AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electrical Power and Machines Engineering

Optimal Demand Energy Management for Smart Distribution Networks

A Thesis submitted in partial fulfillment of the requirements of the degree of
Master of Science in Electrical Engineering
(Electrical Power and Machines Engineering)

by

Mohamed Wagdy El-Desouki Abdel-Ghany

Bachelor of Science in Electrical Engineering
(Electrical Power and Machines Engineering)
Faculty of Engineering, Ain Shams University, 2012

Supervised By

Associate Professor Walid Aly El-Khattam

Assistance Professor Amr Magdy Abden

Cairo - (2016)

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electrical Power and Machines Engineering

Optimal Demand Energy Management for Smart Distribution Networks

by

Mohamed Wagdy El-Desouki Abdel-Ghany

Bachelor of Science in Electrical Engineering
(Electrical Power and Machines Engineering)
Faculty of Engineering, Ain Shams University, 2012

Supervising' Committee

Name and Affiliation	**Signature**
Associate Professor Walid Aly Seif El-Islam El-Khattam Electrical Power and Machines Department, Faculty of Engineering, Ain Shams University	………………………….
Assistance Professor Amr Magdy Abden Electrical Power and Machines Department, Faculty of Engineering, Ain Shams University	………………………….

Date: 9 November 2016

AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING
Electrical Power and Machines Engineering

Optimal Demand Energy Management for Smart Distribution Networks

by

Mohamed Wagdy El-Desouki Abdel-Ghany

Bachelor of Science in Electrical Engineering
(Electrical Power and Machines Engineering)
Faculty of Engineering, Ain Shams University, 2012

Examiners' Committee

Name and Affiliation	**Signature**
Professor Omar Hanafy Abdalla Electrical Power and Machines Department, Faculty of Engineering, Helwan University.	……………….
Professor Mahmoud Abd EL-Hamid Mohamed Mostafa Electrical Power and Machines Department, Faculty of Engineering, Ain Shams University	……………….
Associate Professor Walid Aly Seif El-Islam El-Khattam Electrical Power and Machines Department, Faculty of Engineering, Ain Shams University	……………….

Date: 9 November 2016

Statement

This thesis is submitted as a partial fulfillment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Signature

…………………..……….

Mohamed Wagdy El-Desouki Abdel-Ghany

Date: 9 November 2016

Acknowledgments

The effort in putting together this research work has been shared by many people. Foremost, I am grateful of Allah for blessing me with intellect and knowledge to pursue this research work. I would like to thank Faculty of Engineering Ain Shams University for facilitating the platform for conducting this research work.

I sincerely thank my advisors *Dr. Walid El-Khattam* and *Dr. Amr Magdy* for giving me the opportunity to pursue my research under their guidance. It has been a great learning experience working with them. I would also like to express my deepest gratitude towards them for offering instructive advices at all times, treating me with endurance and constantly encourage me to improve during the course of this research.

Last, but not the least, I thank my family, fiancé, and friends who have been a constant source of encouragement and support for me throughout my research journey.

I am grateful of all the people who have supported, encouraged and helped me on this research.

Mohamed Wagdy El-Desouki Abdel-Ghany

Researcher Data

Name	**:** Mohamed Wagdy El-Desouki Abdel-Ghany
Date of birth	**:** 20/09/1989
Place of birth	**:** Cairo, Egypt
Last academic degree	**:** Bachelor Degree
Field of specialization	**:** Electrical Power Engineering
University issued the degree	**:** Ain Shams University
Date of issued degree	**:** July, 2012
Current job	**:** Teaching Assistant, Electrical Power and Machines Department, Faculty of Engineering, Ain Shams University, Cairo, Egypt.

Abstract

Utilities all over the world consider the wide spread integration of renewable energies in modern power systems which will reduce cost and minimize the environmental impact. The main problem that faces these kinds of resources is their nature which has changing profile curves of the power generated. Consequently, they have an effect on the ability to face the needed demand. One of the solutions to solve this mismatching issue between both the needed demand curves and available resource curves is through reshaping the demand curves to match the available source curves.

Utilities use Demand Side Management (DSM) programs to help in reducing their peak power purchases on the wholesale market. Consequently DSM programs can decrease the bill for customers. On the other hand DSM programs limit the cost that utilities needed to rebuild new stations for generation, transmission and distribution.

This thesis proposes implementation for Genetic Algorithm (GA) technique in solving the problem for mismatching of supply and load curves using DSM program. The proposed algorithm is implemented on a day with realistic demand and supply profiles.

The DSM strategy is implemented on the demand taking into consideration all different type of loads which are divided into different types of loads residential, commercial and industrial loads.

The proposed DSM optimization algorithm is carried out in two directions:

1- Scenario A [Load Shifting]:

***Case I*:**

Optimally maximizing the system LF through minimizes the gap area between the supply and the load curves. This process is carried out by shifting the load profile for all residential, commercial and industrial types.

***Case II*:**

Optimally maximizing the system LF through minimizes the gap area between the supply and the load curves. Unlike case I, the load shifting is carried out for all types while taking into consideration two different Time of Use (ToU) tariff.

***Case III*:**

Optimally maximizing the system LF through minimizes the gap area between the supply and the load curves. Unlike case I and case II, the load shifting is carried out based on a priority matrix (i.e. only for industrial type loads) and ToU constrains.

2- Scenario B [Valley Filling - Plug-in Hybrid Electric Vehicles (PHEVs)]:

***Case IV*:**

If the load shifting is not applicable, thus PHEVs can be used to supply the peak demand (i.e. supplying the shortage in the given utility supply at peak loads). This discharge is carried out at high prices while they are being charged (as loads) at off peak load (i.e. at low prices). Therefore, case IV optimally shifting the PHEVs charging time to minimize the charging cost while satisfying the required peak loads.

This thesis proposes solving the mismatch problem between the demand profiles and available sources profiles using GA technique. The obtained results from this thesis can be generalized to be applied in countries based on their load and available supply profiles. The countries can use the algorithm that proposed in this thesis to obtain the best match between the demand profiles and available sources profiles to maximizing the use of their renewable energy sources, maximizing the economic benefit and reducing their peak load demand.

Key Words: Demand Side Management, Genetic Algorithm, Negawatt

Table of Content

Contents

List of Tables

List of Figures

List of Abbreviations

DSM : Demand Side Management

GA : Genetic Algorithm

LF : Load Factor

ToU : Time of Use

PHEVs : Plug in Hybrid Electric Vehicles

HVAC : Heating Ventilation and Air Conditioning

MERIT : Mentored Experiences in Research, Instruction, and Teaching

TC : Total Cost