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Energy management for multi-microgrid system based on model predictive control

Key words: Microgrids; Energy management; Predictive control; Renewable energy; Controllable energy

Corresponding author: Ke-yong HU
E-mail: hukeyong@yeah.net
ORCID: Ke-yong HU, http://orcid.org/0000-0002-8963-6237

Motivations

1. The existing incentive methods use only the electricity price and load curve, rather than an electricity pricing mechanism, for the direct purpose of peak clipping and valley filling. Therefore, it is impossible to fully characterize peak clipping and valley filling.

2. Due to the development of the communication and signal processing technology, a microgrid can be regarded as an intelligent node, having many microgrids that can reduce the constraints in a power transmission network.

3. To reduce the computation complexity of the optimization algorithm used in energy management of a multi-microgrid system, an energy optimization management method based on model predictive control is presented.

Main ideas

1. The idea of decomposition and coordination is adopted to achieve the balance between power supply and user demand, and the power supply cost is minimized by coordinating surplus energy in the multi-microgrid system.

2. The energy management model and energy optimization problem are established according to the power flow characteristics of microgrids.

Methods

1. A dual decomposition approach is imposed to decompose the optimization problem into two parts, and a distributed predictive control algorithm based on global optimization is introduced to achieve the optimal solution by iteration and coordination.

2. The proposed algorithm has been compared with the particle swarm optimization (PSO) algorithm. The results show that, compared with PSO, the proposed method has better performance, faster convergence, and significantly higher efficiency.

Major results

1. The energy management model was applied to the multi-microgrid system working in the interconnected mode, and the dependence on controllable energy was greatly decreased.

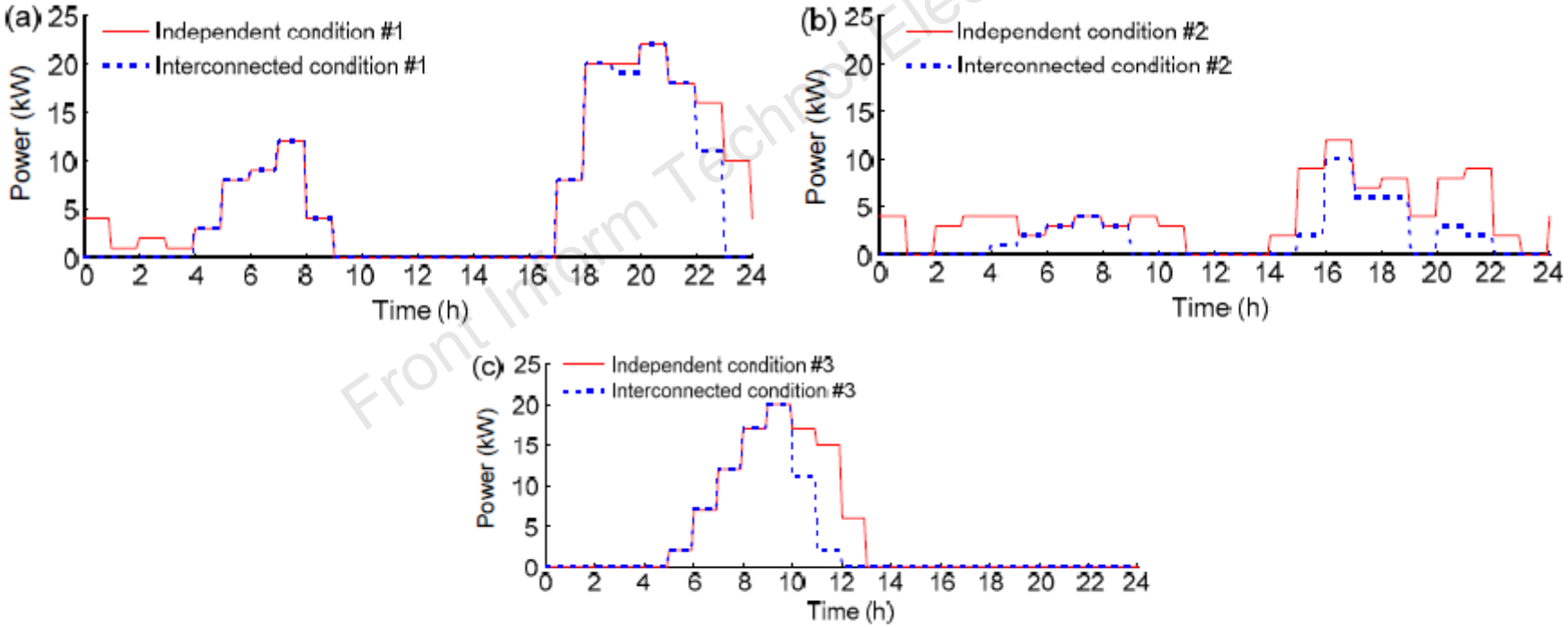

Fig. 10 Curves of the controllable power supply in independent and interconnected conditions of microgrids #1 (a), #2 (b), and #3 (c)

Major results

2. The convergence specification of the proposed algorithm has been analyzed and compared with that of PSO. The EMS-MPC requires less computation than EMS-PSO.

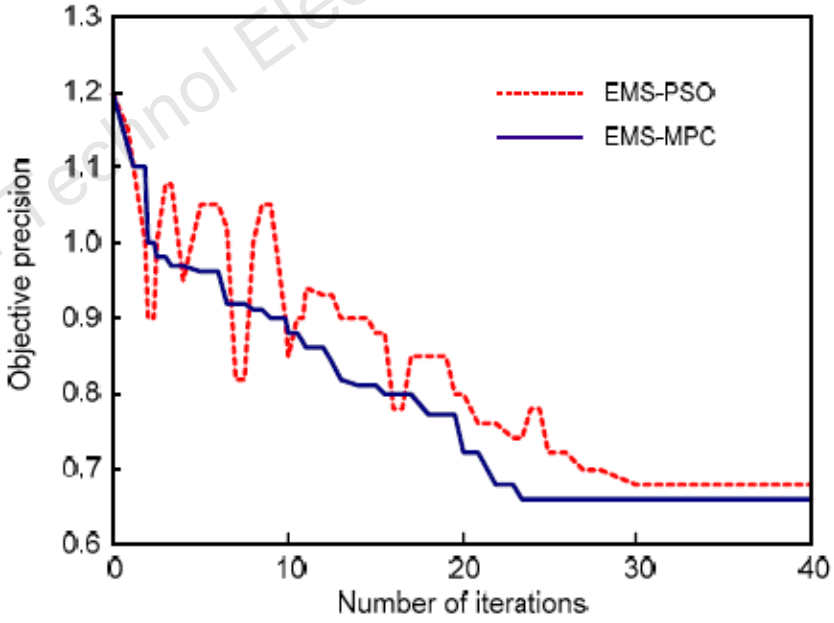

Fig. 12 Characteristics of convergence

Conclusions

1. A energy optimization management algorithm has been proposed based on model predictive control to reduce the computation complexity of an optimization algorithm. The idea of decomposition and coordination has been proposed to achieve the balance between power supply and user demand.

2. The approach decomposes the optimization problem into two parts, and a distributed predictive control algorithm based on global optimization is improved to achieve the optimal solutions by iteration and coordination.

3. The performance of the proposed algorithm has been compared with that of a PSO algorithm, and results show that the convergence speed of the proposed algorithm is increased and that a remarkable improvement of efficiency is achieved.