

Fangjie Gao, Congyi Ding, Yubin Wang, Qinqing Zhang and Yin Zhao, 2026, Research on three-layer cooperative robust optimal scheduling of rural integrated energy system based on potential game information gap, *Systems*, 14(6), 621.

<https://doi.org/10.3390/systems14060621>

Abstract A clean and efficient rural energy system is essential for building a modern energy system and for accelerating the transition to renewable energy in rural areas. Therefore, a robust collaborative optimal scheduling method for rural integrated energy systems is proposed, incorporating multi-agent gaming. First, a three-layer cooperative structure is developed based on current rural energy consumption patterns. Second, a scheduling model is formulated using potential game theory, with the objective of maximizing the overall benefits of all parties. The model also accounts for multi-energy complementarity, demand response, and multiple uncertainties, leading to a robust optimal scheduling framework based on information gap decision theory. The resulting problem is solved using a chicken swarm optimization algorithm improved by Lévy flight. Finally, a case study of the three-layer cooperative optimization model is presented. The results show that multi-energy complementarity can increase local renewable energy consumption and improve the economic efficiency of diverse energy use for rural consumers. Information gap decision theory helps balance economic and uncertain factors and supports decision-making for agents with different risk preferences.

Keywords rural integrated energy system; three-layer cooperative robust optimal scheduling model; multi-energy complementary; potential game; information gap decision theory.