Bi-level Robust Pricing Method for Community Integrated Energy System with the access of HEVCS and EVCS

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BACKGROUND

- The efficient and economical consumption of the distributed resources has become an important task for energy systems.
- Community integrated energy system (CIES) enhances the consumption capacity of the distributed resources by transforming and utilizing various energy sources such as electricity, gas and heat.
- Electrical vehicles (EVs) and hydrogen fuel cell electrical vehicles (HEVs) have proliferated in past years and gradually the charging stations have become the distributed resources.

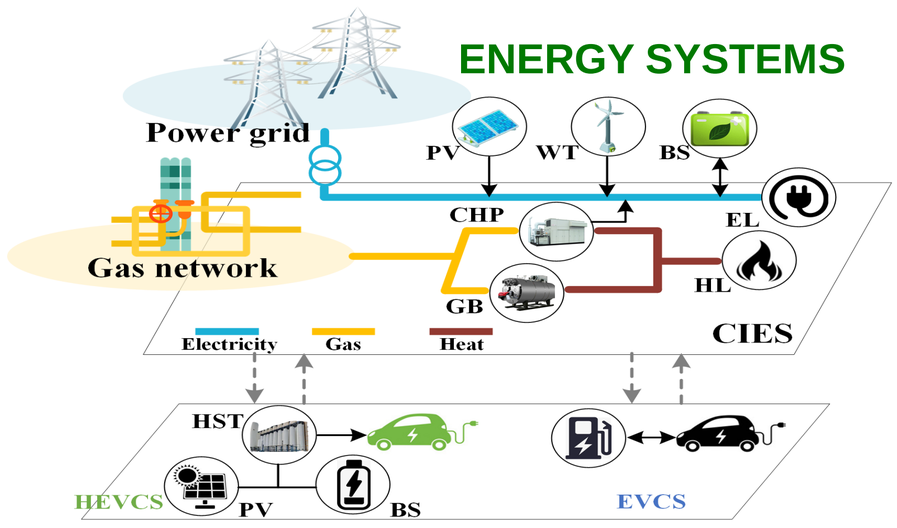


Fig. 1 Bi-level optimization framework for the energy systems

METHODOLOGY

OPTIMIZATION FRAMEWORK

- The proposed system consists of three participating entities and we use the Stackelberg game-based pricing method to model the interactive relationship of this system.

MODELING OF HEVCS

- The HST capacity dynamic model is established to ensure the safety of HEVCS, where the uncertainties from the HFCEV can be easily addressed.

MODELING OF CIES

- For the upper-level leader CIES, a two-stage robust optimization model is formulated to realize the economic and robust operation by optimizing the daily scheduling and the electricity prices.

MODELING OF EVCS

- The DRO method is used to deal with the uncertainties of EVs to aggregate the discrete EV data into n classes by historical data.

PERFORMANCE

CASES SETUPS

- Without the robust pricing strategy. HEVCS and EVCS are included in the CIES, which requires that HEVs and EVs aggregators follow the operation schedule and associated with the potential privacy threats. Case 1 can be the ideal benchmark to test the performance of proposed framework.
- With the fixed pricing strategy. Compared with Case 1, this scheduling method relatively avoid the privacy threats. However, the operation flexibility provided by two entities under different uncertainties are not fully utilized due to this pricing strategy.
- Proposed robust pricing strategy.

HCT CAPACITY ANALYSIS

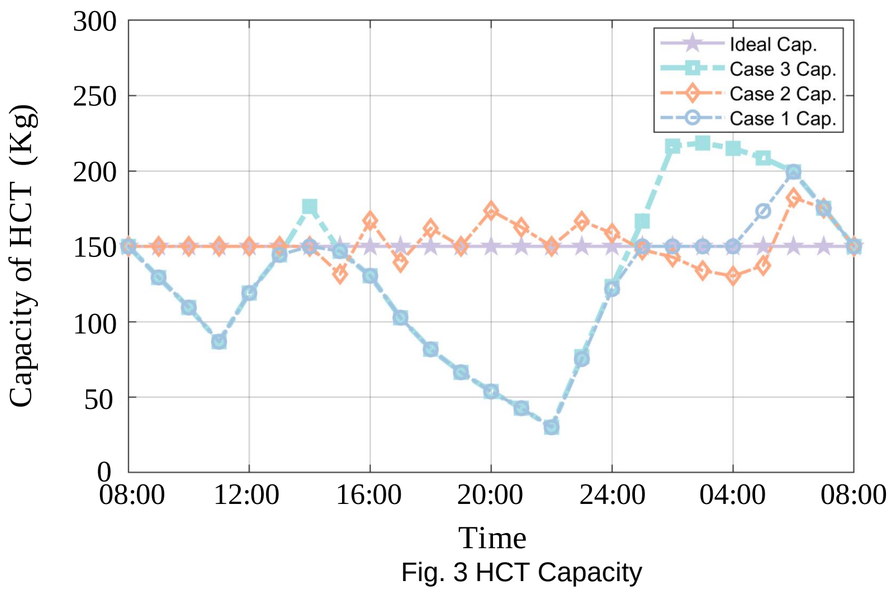


Fig. 3 HCT Capacity

- Compared with case 1 and case 2, the capacity of HCT varies over a wider range while maintaining the safe operation.

ECONOMIC ANALYSIS

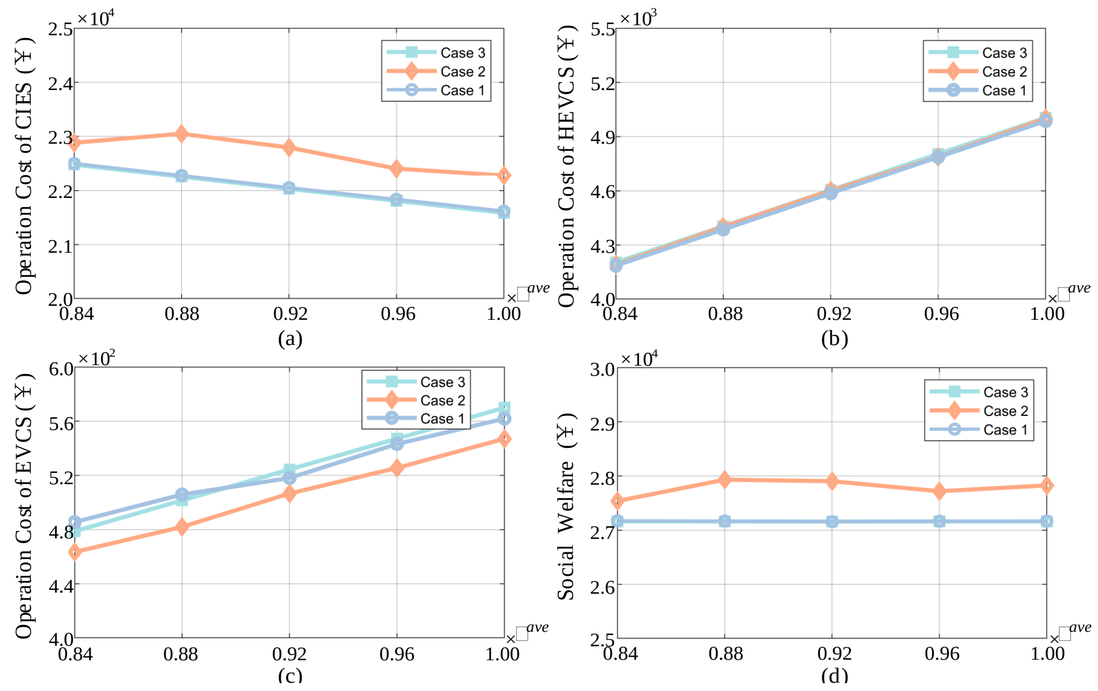
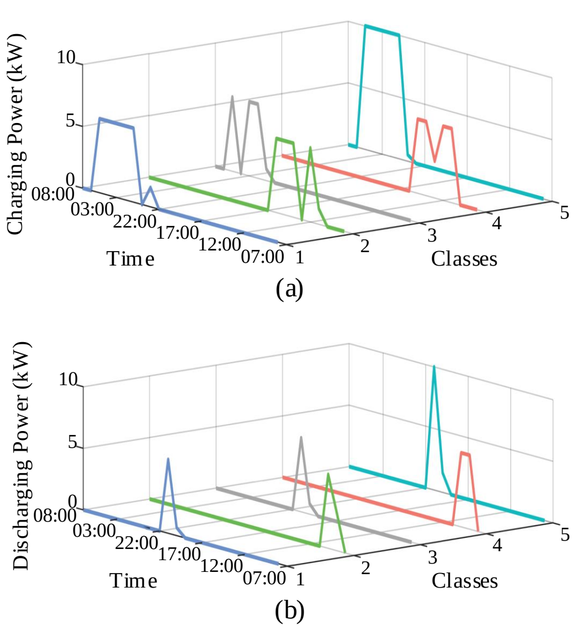


Fig. 2 Operation cost comparisons of each case

EVs OPERATION ANALYSIS



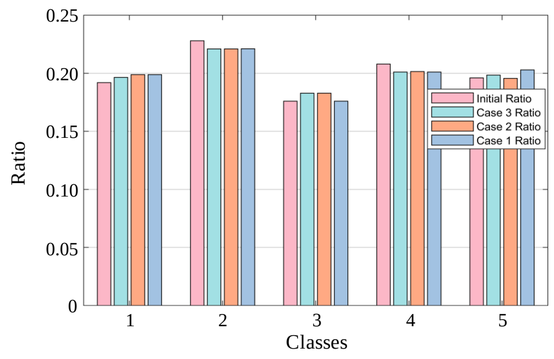


Fig. 5 Classes ratio of EVs

Fig. 4 Charging/Discharging Power

- EVs provide the V2G capability and also shows that DRO has the better robustness under the uncertainties of EVs.

CONCLUSION

- The proposed pricing model can achieve the lower operation cost compared with the cost under fixed pricing model.
- The safe operation range of HCT can be ensured by the proposed capacity model. Also, the model shows the good robustness of energy systems.