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An Optimal Scheduling Model for a Hybrid Energy Microgrid Considering Building Based Virtual Energy Storage System

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Abstract

An optimal scheduling model for a hybrid energy microgrid considering the building based virtual energy storage system (VSS) is developed in this paper. The VSS model is developed by utilizing the building thermal equilibrium equation taking the heat storage characteristics of building into consideration. Firstly, mathematical models of various energy systems and VSS in the hybrid energy microgrid are developed. Then, an optimal scheduling model is developed to minimize the operation costs of the microgrid. Numerical studies demonstrate that the proposed optimal scheduling model can provide the microgrid with an effective and economical scheduling scheme and reduce the operation costs.

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Keywords: Microgrid; Optimal Scheduling; Virtual storage System (VSS); Low-carbon City

Nomenclature

Abbreviation

CHP	Combined heat and Power
VSS	Virtual Storage System

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HVAC	Heating, Ventilation and Air Conditioning
Variables:	
P^t_{grid} / P^t_{gas}	Electric/ Natural gas power purchases
P^t_{CHP}	Electric power generated by CHP
P^t_{EC}	Electric power consumed by electric chiller
P^t_{bt}	Charging and discharging power of the battery storage system
Parameters and constants	
C^t_e / C_{gas}	Wholesale electricity/natural gas price
P^t_{HVAC} / P^t_{other}	Electric power consumption of HVAC/ other devices in the building
$W_{bt,\min}$ / $W_{bt,\max}$	The minimum/maximum power storage of the battery storage system
P^t_{PV}	Electric power generated by photovoltaic
P^t_{MGL}	Electric loads of the microgrid without building
k_{wall} / k_{win}	Heat transfer coefficient of wall/window in the building
F_{wall} / F_{win}	Wall/Window area in the building
$T_{out,t}$ / $T_{in,t}$	Outdoor/ Indoor temperature
$\dot{I}_t$ / SC	Solar radiation/Shading coefficient
$Q_{man,t}$ / $Q_{ea,t}$	Internal heat gain caused by metabolism/ electric appliances in the building
Q^t_{AC}	Cooling generated by absorption chiller
ρ, C, V	The density, specific heat capacity and volume of the air in the building
η_{CHP} / η_{HE}	Efficiency of CHP/heat recovery system
γ_{CHP}	Thermoelectric ratio of CHP
COP_{AC} / COP_{EC}	Coefficient of performance of absorption chiller/electric chiller

1. Introduction

Renewable and distributed power generations have been recognized as solutions for safe, secure, sustainable and affordable energy production, distribution and consumption in the future low-carbon cities.