

Analysis of Commercial Model of Park-level Integrated Energy System Participating in Carbon Trading Considering Electric Vehicles

Author: Lei Huang, Xiaoyan Zhang, Xi Ding, Chuangxin Guo

I. INTRODUCTION

Climate change is a major global issue of universal concern to the international community and bears on the development of all mankind. In recent years, a large number of park-level integrated energy systems (PIES) have sprung up. The operation of PIES is more complex than traditional power system. Besides, electric vehicles (Evs) have attracted wide attention due to green and energy-saving characteristics. So this paper takes the PIES as the main body, and firstly establishes its structure diagram to clarify the supply and demand relationship of PIES. Secondly, the energy supply mode with demand response is considered through price elasticity matrix and users' comfort model. Then we analyze the commercial model of the PIES after the participation of EVs, summarize the charging mode, and analyze the cost and benefit when EVs are involved. What's more, we also analyze the carbon trading cost of PIES through carbon quotas and government certified emission reduction (CCER). Finally, the influence of demand response and participation of EVs on the PIES's revenue and cost under different carbon trading prices are analyzed by numerical examples, as well as the internal rate of return (IRR) and payback period(PP) of the invested charging pile, which illustrate the advantage and rationality of the proposed commercial model.

II. OPERATION MODE OF PIES

The structure of PIES is shown in Fig.1. It has to meet the electricity load, heat load, and cooling load requirements of users. At the same time, PIES has invested in the construction of a variety of energy supply equipment and energy conversion equipment to meet the energy demands. As shown in figure.1, the electricity load can be supplied by photovoltaic power generation devices, CHP and external power grid; the heat load can be met by CHP, gas boiler and electric boiler; the cooling load can be met by electric chiller and absorption chiller. In addition, PIES has also invested in the construction of electric energy storage device, which can play the role of smoothing photovoltaic output, peak cut and valley filling, load shifting, improving the flexibility of PIES's energy using method. PIES provides users with energy services to meet their demands. Therefore, the park charges users of energy supply fees as its own income. At the same time, PIES needs to purchase electricity from the power grid and natural gas from the gas network as its energy purchasing cost.

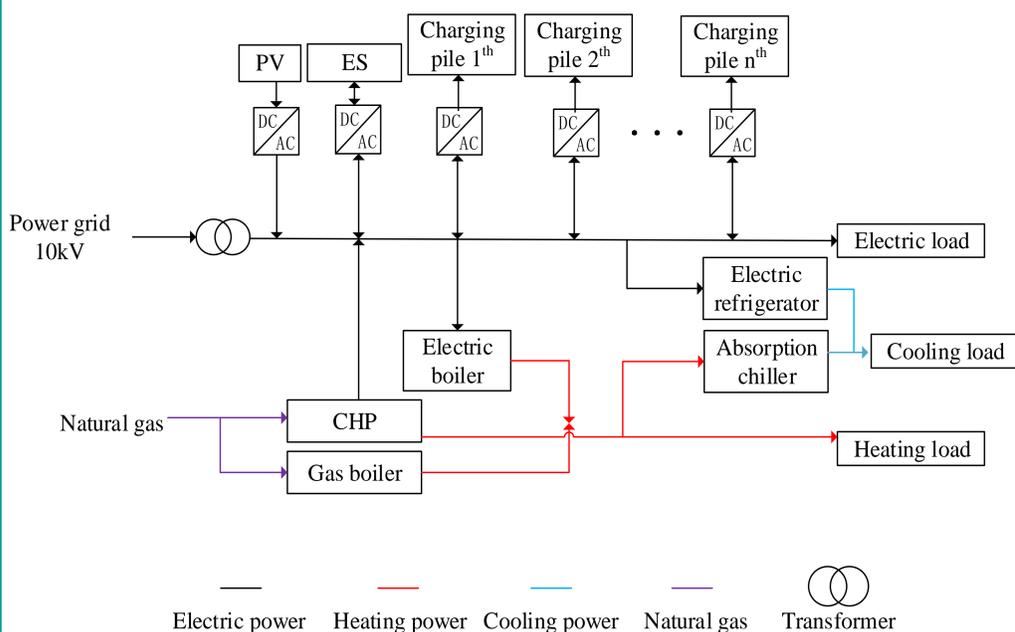


Fig. 1 The structure of PIES

III. THE OPERATION MODE OF PIES AFTER CONSIDERING CARBON TRADING

The capital invested in the construction of the charging pile is initial cost of PIES. In addition to providing charging services to EVs, obtaining certain benefits through charging piles, as mentioned in B part of section III, PIES can also obtain benefits from carbon emission reduction. According to relevant policies, EVs can reduce carbon dioxide emissions by replacing traditional fuel vehicles, and these emissions reductions are issued by the government certified emission reduction (CCER), which can be sold through carbon market. However, carbon dioxide emissions during the construction period of EVs charging piles should also be considered

IV. CASE STUDIES

The typical summer load curve is selected as electricity load and heat load demand that the PIES needs to meet, and the typical outdoor temperature curve in Fuzhou, Fujian Province, China is selected to calculate the standard cooling load, maximum cooling load and minimum cooling load. Four cases are set up to compare. Case 1 does not consider EVs and demand response; Case 2 considers demand response, but does not include EVs; Case 3 does not consider demand response, but adds EVs; Case 4 considers both demand response and EVs. The total revenue can be calculated, and their relationship with carbon trading price are shown in Fig.2..

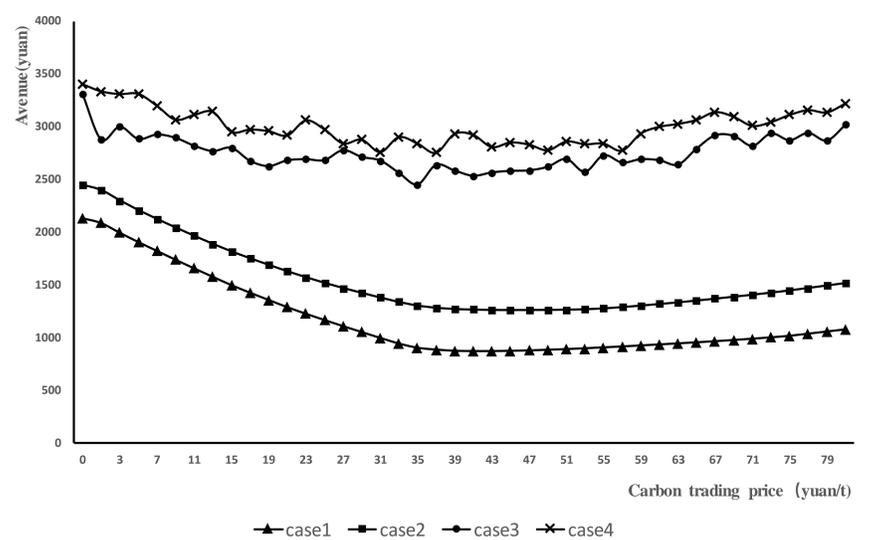


Fig.2 Total average curve

V. CONCLUSION

The total revenue of PIES decreases firstly and then increases. Because when the carbon trading price rises, the carbon trading cost and operation cost will both rise at first, so the total cost will increase. However, when the carbon trading price continues to rise, the carbon trading cost will decrease. When its reduction is greater than the increase of operation cost, the total cost will decrease. When demand response is considered, the load of PIES is more reasonable, which will increase the revenue. When considering EVs, although PIES needs to meet its charging load, which increases the operation cost, the overall benefits that includes the fee charged to EVs owners and the carbon emission reduction benefits dominate, so the total revenue of park is higher than before.