شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

بسم الله الرحمن الرحيم

HANAA ALY

شبكة المعلومات الجامعية

التوثيق الالكتروني والميكروفيلم

HANAA ALY

شبكة المعلومات الجامعية

التوثيق الإلكتروني والميكروفيلم

جامعة عين شمس

التوثيق الإلكتروني والميكروفيلم

قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها
علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

HANAA ALY

RENEWABLE ENERGY EMBEDDED PUBLIC OPEN SPACES

‘‘AN APPROACH TOWARDS SUSTAINABILITY”

By

Khlood Moustafa Mohammed Fouad

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
Architectural Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2021

RENEWABLE ENERGY EMBEDDED PUBLIC OPEN SPACES

‘‘AN APPROACH TOWARDS SUSTAINABILITY”

By

Khlood Moustafa Mohammed Fouad

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
Architectural Engineering

Under the Supervision of

Prof. Dr. Amr Mostafa Kamal EL-Halafawy

Professor of Architecture and Urban Design
Architecture Department
Faculty of Engineering, Cairo University

Prof. Dr. Ahmed Mohammed Amin Mohammed Amin

Professor of Architecture and Landscape
Architecture Department
Faculty of Engineering, Cairo University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2021

RENEWABLE ENERGY EMBEDDED PUBLIC OPEN SPACES

‘‘AN APPROACH TOWARDS SUSTAINABILITY”

By

Khlood Moustafa Mohammed Fouad

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
Architectural Engineering

Approved by the
Examining Committee

_____

Prof. Dr. Amr Mostafa Kamal EL-Halafawy, Thesis Main Advisor
Professor of architecture and urban design – Faculty of Engineering – Cairo University

_____

Prof. Dr. Ahmed Mohammed Amin Mohammed Amin, Advisor
Professor of architecture and landscape – Faculty of Engineering – Cairo University

_____

Prof. Dr. Ayman Hassan Ahmed Mahmoud, Internal Examiner
Professor of architecture and landscape and Head of Architectural Engineering Department -– Faculty of Engineering – Cairo University

_____

Prof. Dr. Mohammad Essmat El-Attar, External Examiner
Professor of Architecture and urban design - Faculty of Engineering - The British University

FACULTY OF ENGINEERING, CAIRO UNIVERSITY
GIZA, EGYPT
2021

Engineer: Khlood Moustafa Mohammed Fouad
Date of Birth: 11/11/1993
Nationality: Egyptian
E-mail: Khlood.mostafa90@gmail.com
Phone: 01093053387
Address: 96L – Pyramid Gardens, Giza

Registration Date: 1/3/2017
Awarding Date: …./…./2021
Degree: Master of Science
Department: Architectural Engineering

Supervisors:

Prof. Dr. Amr Mostafa Kamal EL-Halafawy
Prof. Dr. Ahmed Mohammed Amin Mohammed Amin

Examiners:

Prof. Dr. Mohammad Essmat El-Attar (External examiner)
Professor of Architecture - The British University
Prof. Dr. Ayman Hassan Ahmed Mahmoud (Internal examiner)
Prof. Dr. Amr Mostafa Kamal EL-Halafawy (Main advisor)
Prof. Dr. Ahmed Mohammed Amin (Advisor)

Title of Thesis:

RENEWABLE ENERGY EMBEDDED PUBLIC OPEN SPACES
‘‘AN APPROACH TOWARDS SUSTAINABILITY”

Key Words:
Sustainable urbanism; public open spaces; Landscape elements; Renewable energy technologies; Energy-scape elements

Summary:

Nowadays, most of countries face the energy demand crisis and the renewable energy approach is a core sustainable solution. At the same time, public open spaces are a mediator for many sustainable interpretations, but most of their landscape installations are applied for social interaction without regarding the availability of integrating new innovative renewable energy technologies as Eco landscape to be effective socially and environmentally. So, the research aims to induce new innovative applications and design guidelines for integrating energy-scape elements within public open spaces regarding the five main aspects of sustainable urbanism, which are the environmental, social, economic, organizational, and technological aspects, in order to create effective interactive renewable energy embedded environments.

Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute.

I further declare that I have appropriately acknowledged all sources used and have cited them in the references section.

Name: Khlood Moustafa Mohammed Fouad Date: …./…./2021

Signature:

Acknowledgments

I owe my deepest gratitude to my family who suffered the most until this work was completed.

Completing this thesis would not have been possible without the guidance and assistance of several individuals. I am sincerely grateful to each one of them.

First, I would like to thank my supervisors for their encouragements and support throughout my extended thesis process. I would like to thank **Prof. Dr. Amr El-Halafawy** for his help, guidance, and support, I will never forget all his advices that were helpful for my research and my personal life. I would like to thank **Prof. Dr. Ahmed Amin** for not giving up on me, encouraging and confronting me about my thesis all the time. I would never have finished this thesis without the help and encouragement of both of them.

Dr. Sara Tarek, thanks for supporting me in my study, and guidance in statistics.

Dr. Ayman Hassan, thanks for supporting me with references and guidance in my study.

Last but not least, I want to thank my friend **Eng. Dhalia Bassiony** for her continuous support and encouragement to continue the work.

Table of Contents

DISCLAIMER ..... **I**

ACKNOWLEDGMENTS ..... **II**

TABLE OF CONTENTS ..... **III**

LIST OF TABLES ..... **VII**

LIST OF FIGURES ..... **IX**

NOMENCLATURE ..... **XII**

ABSTRACT ..... **XIV**

CHAPTER 1 : INTRODUCTION **1**

1.1. INTRODUCTION 1
1.2. PROBLEM DEFINITION 2
1.3. RESEARCH QUESTIONS 2
1.4. RESEARCH OBJECTIVES 3
1.4.1. The main research objective 3
1.4.2. Secondary objectives 3
1.5. RESEARCH LIMITATIONS 3
1.6. RESEARCH METHODOLOGY 4
1.6.1. Part 1 (Theoretical approach): 4
1.6.2. Part 2 (Analytical approach) 4
1.6.3. Part 3 (Empirical approach): 5
1.7. RESEARCH COMPONENT 7

CHAPTER 2 : RENEWABLE ENERGY APPROACH FOR ACHIEVING SUSTAINABLE URBANISM **8**

2.1. INTRODUCTION 8
2.2. SUSTAINABILITY IMPACT ON URBAN DESIGN 9
2.2.1. Sustainability concepts 9
2.2.2. Sustainable urbanism approach 9
2.2.2.1. Aspects of sustainable urbanism 10
2.2.2.2. Principles of sustainable urbanism 13
2.3. TRANSITION TO THE SUSTAINABLE ENERGY URBANISM APPROACH 15
2.3.1. Energy concepts in nature and urban systems 15
2.3.2. Sustainable energy urbanism approach 17
2.3.2.1. Energy efficiency approach (Sustainable Energy Use) 18
2.4. RENEWABLE ENERGY AS A TOOL FOR SUSTAINABLE URBANISM 21
2.4.1. Renewable energy approach 21
2.4.2. Introduction to Renewable Energy Sources (RESs) 22
2.4.2.1. Solar energy 23
2.4.2.2. Wind energy 24
2.4.2.3. Hydropower energy 25
2.4.2.4. Geothermal energy 25

2.4.2.5. Biomass energy....26
2.4.3. Renewable energy concept and aspects of the sustainable urbanism 28
2.4.4. Renewable energy integration into cities 29
2.4.4.1. Renewable energy responsive urban planning (Centralized macro generation)....30
2.4.4.2. Renewable energy responsive urban design (Decentralized/ distributed electricity generation) 32
2.5. CONCLUSION 34

CHAPTER 3 : RENEWABLE ENERGY INTEGRATION INTO PUBLIC OPEN SPACES.... 35

3.1. INTRODUCTION 35
3.2. PUBLIC OPEN SPACES AS A TOOL FOR SUSTAINABLE URBANISM 35
3.2.1. Urban open spaces' definitions, types, and components 35
3.2.2. Sustainable green public open spaces 37
3.2.2.1. Aspects of sustainable green public open spaces....37
3.2.2.2. Principles of sustainable green public open spaces 40
3.2.2.3. Ecological regenerative infrastructure 40
3.3. RENEWABLE ENERGY EMBEDDED PUBLIC OPEN SPACES 42
3.3.1. Energy-scape elements 44
3.3.2. Technical study of energy-scape elements 45
3.3.3. Integration of energy-scape elements within public green open spaces 46
3.3.3.1. Solar energy-scape elements....47
3.3.3.2. Wind energy-scape elements 56
3.3.3.3. Hydropower energy-scape elements....60
3.3.3.4. Geothermal energy-scape elements....62
3.3.3.5. Biomass energy-scape elements....62
3.3.3.6. Human-based energy-scape elements....63
3.4. CONCLUSION 67

CHAPTER 4 : ENERGY-SCAPE DESIGN GUIDELINES 70

(OPERATIONAL STUDY OF THE ENERGY-SCAPE ELEMENTS) 70

4.1. INTRODUCTION 70
4.2. LITERATURE OF CURRENT STUDIES OF RENEWABLE ENERGY CONCEPTS WITHIN PUBLIC OPEN SPACES 70
4.2.1. The Sustainable Site Initiative (SITES) 71
4.2.2. Land Art Generator Initiative (LAGI) 71
4.2.3. Dynamic Loop System (DLS) 71
4.2.4. Triple Bottom Line (TBL) 72
4.2.5. Optimal Electricity Distribution (OED) 72
4.3. RENEWABLE ENERGY EMBEDDED PUBLIC OPEN SPACES GUIDELINES (REGARDING SUSTAINABLE URBANISM ASPECTS) 74
4.3.1. Environmental and visual aesthetic factor 75
4.3.1.1. Environmental and visual aesthetic barriers....75
4.3.1.2. Environmental and spatial aesthetic requirements....77
4.3.1.3. Practical example of the environmental and visual aesthetic factor....79
4.3.1.4. Guidelines for the spatial environmental factor....80
4.3.2. Social and user-related factors 80
4.3.2.1. Social barriers....80
4.3.2.2. Social requirements....81
4.3.2.3. Guidelines for the social factor 88
4.3.3. Organizational factor 89

4.3.3.1. Organizational barriers 89
4.3.3.2. Organizational requirements 89
4.3.3.3. Guidelines for the organizational factor 90
4.3.4. Economic factor 91
4.3.4.1. Economic barriers 91
4.3.4.2. Economic requirements 91
4.3.4.3. Guidelines for the economic factor 92
4.3.5. Technological factor 92
4.3.5.1. Technological barriers 92
4.3.5.1. Technological requirements 93
4.3.5.2. Guidelines for the technological factor 95
4.4. THE APPROPRIATED GUIDELINES FOR DESIGNING RENEWABLE ENERGY EMBEDDED PUBLIC OPEN SPACES 96
4.5. CONCLUSION 1

CHAPTER 5 : GLOBAL PROJECTS FOR CREATING RENEWABLE ENERGY EMBEDDED PUBLIC OPEN SPACES 99

5.1. INTRODUCTION 99
5.2. TOWARDS SELECTING THE PROJECTS OF THE KEY STUDY 99
5.2.1. Aims of studying global examples 99
5.2.2. Criteria for selecting the key study projects 99
5.2.3. The selected projects of global renewable energy embedded public open spaces 100
5.2.4. Methodology of analyzing the selected projects 100
5.2.4.1. Analyzing the compatibility of energy-scape element with the appropriated guidelines 101
5.3. ANALYSIS OF THE KEY STUDY PROJECTS 103
5.3.1. Ballast Point Park (BPP), Sydney, New South Wales (NSW) 103
5.3.1.1. Project overview 103
5.3.1.2. Project main objective 103
5.3.1.3. Identifying energy-scape elements 104
5.3.1.4. Identifying compatibility with the guidelines ofsustainable RE embedded public open spaces 104
5.3.1.5. Case study evaluation and conclusion 111
5.3.2. Freshkills park – LAGI competition, New York City (NYC) 113
5.3.2.1. Project overview 113
5.3.2.2. Project main objective 114
5.3.2.3. Identifying energy-scape elements 115
5.3.2.4. Identifying compatibility with the guidelines of sustainable RE embedded public open spaces 115
5.3.2.5. Case study conclusion 131
5.4. CONCLUSION 133

CHAPTER 6 : PREFERENCES OF RENEWABLE ENERGY EMBEDDED PUBLIC OPEN SPACES IN EGYPT 134

6.1. INTRODUCTION 134
6.2. MAIN OBJECTIVE 134
6.3. METHODOLOGY 135
6.4. EGYPTIAN CASE STUDY PROJECTS 136
6.4.1. Criteria for selecting the case study project 136
6.4.2. The selected RE embedded public open spaces in Egypt 136
6.4.3. Methodology of analyzing the selected project 138

6.4.4. Analysis of the selected project 138
6.4.4.1. Project overview 138
6.4.4.2. Project main objective 139
6.4.4.3. Analyzing the landscape components of the ZCP park 140
6.4.4.4. Identifying energy-scape elements 144
6.4.4.5. Identifying compatibility with the guidelines of sustainable RE embedded public open spaces 145
6.4.4.6. Case study evaluation 149
6.5. QUESTIONNAIRE DEVELOPMENT 151
6.5.1. Questionnaire aim 151
6.5.2. Questionnaire design 151
6.5.2.1. Section (A): General (personal) information 151
6.5.2.2. Section (B): Introductive questions 152
6.5.2.3. Section (C): Patterns specified questions 152
6.5.2.4. Section (D): General questions 158
6.5.2.5. Section (E): Aspects & guidelines priorities 158
6.5.3. Questionnaire Procedures 159
6.5.4. Questionnaire participants' sample 159
6.5.4.1. Demographic data summary 159
6.5.5. Questionnaire Results 161
6.5.5.1. Results of section (B): Introductive questions 161
6.5.5.2. Results of section (C): Patterns specified questions 162
6.5.5.3. Results of section (D): General questions 179
6.5.5.4. Results of section (E): Aspects & guidelines priorities 181
6.6. CONCLUSIONS 185

CHAPTER 7 : CONCLUSIONS, RECOMMENDATIONS, AND FUTURE RESEARCHES 190

7.1. INTRODUCTION 190
7.2. THEORETICAL PART CONCLUSIONS AND FINDINGS 190
7.3. ANALYTICAL AND EMPIRICAL STUDY CONCLUSIONS 192
7.4. RECOMMENDATIONS 193
7.5. FUTURE RESEARCH 194

REFERENCES 195

APPENDIX A: QUESTIONNAIRE SAMPLE (EXPERT & USER) 203

APPENDIX (B): QUESTIONNAIRE SAMPLE (EXPERT) 216

List of Tables

Table 3.1: Micro Concentrated Solar Power Technologies 48
Table 3.2: List of solar PV Technologies..... 49
Table 3.2: List of solar PV Technologies..... 50
Table 3.3: List of three other solar Technologies 51
Table 3.4: Patterns of different energy-scape applications in public urban open spaces 68
Table 4.1: Negative environmental impacts of each RET 76
Table 4.2: Renewable Energy Embedded Public Open Spaces Guidelines..... 97
Table 5.1: Analysis of the environmental aspect of Ballast Point Park's energy-scape element 105
Table 5.2: Analysis of the social aspect of Ballast Point Park's energy-scape element 107
Table 5.3: Analysis of the economic aspect of Ballast Point Park's energy-scape element 109
Table 5.4: Analysis of the organizational aspect of Ballast Point Park's energy-scape element 110
Table 5.5: Analysis of the technological aspect of Ballast Point Park's energy-scape element 111
Table 5.6: Analysing energy-scape element in Ballast Point Park..... 112
Table 5.7: Assessment for the LAGI 2012 energy-scape proposals..... 116
Table 5.8: Analysis of the environmental aspect of Scene-Sensor energy-scape element 121
Table 5.9: Analysis of the social aspect of Scene-Sensor energy-scape element..... 122
Table 5.10: Analysis of the economic aspect of Scene-Sensor energy-scape element 123
Table 5.11: Analysis of the technological aspect of Scene-Sensor energy-scape element 123
Table 5.12: Analysis of the environmental aspect of 99 Red Balloons energy-scape element 124
Table 5.13: Analysis of the social aspect of 99 Red Balloons energy-scape element . 125
Table 5.14: Analysis of the economic aspect of 99 Red Balloons energy-scape element 126
Table 5.15: Analysis of the technological aspect of 99 Red Balloons energy-scape element 127
Table 5.16: Analysis of the environmental aspect of Between memory and future energy-scape element..... 128
Table 5.17: Analysis of the social aspect of Between memory and future energy-scape element 129
Table 5.18: Analysis of the economic aspect of Between memory and future energy-scape element..... 130
Table 5.19: Analysis of the technological aspect of Between memory and future energy-scape element..... 131
Table 6.1: Landscape components of the ZCP park according to the classification used in the thesis; ceiling, flooring, walls, furniture, and activities..... 141
Table 6.2: Analysis of the environmental aspect of Zayed Central Park (ZCP) energy-scape element..... 146

Table 6.3: Analysis of the social aspect of Zayed Central Park (ZCP) energy-scape element 147
Table 6.4: Analysis of the economic aspect of Zayed Central Park (ZCP) energy-scape element 147
Table 6.5: Analysis of the organizational aspect of Zayed Central Park (ZCP) energy-scape element 148
Table 6.6: Analysis of the technological aspect of Zayed Central Park (ZCP) energy-scape element 149
Table 6.7: Analyzing energy-scape element in Zayed Central Park (ZCP) 150
Table 6.8: The proposed interactive energy-scape technologies that are proposed to be integrated into the current landscape elements of Zayed Central Park 153
Table 6.9: Demographic data summary (Users sample) 160
Table 6.10: Demographic data summary (Experts sample) 160
Table 6.11: Analysis charts for section (B) of questionnaire responses 162
Table 6.12: Analysis charts for the percentages of the questionnaire responses (section C) for ceiling energy-scape technologies 163
Table 6.13: Mean ratings of the questionnaire responses (section C) for ceiling energy-scape technologies 164
Table 6.14: Analyzing the most preferred ceiling energy-scape technologies 165
Table 6.15: Analysis charts for the percentages of the questionnaire responses (section C) for flooring energy-scape technologies 167
Table 6.16: Mean ratings of the questionnaire responses (section C) for flooring energy-scape technologies 168
Table 6.17: Analyzing the most preferred flooring energy-scape technologies 169
Table 6.18: Analysis charts for the percentages of the questionnaire responses (section C) for wall energy-scape technologies 170
Table 6.19: Mean ratings of the questionnaire responses (section C) for wall energy-scape technologies 171
Table 6.20: Analyzing the most preferred wall energy-scape technologies 172
Table 6.21: Analysis charts for the percentages of the questionnaire responses (section C) for furniture energy-scape technologies 174
Table 6.22: Mean ratings of the questionnaire responses (section C) for furniture energy-scape technologies 175
Table 6.23: Analyzing the most preferred furniture energy-scape technologies 177
Table 6.24: Analysis charts for the percentages of the questionnaire responses (section C) for activities energy-scape technologies 178
Table 6.25: Mean ratings of the questionnaire responses (section C) for activities energy-scape technologies 179
Table 6.26: Analysis charts for the questionnaire responses of section (D) 181
Table 6.27: Analysis charts for the questionnaire responses of section (E) 183