Classification, principle and pricing manner of renewable power purchase agreement

Chenghui Tang¹ and Fan Zhang¹
¹State Grid Energy Research Institute CO.,LTD.
¹tangchenghui@sgeri.sgcc.com.cn

Abstract. As a promising manner of renewable energy consuming, renewable power purchase agreement has get more and more attentions from multiple countries. This paper introduces the financial renewable power purchase agreement, physical renewable power purchase agreement and their corresponding operations. The electricity price of renewable power purchase agreement is discussed. The introduction of renewable power purchase agreement in this paper provides a reference for the development of renewable energy in China.

1. Introduction
In recent years, countries around the world have formulated energy transformation strategies to promote the development of renewable energy. At the end of 2018, the cumulative installed capacity of China's wind power reached 184 million kilowatts, accounting for 9.7% of all power generation capacity. Wind power generation capacity was 366 billion kilowatt hours, accounting for 5.2% of total power generation [1]. The installed capacity of solar photovoltaic power generation reached 174 million kilowatts, accounting for 9.2% of the total installed capacity of power generation, including 132.84 million kilowatts of centralized solar photovoltaic and 50.61 million kilowatts of distributed solar photovoltaic. Solar photovoltaic power generation was 177.5 billion kWh, accounting for 2.5% of total power generation [1]. China's National Development and Reform Commission pointed out that the 2020 renewable energy development goal of China's "13th Five-Year Plan" is to increase the installed capacity of wind power and solar photovoltaic power generation to 350 million kilowatts and 200 million kilowatts respectively [2].

At present, most of China's renewable energy projects depend on the “priority purchase” policy. With the further marketization of China's electric power, policies such as the spot market and renewable portfolio standard are replacing the “priority purchase of electricity” policy to a certain extent, becoming a new mechanism for China's renewable energy development. The current rapid development of the Renewable Power Purchase Agreements (PPAs) mode in many countries could be a useful reference for the development of renewable energy in China for its stable income guarantee for wind power and solar photovoltaic power generation projects.

2. Overview of Renewable PPA
Enterprises usually purchase electricity from utility in the short term in the traditional manner, which lack long-term price certainty, and are unable to control the source of electricity delivered. In recent years, power companies have become more inclined to establish an image of energy conservation and environmental protection, and to reduce energy costs. This makes electricity consumers to purchase electricity directly from renewable power producers. These power purchase contracts are called
“Renewable PPAs”. The renewable power purchase agreement is a long-term contract for the purchase of renewable energy at an agreed quantity and at a price that meets the needs of renewable power producers and consumers. These agreements not only provide economically beneficial solutions for both parties, but also provide companies with a clean renewable energy supply and investment in other renewable energy development.

According to Bloomberg New Energy Finance, the Renewable PPAs increased to 13.4GW in 2018 [3]. The US Renewable PPAs accounted for more than 60%, and a total of 8.5GW was signed, almost three times that of 2017. Among them, Facebook leads an experienced US enterprises energy buyer, buying more than 2.6 GW of renewable energy.

How to reduce power generation costs to a greater extent is a focus of attention for renewable energy project developers. The cost of electricity is affected by many factors, including the term of the agreement. Since the cost of renewable energy projects such as solar and wind energy is not subject to unknown fuel prices, it is theoretically a good idea to sign long-term Renewable PPA agreements for longer price stability guarantees.

3. Classification of Renewable PPA
The vast majority of Renewable PPA protocols are financial PPA, also known as virtual PPAs or structural PPAs. That is, if the enterprise is not in the same area as the renewable energy project, the renewable energy of the wind or solar power plants is connected to the grid, and the electricity purchaser obtains the power from the grid at a fixed price (see Section 4.1 for details). Renewable energy will be sold in the wholesale market and sold at a fixed price. In addition, the electricity purchaser can continue to purchase electricity demand from existing utilities and reconcile them on a regular basis. So in the long run, any increase in electricity prices will be offset by the additional surplus generated by the sale of renewable energy projects.

In contrast, there are a few physical PPAs, and the project is closely related to the enterprise and even directly controlled by the enterprise (see Section 4.2 for details). These agreements are usually limited to enterprises such as Google and Apple that are registered as participants in the wholesale electricity market. Compared with the former, this PPA enables enterprises to gain more autonomy, but requires a much higher degree of technical expertise.

The structure of the Renewable PPA affects the risks borne by the acquirer. Because one of the biggest advantages of renewable energy is that the marginal cost is almost zero, all costs can be calculated at the beginning of the project. Then electricity is wholesaled at a stable price, without having to consider the change in fuel costs. However, project developers still have to wholesale electricity to the market in most cases, which contains risks.

In virtual PPA, enterprises and projects are often not in the same electricity market, and power stations sell electricity at wholesale prices to power exchange at local prices. If the wholesale price of the location of the enterprises is higher than the price of Renewable PPA, enterprises reduce the cost. For renewable energy project developers, if the price of Renewable PPA is higher than the wholesale price of the project location, it will greatly reduce the risk and even obtain higher profits. In fact, the risk of electricity prices is not new for large consumers of electricity. The existence of Renewable PPA only allows enterprises to have more means to evade them.

4. Principle of Renewable PPA
4.1. Financial Renewable PPA operation
Since the electricity purchaser wants to obtain electricity from the grid at a fixed price, the way the user buys electricity in the financial Renewable PPA is the wholesale market and does not directly settle with the renewable power producers. Therefore, financial Renewable PPAs are generally carried out in the form of "contract for difference". That is, users who purchase less electricity and pay more in the wholesale market are transferred to renewable power producers.
As shown in Figure 1, blue lines represent power flow and green lines represent cash flow. Renewable power producers sell renewable energy to the wholesale electricity market and get the benefits [4]. Consumers buy electricity from the wholesale electricity market and pay for it in the wholesale electricity market. This means that financial Renewable PPA allows renewable energy to participate in the wholesale market. Because renewable power producer and the user signed a power purchase contract to purchase electricity in the Renewable PPA, if the consumer's electricity purchase cost in the wholesale market exceeds the agreed electricity price, the renewable power producer must compensate the extra cost to the consumer. If the user's purchase cost in the wholesale market is lower than the agreed electricity price, the consumer must compensate the generator in the wholesale electricity market. This process is the financial settlement of "contract for difference" between renewable power producer and consumer, as the top green line in Figure 1. In addition, renewable power producer needs to provide consumer with an “origin guarantee” for renewable energy generation.

4.2. Physical Renewable PPA operation

Different with the financial Renewable PPA, since the physical Renewable PPA uses a dedicated line transmission in many cases, the electricity user directly settles with the renewable power purchasers.

As shown in Figure 2, blue lines represent power flow and green lines represent cash flow. Because "physical PPA" is a dedicated line transmission in many cases, the renewable power producer directly delivers electricity to the power consumer through the grid operators. In this way, users provide electricity purchase costs to renewable power producer. In addition, renewable power producer needs to provide the consumer with an “original guarantee” for renewable energy generation.
5. Electricity price of Renewable PPA

Electricity prices of Renewable PPAs usually are "two-part electricity price", in which the total electricity price is divided into two parts: the capacity charge and the energy charge. Among them, the capacity charge refers to the electricity purchaser and the electricity seller. According to the agreed reliable net capacity of the power plant as the basis for calculation, the electricity seller and the electricity purchase party sign the electricity agreement, determining the power generation capacity of the power plant, charging the electricity fee regularly. In most cases, power generation income that corresponding to the capacity charge is not influenced by the actual power generation quantity. The energy charge is based on the actual power generation degree of the electricity seller to calculate the basic electricity price of the electricity fee.

The capacity charge is the main electricity cost component of the project company and is the main guarantee for ensuring that the project can repay the principal and interest. The capacity charge is further related to the output capacity and availability of the power station. The output power is mainly related to the performance of the power generation equipment, the design of the power station, and so on. The availability rate refers to the ratio of the actual power generation hours of the power station to the natural hours of the time period within a predetermined period of time, which is mainly related to the operation and maintenance quality of the operation and maintenance (O&M) contractor.

The energy charge is used to compensate for the fuel cost and other variable costs of the power station. Therefore, it is necessary to ensure that the upstream cost changes are completely transmitted to the energy price. For example, the upstream coal cost will generally be adjusted according to some benchmark coal prices and according to certain formulas, then the energy charge should also be adjusted according to the same mechanism.

Acknowledgments

This work was supported by SGCC Science and Technology Project “National unified electricity market framework design and quantitative assessment technique study”.

6. Conclusion

Classification, principle and pricing manner of renewable power purchase agreements are introduced in this paper, respectively. Financial Renewable PPA, Physical Renewable PPA and their corresponding operations are discussed and compared to show their principles. Finally, the electricity price of Renewable PPA is introduced. Renewable PPA provides economically beneficial solutions for...
renewable power producers and consumers, which could be a feasible mode for the renewable energy development in China.

References
[1] National Energy Administration. Wind power integration capacity and operation in 2018. http://www.nea.gov.cn/2019-1/28/c_137780779.htm
[2] National Development and Reform Commission. China renewable energy outlook 2017. http://www.cnrec.org.cn/cbw/zh/2017-10-18-531.html
[3] Bloomberg New Energy Finance. Corporate Clean Energy Buying Surged to New Record in 2018. https://about.bnef.com/blog/corporate-clean-energy-buying-surged-new-record-2018/
[4] GE Renewable Energy. Power Purchase Agreements. https://www.ge.com/renewableenergy/power-purchase-agreements