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Carbon emission impact on the operation of virtual power plant with combined heat and power system

Key words: Virtual power plant (VPP), Carbon emissions, Electric boiler, Wind power, Combined heat and power (CHP)

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Motivation

- Managing the effect of fluctuations in the amount of available renewable resources on the operation of virtual power plant
- Maintaining an economical supply of electric power and heat energy for users
- Typically, the virtual power plant concept is originally used for smoothing of electric power generation without concerning the CO_2 emission
- The limitation of heat output from a combined heat and power (CHP) unit under the pattern of heat generation determined by electricity

Main idea

- Introduce the allocation of an electric boiler to realize wind power directly converted for supplying heat.
- The wind power was split into two parts. One is used to supply electric boiler for consumers' heat need, and the other is used to compensate for the reduced real power because of the decreasing heat output of CHP units.
- Reduce the frequent start-up of conventional units in VPPs caused by the fluctuation of renewable distributed generation output, and maximize the use of wind power.

Method

1. Introduce the carbon emission cost of virtual power plant to increase the marginal operation cost of conventional distributed generation and promote the consumption of renewable energy.
2. Establish a multi-objective model which includes the costs of carbon emissions, total operation of the VPP, and the electricity traded between the VPP and the main grid.
3. The model is solved by the CPLEX package using the fuzzy membership function in the Matlab environment.
4. Carry out numerical simulation under four scenarios based on the proposed model.

Major results

- The amount of traded energy under different scenarios

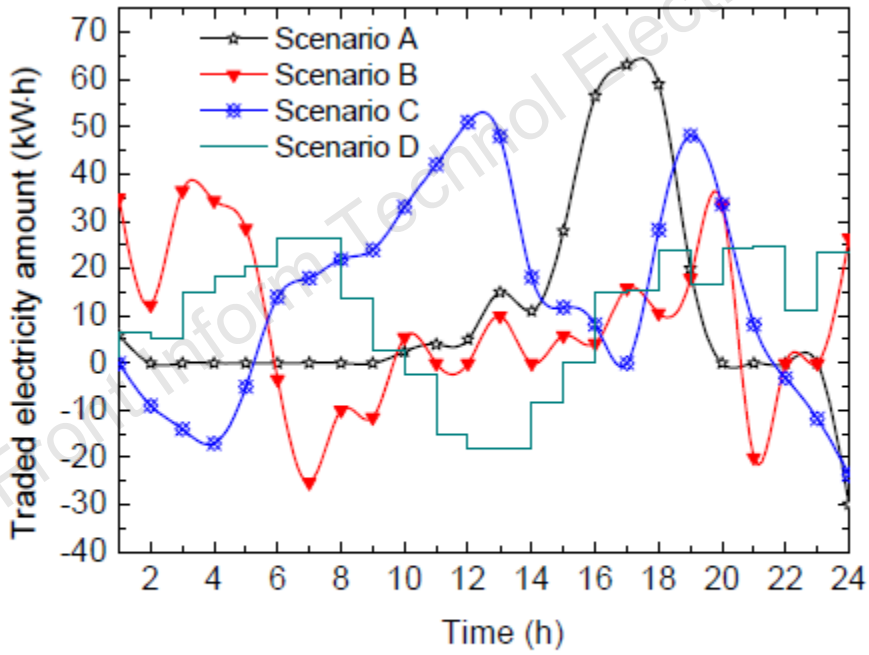

Fig. 9 Traded electricity between the virtual power plant and the main grid under different scenarios

Major results (Cont'd)

- Carbon emissions under different scenarios

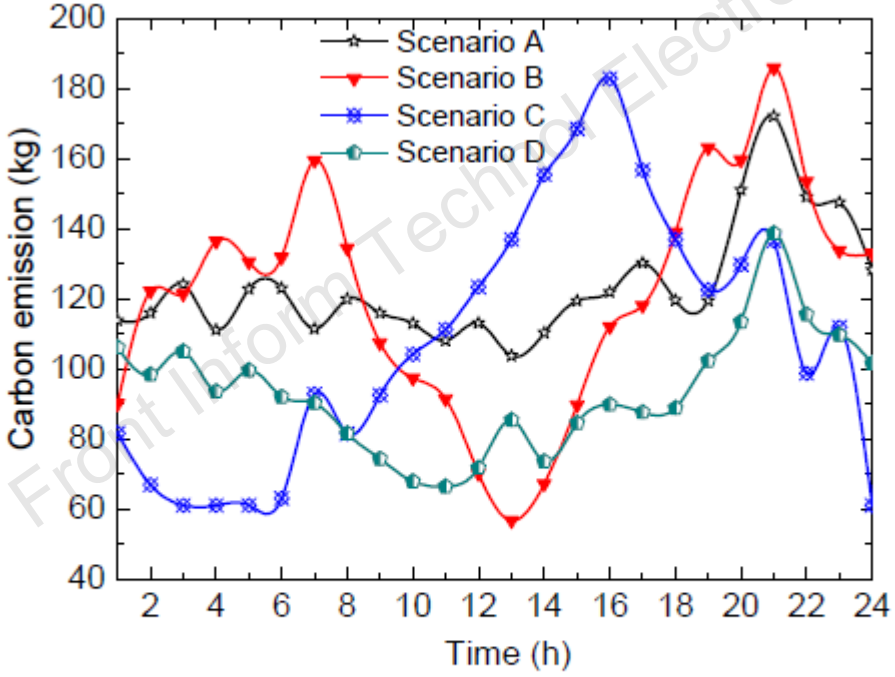

Fig. 10 The amount of carbon emitted under different scenarios

Conclusions

- After carbon emission is taken into account, the output of low carbon units is significantly increased.

- The allocation of an electric boiler can facilitate the maximum absorption of renewable energy, which also reduces carbon emissions from the VPP.