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Grid Flexibility Support of a Microgrid by Integrated Control of Distributed Energy Resources

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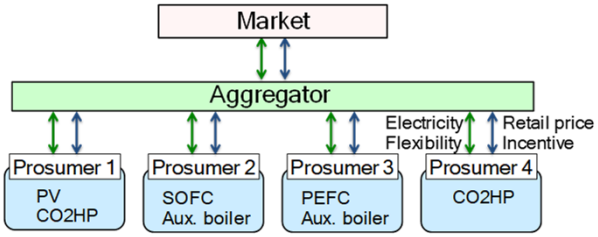
- Grid flexibility dispatch by controlling distributed energy resources (DER) of prosumers was proposed.
- DER are controlled by an energy management system (EMS) which is installed on-site.
- Possibility of flexibility dispatch by DER responding to incentives was evaluated by an operational simulation.

Introduction

- Power systems need more **flexibility** in adapting to the high penetration of variable renewable energy (VRE).
- The flexibility can be provided by demand-side by controlling distributed energy resources (**DER**).
- Flexibility dispatch by DERs responding time-of-use (TOU) rates change was evaluated by operation simulation including energy trading among an aggregator and prosumers.

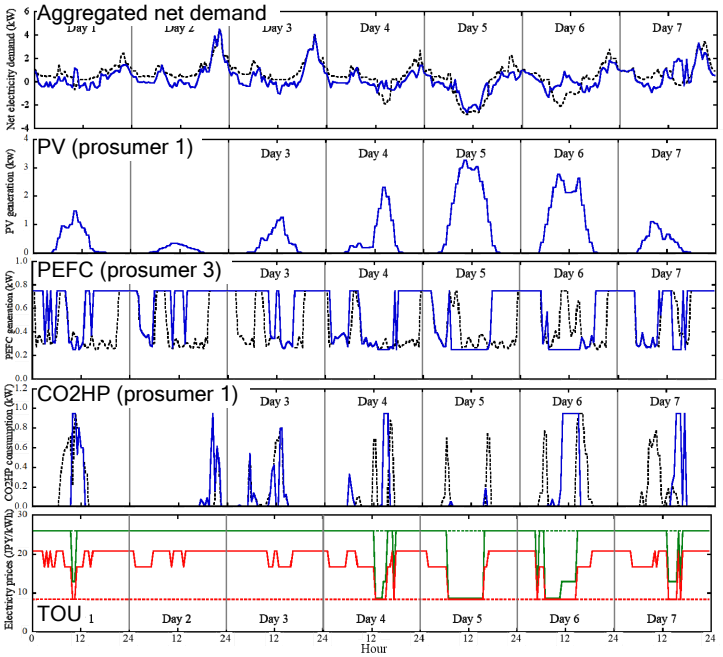
Case Studies by Simulation

- Interactions between an aggregator and prosumers.



Simulation Result

- 7 days in spring, summer, and winter
- 2 cases compared (Case 1: flat rate, Case 2: TOU rate applied)



Simulation results: operation in spring

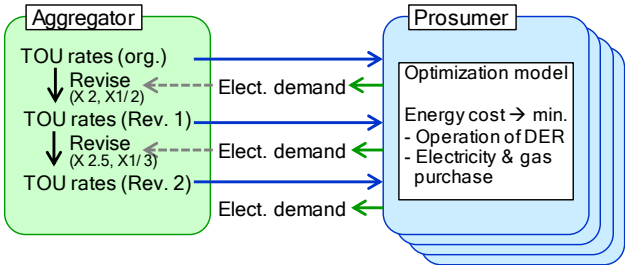
DER in Residential Dwellings

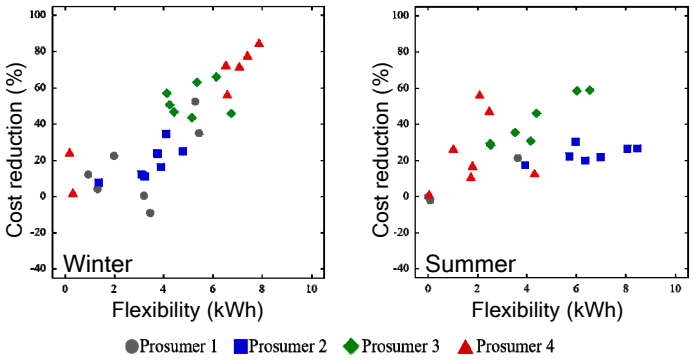
- Fuel cell CHP systems (FC-CHP)
  Natural gas → electricity & hot water
  Electricity generation: 0.70-0.75 kW
- CO2 heat pump water heater (CO2HP)
  Electricity → hot water
  Electricity consumption: 1.0-1.5 kW

Primal role: electricity and hot water supply
➡ No additional costs for flexibility supply
DER is cost effective resource for grid flexibility


(Panasonic)

- Revise TOU rates to aggregated net electricity demand flattening.





Simulation results: flexibility and cost reduction

- Spring & Winter: flexibility and cost reduction have linear relation. Prosumer 4: CO2HP provides large flexibility.
- Summer: Prosumers 2 and 3 provided large flexibility but cost reduction was small (hot water by FC-CHP wasted).

Conclusion

- Appropriate TOU rates and integrated control of DER contribute to flexibility and net electricity demand flattening. The effect varies to energy demand and types of DER.
- TOU rates are influenced by PV generation (= weather) because the peak generation of PV is large and its impact to electricity balance is significant.

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