SCHEDULING APPROACHES FOR SMART ENERGY MANAGEMENT SYSTEMS

By

Mohamed Sayed Fathi Salhen

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Mechanical Design and Production Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2024

SCHEDULING APPROACHES FOR SMART ENERGY MANAGEMENT SYSTEMS

By

Mohamed Sayed Fathi Salhen

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Mechanical Design and Production Engineering

Under the Supervision of

Prof. Dr. Tamer F. Abdelmaguid

……..

Professor of Industrial Engineering
Mechanical Design and Production
Department, Faculty of Engineering,
Cairo University

Prof. Dr. Mohamed A. Shalaby

……..

Professor of Industrial Engineering
Mechanical Design and Production
Department, Faculty of Engineering,
Cairo University

Dr. Ahmed Shaban Shaban Khalifa

……

Associate Professor of Industrial Engineering
Mechanical Engineering Department
Faculty of Engineering,
Fayoum University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2024

SCHEDULING APPROACHES FOR SMART ENERGY MANAGEMENT SYSTEMS

By
Mohamed Sayed Fathi Salhen

A Thesis Submitted to the
Faculty of Engineering at Cairo University
in Partial Fulfillment of the
Requirements for the Degree of
MASTER OF SCIENCE
in
Mechanical Design and Production Engineering

Approved by the
Examining Committee

_____
Prof. Dr. Tamer F. Abdelmaguid **Thesis Main Advisor**

_____
Prof. Dr. Mohamed H. Gadallah **Internal Examiner**

_____
Prof. Dr. Mohamed Fahmy Aly **External Examiner**
- Professor of Industrial Engineering, Fayoum University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2024

Title of Thesis:

SCHEDULING APPROACHES FOR SMART ENERGY MANAGEMENT SYSTEMS

Key Words:
Smart grid; Smart home; Demand side management; Energy management systems; Household appliances scheduling

Summary:

Upgrading traditional grids to integrated smart grids in which household renewable energy sources are integrated with the national electricity grid helps in smart energy management. Energy management in smart grids depends on the exchange of information in real time between the electricity grid and the consumer.

The literature lacks scheduling models for household electrical appliances that consider all the characteristics and advantages of energy management systems in Egypt. This thesis introduces two mixed-integer quadratic programming (MIQP) mathematical models for managing energy in smart homes equipped with renewable energy sources. One of these models focuses on minimizing the cost of electricity, while the other focuses on maximizing consumer convenience through smart scheduling to operate electrical appliances under the inclined block rate (IBR) tariff and the net metering system adopted in Egypt. The models can be employed to schedule the household electrical appliances at the Egyptian household level and provide the optimal solution for determining the hours number and operating times for various appliances on a daily basis. Additionally, they determine the optimal amount of energy to be either purchased from or sold to the national electricity grid. The results confirm the ability of the two proposed MIQP models for managing household energy at the Egyptian household level