論文 / 著書情報
Article / Book Information

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種別(和文)	論文要旨
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（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

In recent decades, the inexhaustible renewable energy is gradually penetrating our daily life. The associated environmentally-friendly property is promising to invoke the replacement of traditional energy. Providing a residential scenario, we take the most representative one, photovoltaic power, into consideration. However, the output of the photovoltaic panel, a device transferring solar power into electric energy, is vulnerable to the solar irradiation fluctuation, which makes the production of the particular energy uncertain. Therefore, how to tackle uncertainty and accept a larger amount of specific renewable energy become a challenging issue.

In Chapter 1, we introduce the background and the motivation of this thesis. Initially, we discussed that this thesis focuses on the photovoltaic power as a representative of non-dispatchable REs, since the basic techniques proposed in this thesis can be also applied to the other non-dispatchable REs such as wind power, in addition to dispatchable ones. Then, a contradiction is analyzed among the trends of the devices' price, the installed capacity and the associated proportion. Motivated by such contradiction, a study is initiated to facilitate households with renewable energy integrated join the day-ahead power market.

In Chapter 2, the problem configuration, including the day-ahead market and energy aggregator, are introduced. Firstly, we introduce the day-ahead electricity market, which covers most of the energy transactions within a day. Then, we suppose that the households who own the solar panels, the storage systems, and the fossil fuel generator systems collaborate mutually for a common benefit. The proposed market player is expected to join the day-ahead electricity market with the management of an energy coordinator. However, with the PV realization uncertainty (PVRU) is clarified, the households to join the market is influenced. To overcome the specific uncertainty issue, we propose several strategies which are about to be addressed in Chapter 3 and Chapter 4.

As we have analyzed in Chapter 2, the fluctuated resultant energy varies with the PV power realization uncertainty (PVRU), which might bring unacceptable risk to an energy aggregator during its market activity. In Chapter 3, we propose an uncertain-averse framework to deal with the PVRU in the day-ahead market. Specifically, according to the robust optimization method, we formulate the problem into a two-stage framework. Furthermore, with the strong duality holds, we recast the primal problem to the dual problem, with which a profit maximization issue is formulated. To solve the bi-linear term inside, we expand the original formulation into two sub-problems. Additionally, the problem is solved by a constraint-generation algorithm. According to the numerical simulation, the validity of the proposed framework is demonstrated.

In Chapter 3, a risk-averse profit maximization strategy based on the robust optimization is applied in an energy scheduling issue under the PVRU condition. Since the worst-case profit is considered, the strategy leads all the risks been carefully tackled. However, the conservative attitude also makes the profit not persuasive. In Chapter 4, a budget-based profit optimization strategy is studied. To deal with the PVRU, we firstly implement an SP-based strategy to maximize the profit of the aggregator. Then, by comparing with the RO-based strategy proposed in Chapter 3, we show that both of the strategies are limited in the real-world application. To overcome the issue, we propose a budget-based strategy by adding a variance-bounded constraint to the SP-based framework. At last, the validity of the strategies has been verified, and the profits distributions are discussed with respect to the different budget conditions.

In Chapter 5, we established an uncertainty dealing game-theoretic framework to describe the strategic behavior of each selfish market player. Respecting the PV realization uncertainty, we modeled the profit

function for each market player via a two-stage stochastic structure. Since the decisions of the market players are related, we defined a coupled constraint equilibrium and studied the associated existence. To solve the equilibrium, we recast the problem by its KKT condition and finally reformulate the problem as a MILP. Finally, the simulation illustrates the behaviors of the market players and the existence of the game equilibrium.

In the concluding chapter, I summarize the main contributions of this thesis. Then, I comment on the limitations of the thesis and discuss future extension work. The main contribution of this thesis is that, by providing uncertain solar energy, we systematically investigate the energy scheduling issue of an energy aggregator who joins the day-ahead electricity market. Additionally, motivated by a real-world event, network economics issues would be my research interests in the future.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。

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