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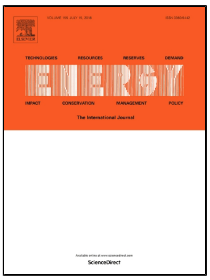

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The Optimal Structure Planning and Energy Management Strategies of Smart Multi Energy Systems

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Abstract:

Multi energy system is considered an effective pattern to improve the energy efficiency and reduce energy supply cost by integrating multi energy carriers. Face abundance energy convertor and storage devices with various characteristics, how to select the types and capacities of devices, how to connect and manage the selected devices are core challenging problems to design the optimal structures of new multi energy systems. A generic optimal planning framework and model is proposed to design multi energy systems, which can obtain both the optimal structure configuration and energy management strategies. The optimal planning problem is formulated as a mixed-integer linear programming model with the objective to minimize the overall cost. Three different energy system schemes are compared to demonstrate the effectiveness and advantages of the proposed optimal planning model. Simulation results show that the multi energy system designed by the proposed planning model (scheme 3) shows better economic and environmental performances than the conventional centralized energy system (scheme 1) and the typical combined cooling, heating and power systems (scheme 2). Compared with scheme 1, the total annual and carbon emission costs of scheme 3 decrease by 35.21% and 55.34%, respectively. While, compared to scheme 2, the total annual and carbon emission costs of scheme 3 decrease by 14.53% and 26.14%, respectively. Moreover, the robustness and performances of the optimization planning model are demonstrated through sensitivity and comparative analyses.

Keywords: Smart multi energy system, structure planning, energy management, energy convertor, energy storage, renewable energy.

Nomenclature

k	Index of devices	C_C	Capital cost, \$
t	Index of time slots	C_E	Energy cost, \$
i / j	Index of energy types	C_M	Maintenance cost, \$
s	Index of typical scenarios	C_{CE}	Carbon emission cost, \$
g	Index of purchased energy types	T	Total number of time slots in one day
MES	Multi Energy System	S	Total number of scenarios
SMES	Smart Multi Energy System	K	Total number of candidate devices
EH	Energy Hub	r	Interest rate
T	Transformer	Y	Payback period, year
GICE	Gas Internal Combustion Engine	θ_k	Capital cost of unit capacity, \$/kW, \$/kWh
GT	Gas Turbine	D_s	Number of days that scenario s represents
GB	Gas Boiler	λ_k	Unit maintenance cost, ¢/kWh
AC	Absorption Chiller	κ	CO_2 processing cost, \$/kg