply provision in the power market, take

on the role of sales businesses. It would effectively make them competitors to KEPCO, the current sales business. Meanwhile, as KEPCO is also the sole grid operator of Korea, renewable energy electricity supply businesses have no choice but to use the network operated by KEPCO. In this case, fair competition cannot be ensured. In addition, it could add constraints to demand-side enterprises opting for direct PPAs provided by RE electricity business suppliers, on top of issues such as the realization of grid usage fees within KEPCO's electricity tariffs. Therefore, a separate business entity should be established to separate KEPCO's role as a grid operator. Simultaneously, KEPCO as a sales business should assume dual roles by owning power generation facilities, similar to how renewable energy electricity suppliers perform surplus generation. Utility companies in advanced overseas power markets take both roles as a sales entity and a power generator. This enables them to hedge risks involved in fluctuation of electricity prices in the market, by engaging in production and sales at the same time.

The strategies outlined can contribute to reshaping the domestic power market, fostering an environment for fair competition among stakeholders. Specifically, for the effective implementation of the direct Power Purchase Agreement (PPA) scheme, it is desirable to consider a more inclusive approach to the participation of different stakeholders in the domestic power market. Nonetheless, given that such long-term changes may have wide-ranging effects across diverse societal sectors beyond the realm of the power market, it becomes imperative to adopt a holistic and forward-looking approach.

The strategies outlined can contribute to reshaping the domestic power market, fostering an environment for fair competition among stakeholders.



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