DEVELOPING A STRATEGIC DECISION-MAKING PROCESS FOR LOCAL ENERGY PLANNING AND URBAN LAND-USE EVALUATIONS: THE CASE FOR BALÇOVA GEOTHERMAL ENERGY

A Thesis Submitted to
the Graduate School of Engineering and Sciences of
İzmir Institute of Technology
in Partial Fulfillment of the Requirements for the Degree of

DOCTOR OF PHILOSOPY

in City and Regional Planning

by
Ahmet Kıvanç Kutluca

January 2009
İZMİR

We approve the thesis of **Ahmet Kıvanç KUTLUCA**

…………………………………………
Assist. Prof. Dr. Yavuz DUVARCI
Supervisor

…………………………………………
Assoc. Prof. Dr. Semahat ÖZDEMİR
Co-Supervisor

…………………………………………
Assoc. Prof. Dr. Gülden GÖKCEN
Co-Supervisor

…………………………………………
Prof. Dr. Zafer İLKEN
Committee Member

…………………………………………
Prof. Dr. Güneş GÜR
Committee Member

…………………………………………
Assist. Prof. Dr. Ömür SAYGIN
Committee Member

…………………………………………
Assist. Prof. Dr. Nicel SAYGIN
Committee Member

……………………
Date

…………………………………………
Assoc. Prof. Dr. Semahat ÖZDEMİR
Head of City and Regional Planning Department

…………………………………………
Prof. Dr. Hasan Böke
Dean of the Graduate School of
Engineering and Sciences

ACKNOWLEDGMENTS

I would like to thank all people who have helped and inspired me during my doctoral study.

I want to thank my advisor, Assist. Prof. Dr. Yavuz Duvarcı, for his guidance during my research and study. Especially, I would like to thank Assoc. Prof. Dr. Semahat Özdemir and Assoc. Prof. Dr. Gülden Gökcen as my co-advisor. Their perpetual energy and enthusiasm in research had motivated all their advisees, including me. Prof. Dr. Zafer İlken, Prof. Dr. Güneş Gür, Assist. Prof. Dr. Ömür Saygın and Assist. Prof. Dr. Nicel Saygın deserves special thanks as my thesis committee members.

In particular, I would like to thank my friends Işın Can, Uğur Bozkurt, Rabia Bolposta, Mine Ulema, Burcu Irgat, İpek Ek, Fulya Murtezaoğlu, Çağlayan Deniz Kaplan, Kader Reyhan, Özgü Hafızoğlu Özkan, Başak Güçyeter and Belgin Terim for their friendships and helps. Furthermore, I want to special thank Bahar Durmaz and Hamidreza Yazdani one more time for their moral supports, encouragements and friendships.

My deepest gratitude goes to my family for their unflagging love and support throughout my life; this dissertation is simply impossible without them. I am indebted to my father, Özer Kutluca and my mother, Şefika Kutluca, for their care and love.

Apart from these, I would like to thank to personals of İzmir Geothermal Incorporate Company, General Directorate of Mineral Research and Exploration and Balçova Municipality for their technical helps. Last, I would like to acknowledge The Scientific and Technological Research Council of Turkey (TUBITAK) as my research was supported in part by them under the 104 M 301 project.

ABSTRACT

DEVELOPING A STRATEGIC DECISION-MAKING PROCESS FOR LOCAL ENERGY PLANNING AND URBAN LAND-USE EVALUATIONS: THE CASE FOR BALÇOVA GEOTHERMAL ENERGY

The concept of ‘renewable energy’ for countries such as Turkey which are classified as poor, in terms of reserving the mentioned fossil energies could be an opportunity for being independent. ‘Geothermal Energy’ among the renewable energy sources in our country is known as an important type of valid and potential energy sources.

Design and land-use are closely linked to the energy efficiency levels for an urban area. The current urban planning practice does not involve an effective land-use-energy evaluation in its ‘blueprint’ urban plans.

The case of Balçova, a district in the Izmir Metropolitan area, is used conformingly for evaluating the proposed master plan and the “geothermal energy district heating system” use for the concern district.

The examination of the existing development plan with an “energy sensitive” point of view, determination of the questioning criteria’s, and the evaluation of alternative compromises that can be done on planning principles, form the originality of thesis. The construction is completed by the integration of these policy-plan- project scaled approaches during this evaluation.

According to the thesis main idea, the proposed energy sensitive land-use planning method can be an effective tool for planners as simulation media in GIS programs using, to evaluate efficiency levels for different plan proposals, letting to know how much energy saving causes how much deviation from the other planning ideals.

In the extent of the thesis, an alternative energy sensitive (integrated) land-use planning approach is aimed in the example of ‘geothermal energy district heating system’ by using development tools of land-use planning, planning brief and plans on ‘the increase in energy efficiency in urban settlement’ approach.

ÖZET

YEREL ENERJİ PLANLAMASI VE KENTSEL ARAZİ KULLANIMI ÖNERİLERİNİN DEĞERLENDİRİLMESİNDE STRATEJİK KARAR VERME SÜRECİNİN GELİŞTİRİLMESİ: BALÇOVA JEOTERMAL ENERJİ ÖRNEĞİ

"Yenilenebilir enerji" kavramı, özellikle Türkiye gibi fosil enerji türleri bakımından fakir olarak nitelendirilen ülkeler açısından dışa bağımlı olmayan enerji bağlamında çıkış noktası konumundadır. Yenilenebilir enerji türleri içerisinde mevcut ve bilinen potansiyelleri anlamında ülkemiz için önemli enerji çeşitlerinden biri de"jeotermal enerji"dir.

Kentsel alan bağlamında enerji verimliliği düzeyi ile tasarım ve arazi kullanım kararları arasında kuvvetli bir ilişki bulunmaktadır. Fakat günümüz kentsel planlama pratiği, enerji verimli arazi kullanımına dayalı kentsel planları içermemektedir.

İzmir Metropoliten Alanı içerisinde yer alan Balçova semti, jeotermal enerji bölgesel ısıtma sisteminin kullanımına dayalı öneri imar plan çalışmalarında örnek çalışma alanı olarak belirlenmiştir.

Enerjiye duyarlı mevcut imar planı bakış açısı, bu bakış doğrultusunda ilgili kıstas ve prensiplerin belirlenmesi ve bu prensipler ile genel planlama prensipleri arasında bir uzlaşım sağlanması, kurguları tezin özgün yanını oluşturmakta ve bu tez politika, plan ve proje ölçeklerinde ilgili yaklaşımların bir arada uyumuyla tamamlanmaktadır.

Tezin temel iddiası, enerjiye duyarlı arazi kullanım planlaması öneri metodunun plancılar için coğrafi bilgi sistemleri (CBS) kullanılması suretiyle simülasyon çalışmalarının avantajları, farklı plan önerilerinde enerji verimliliği değerinin ölçülebilmesi, ne kadar enerji biriktirilmesi karşılığında ne kadar planlama disiplininin ideallerinden sapma olduğunun bilinmesi açılarından etkin bir araç olabileceğidir.

Tez kapsamında "kentsel yerleşimlerde enerji verimliliğinin arttırılması" yaklaşımına planlama disiplininin uygulama araçları konumundaki plan kararları, plan notları ve planlar üzerinden, jeotermal enerji bölgesel ısıtma sistemi örneğinde, alternatif bir yaklaşım hedeflenmiştir.

TABLE OF CONTENTS

LIST OF FIGURES x

LIST OF TABLES.. xiv

CHAPTER 1. INTRODUCTION 1
1.1. Problem Statement 1
1.2. Aim of the Study and Limitations.. 4
1.3. Research Method 8

CHAPTER 2. THEORETICAL BACKGROUND ON RELATIONSHIP BETWEEN ENERGY AND URBAN LAND-USE CONCEPTS 12
2.1. Literature Review on the Relationship between Energy and Urban Land-use Planning System.. 14
2.1.1. Energy Integrated Urban "Land-use" Planning System................ 15
2.1.1.1. Tools of Energy Integrated Urban "Land-use" Planning System.. 17
2.1.1.2. Models of Energy Integrated Urban "Land-use" Planning System.. 22
2.1.1.3. The Relationship between Urban Models and Energy Integrated Urban Land-use Planning System.......... 23
2.1.2. Energy Integrated Urban Land-use Planning in Renewable Energy Context.. 29
2.1.2.1. International Renewable Energy Cases and Energy Integrated Urban Land-use Planning....................... 30
2.1.2.2. Renewable Energy Technologies and Energy Integrated Urban Land-use Planning.. 33
2.1.2.3. Renewable Energy Technologies and Energy Integrated Urban Land-use Planning System in Sustainable Urban Energy Planning Approach.. 34
2.1.3. Energy Integrated Urban Land-use Planning in Geothermal Energy Context.. 38
2.1.3.1. International Development and Regulatory Requirements of Geothermal Energy 38
2.1.3.2. Geothermal Potential in Turkey 45
2.1.3.3. Environmental Aspects of Geothermal Energy Integrated Urban Land-use Planning System 51
2.2. Overview on the Relationship between Energy "Geothermal Energy" and Urban Land-use Planning System................................. 56
2.2.1. The Variables about Geothermal Energy Integrated Urban Land-use Planning System.. 58
2.2.1.1. Independent Variables.. 58

2.2.1.2. Intervening Variables 63
2.2.1.3. Dependent Variables 64
2.2.2. The Variables Diagram about Geothermal Energy Integrated Urban Land-use Planning System 65

CHAPTER 3. METHOD 67
3.1. The Framework of the Study: Methodological Novelty 67
3.2. Defining the Problem 69
3.3. Data Gathering Method 69
3.3.1. Literature Review and Variable Diagram 70
3.3.2. Components of Method Procedures 71
3.4. Data Compilation Procedures 72
3.5. Data Analysis Procedures 76
3.5.1. The Data of Balçova Case Area and Reservoir-Infrastructure Systems of Geothermal Energy 77
3.5.2. The Data of Socio-economic Context 78
3.5.3. The Data of Land-use Context 80
3.6. Comparing and Measuring the Fidelity of the Energy Sensitive Plan Proposals 81
3.6.1. Simulation and Decision Support System for Planning 82
3.6.2. Energy Sensitive Alternative Planning Model 83
3.7. Findings and Recommendations “Existing and Alternative Plan Analysis” 84

CHAPTER 4. ANALYZING THE DATA OF GEOTHERMAL ENERGY INTEGRATED URBAN LAND-USE PLANNING IN BALÇOVA CASE AREA 86
4.1. Case Area Data Analysis of Balçova District 86
4.1.1. Definition of the Case Area in Balçova District 87
4.1.1.1. Historical Development of Balçova District 87
4.1.1.2. Geographical Location of Balçova District 88
4.1.1.3. Social, Economic and Sectoral Developments of Balçova District 88
4.1.2. The Geothermal Reservoir and Geothermal Infrastructure System in Balçova District 90
4.1.2.1. Geothermal Reservoir and System Features 91
4.1.2.2. Geothermal Reservoir and System Affects 96
4.1.3. Socio-economic Background of the Balçova District 100
4.1.4. Urban Planning Background of Balçova District 102
4.1.4.1. Development Plan (1/1000 Scale) and Master Plan (1/5000 Scale) of Balçova District 103
4.1.4.2. Proposed İzmir Master Plan (1/25000 Scale) 104
4.1.4.3. Proposed Manisa- Kütahya- İzmir Planning Region Environmental Plan (1/100000 Scale) 105
4.1.5. The Local Regulation of Geothermal Energy in İzmir 107

4.2. The Socio-economic Data Analysis of Balçova Case Area about Geothermal Energy Integrated Urban Land-use Planning....... 109
4.2.1. Data Compilation about Socio-economic Survey....................... 110
4.2.2. The Evaluation of the Survey Data about Socio-economic Survey 111
4.2.2.1. General Socio-economic Indicators of Population............. 111
4.2.2.2. Technical and Legal Situation of Buildings........................ 116
4.2.2.3. Expectations about GEDHS 121
4.3. The Land-use Data Analysis of Balçova Case Area about Geothermal Energy Integrated Urban Land-use Planning................. 129
4.3.1. Land-use Analysis of Geothermal Energy and Previous Researches.. 129
4.3.2. Data Collecting Process 130
4.3.3. The Evaluation of the Results 130
4.4. Overview of the Data Analysis on Geothermal Energy Integrated Urban Land-use Planning Approach.. 152

CHAPTER 5. THE MODEL APPLICATION FOR GEOTHERMAL ENERGY DISTRICT HEATING SENSITIVE ALTERNATIVE PLAN: BALÇOVA CASE AREA 156
5.1. Simulation Approach 157
5.2. Development Plan of Balçova Case Area.. 159
5.3. Alternative Energy Sensitive Plan for Balçova Case Area................ 160
5.3.1. The Criterion: “Parcel Size and Vacancy for Drilling and Fault Line” 161
5.3.2. The Criterion: “Residence Equivalence and Development Plan Building Ratio” 163
5.3.3. The Criterion: “Heat Load Density of Buildings” 164
5.3.4. The Criterion: “User Energy Density (Land Block Density)”.... 167
5.3.5. The Criterion: “Mixed Land-use (Residence-office Ratio)”....... 168
5.4. The Evaluation of the Results about Geothermal Energy Sensitive Alternative Development Plan of Balçova Case Area....... 176
5.5. Overview of the Geothermal Energy Sensitive Alternative Plan of Balçova Case Area... 179

CHAPTER 6. CONCLUSION 182

REFERENCES 190

APPENDICES

APPENDIX A. NATIONAL STANDARDS, REGULATIONS, CODES AND LAWS RELATED TO GEOTHERMAL ENERGY SUBJECT OF TURKEY 205

APPENDIX B. QUESTIONNAIRE FORMS OF DATA COLLECTION FOR SOCIO-ECONOMIC AND LAND-USE ANALYSES 212
APPENDIX C. THE VALUES OF REAL ESTATE AND LAND CONTEXT RESEARCHES OF BALÇOVA DISTRICT 215
APPENDIX D. GENERAL SOCIO-ECONOMIC BACKROUND OF BALÇOVA DISTRICT 228

LIST OF FIGURES

Figure **Page**

Figure 2. 1. The relationship between the energy system and spatial structure 13
Figure 2. 2. Typical energy use in urban context.. 18
Figure 2. 3. Alternative urban forms.. 24
Figure 2. 4. Energy supply densities.. 26
Figure 2. 5. Hypothetical urban forms about relationship between urban land-use pattern and travel/transport energy requirements by (a) Hemmens (1967), (b) Stone (1973)……………..……………………………………25
Figure 2. 6. Hypothetical urban forms about relationship between land-use pattern and urban densities; “Compact City” by Dantzig and Saaty and “Archipelago Pattern City” by Magnan and Mathieu................................ 27
Figure 2. 7. The archetypal forms 28
Figure 2. 8. The Lindal diagram on typical fluid temperatures for direct applications of geothermal resources... 39
Figure 2. 9. Direct-use of geothermal energy different sectors 40
Figure 2. 10. Geothermal development permitting process in the U.S. 43
Figure 2. 11. The variable diagram of geothermal energy integrated urban land-use planning system 66
Figure 3. 1. The flowchart of the thesis “Geothermal Energy District Heating System (GEDHS) Utilization in Land-use Plan” framework 68
Figure 3. 2. The process of “Mixed Research Method” design strategies...................... 72
Figure 4. 1. Geological maps of Balçova geothermal field 92
Figure 4. 2. The wells points and dimensions case area in Balçova district.................. 97
Figure 4. 3. A classification depending on these effects of the housing prices by local real-estate agencies in Balçova district 99
Figure 4. 4. A classification groups depending on these effects of the housing prices by local real-estate agencies in Balçova district............................... 99
Figure 4. 5. Total population in case neighborhoods of Balçova district 101
Figure 4. 6. Total household population in case neighborhoods of Balçova district 102

Figure 4. 7. The household size ratio in case neighborhoods of Balçova district 102
Figure 4. 8. An average household size for case area in Balçova district 113
Figure 4. 9. An average age situation for case area in Balçova district........................ 114
Figure 4. 10. The percentage of educational level for case areas in Balçova district 114
Figure 4. 11. The percentage of employment level for case areas in Balçova district 115
Figure 4. 12. The percentage of social assurance situation for case areas in Balçova district... 116
Figure 4. 13. The percentage of building age level for case areas in Balçova district 117
Figure 4. 14. The percentage of building size for case areas in Balçova district 117
Figure 4. 15. The percentage of building ownership situation for case areas in Balçova district... 118
Figure 4. 16. The percentage of building value for case areas in Balçova district....... 119
Figure 4. 17. The percentage of geothermal using situation for case areas in Balçova district 120
Figure 4. 18. The percentage of energy using types for case areas in Balçova district 120
Figure 4. 19. The average heating costs for case areas in Balçova district 121
Figure 4. 20. The percentage the reason of moving in Balçova district 123
Figure 4. 21. The percentage of willingness to moving out from Balçova district 124
Figure 4. 22. The percentage of knowledge about utilization of geothermal energy in Balçova district.. 124
Figure 4. 23. The percentage of utilization of geothermal energy facilities in Balçova district... 125
Figure 4. 24. The percentage of the changing of population in Balçova district.......... 126
Figure 4. 25. The percentage of the change in property values in Balçova district...... 126
Figure 4. 26. The percentage of the change of new work and employment situation in Balçova district 127
Figure 4. 27. The percentage of the change of deed ownership in Balçova district..... 127
Figure 4. 28. The percentage of the positive effects of geothermal energy in Balçova district 128

Figure 4. 29. The percentage of the negative effects of geothermal energy in Balçova district 128
Figure 4. 30. The geothermal energy utilization areas in Balçova district 131
Figure 4. 31. The relationship between the number of floors and geothermal energy utilization in Balçova district 132
Figure 4. 32. The relationship between the number of floors and geothermal energy utilization in Balçova district 133
Figure 4. 33. The relationship between the number of units in buildings and geothermal energy utilization in Balçova district 134
Figure 4. 34. The relationship between the number of units in blocks and geothermal energy utilization in Balçova district 135
Figure 4. 35. The relationship between population ratio and geothermal energy utilization in Balçova district 136
Figure 4. 36. The relationship population ratio and geothermal energy utilization in Balçova district 137
Figure 4. 37. The relationship between land value and geothermal energy utilization in Balçova district 138
Figure 4. 38. The relationship between land value and geothermal energy utilization in Balçova district 139
Figure 4. 39. The relationship between building unit value and geothermal energy utilization in Balçova district 140
Figure 4. 40. The relationship between building value and geothermal energy utilization in Balçova district 141
Figure 4. 41. The relationship between existing building.-residence equivalent and geothermal energy utilization 142
Figure 4. 42. The relationship between existing buildings and residence equivalent ratio in Balçova district 143
Figure 4. 43. The relationship between land ownership and geothermal energy utilization in Balçova district 144
Figure 4. 44. The relationship between land ownership and geothermal energy utilization in Balçova district 145
Figure 4. 45. The relationship between mixed land-use and geothermal energy utilization in Balçova district 146

Figure 4. 46. The relationship between office/house ratio and geothermal energy utilization in Balçova district.. 147
Figure 4. 47. The relationship between land block density and geothermal energy utilization in Balçova district.. 148
Figure 4. 48. The relationship between building types and geothermal energy utilization in Balçova district.. 149
Figure 4. 49. The relationship between heat load density and geothermal energy utilization in Balçova district.. 150
Figure 4. 50. The relationship between heat load density of buildings and geothermal energy utilization in Balçova district................................... 151
Figure 5. 1. Development Plan for Balçova case area 161
Figure 5. 2. "Parcel Size and Vacancy for Drilling and Fault Line" analysis of Balçova case area 171
Figure 5. 3. "Residence Equivalence and Development plan Building Ratio" analysis of Balçova case area.. 172
Figure 5. 4. "Heat Load Density of Buildings" analysis of Balçova case area 173
Figure 5. 5. "User Energy Density (Land Block Density)" analysis of Balçova case area 174
Figure 5. 6. "Mix Land-use (Residence- Office Ratio)" analysis of Balçova case area 175
Figure 5. 7. Geothermal energy integrated alternative urban land-use plan................ 181

LIST OF TABLES

Table **Page**

Table 2. 1. Energy demand of different urban functions 18
Table 2. 2. The tools of energy integrated planning system 19
Table 2. 3. Renewable energy technologies by energy sources and final users in urban environment 35
Table 2. 4. Topics in the code of practice for deep geothermal resources...................... 44
Table 2. 5. City based geothermal district heating systems installed in Turkey............. 46
Table 2. 6. Total area of greenhouse heated 565000m^2 by geothermal energy in Turkey 46
Table 2. 7. Legal, regulatory and institutional problems and proposal approaches in Turkey 48
Table 2. 8. National standards, regulations, codes and laws related to geothermal energy subject 49
Table 2. 9. Geothermal resource characteristics and the effects on development and the environment.. 52
Table 2. 10. The negative effects of geothermal wells on physical environment........... 53
Table 2. 11. Social assessment process of geothermal energy 55
Table 3. 1. The strengths and weaknesses of case study data collection........................ 74
Table 3. 2. Main forms of data collection 79
Table 4. 1. Geothermal wells situation in Balçova district………………………...…93
Table 4. 2. Chronological development process of “Balçova Geothermal District Heating System” 94
Table 4. 3. Heating areas and values of Balçova geothermal field................................ 95
Table 5. 1. The influence of the fault lines and wells conservation zones 162
Table 5. 2. The classifications and ratios of heat load density of buildings 166
Table 5. 3. The influence of the ratios of heat load density of buildings 166
Table 5. 4. The classifications and ratios of user energy density 167
Table 5. 5. The influence of the ratios of user energy density..................................... 167
Table 5. 6. The classifications of building type situation 169
Table 5. 7. The influence of the ratios of mixed land-use 170
Table 5. 8. The variables and land-use impact values 177

Table 5. 9. The comparing the development plan and energy sensitive alternative plan (Fidelity Rate) 178

ABBREVIATIONS

BLM	- Bureau of Land Management (in the U.S. Department of Interior)
BP	- Bank of Provinces
CHP	- Combine Heat and Power
CO_2	- Carbon Dioxide
CREST	- Center for Renewable Energy and Sustainable Technology
DH	- District Heating
DISCUS	- Developing Institutional and Social Capacities for Urban Sustainability
EC	- Energy Cites
EIS	- Environmental Impact Statement
EMRA	- Energy Market Regulatory Authority
EU	- European Union
EVU	- Energy Value Used
FAR	- Floor Area Ratio
FCCC	- Framework Convention on Climate Change
GAR	- Ground Area Ratio
GEA	- Geothermal Energy Association
GEDHS	- Geothermal Energy District Heating System
GEO	- Geothermal Education Office
GHC	- Geothermal Heating Center
GIS	- Geographical Information System
GRC	- Geothermal Resource Council
GRO	- Geothermal Resources Operational Orders
GSA	- Geothermal Steam Act
GTI	- Gas Technology Institute of US
GWh	- Gig Watt Hours
Hmax	- Maximum Height
ICLEI	- International Council for Local Environmental Initiatives
IEA	- International Energy Agency
IGA	- International Geothermal Association
IGIC	- İzmir Geothermal Incorporate Company
IZTECH	- İzmir Institute of Technology

Kcal/h - Kilocalorie per Hours

Kcal/hm2 - Kilocalorie per Hour's Square Meter

KWh - Kilowatt Hours

MMBtu - One Million British Thermal Units

MRE - General Directorate of Mineral Research and Exploitation

MRM - Mixed Research Method

MW - Megawatt

NEPA - National Environmental Policy Act

NGO - Non-Governmental Organization

NU - Number of Units

OESD - Organization for Economic Co-operation and Development

RE - Residence Equivalent

PSD - Passive Solar Design

RTPI - Royal Town Planning Institute

SANZ - Standards Association of New Zealand

SCN - Smart Communities Network

SEE - Sustainable Energy Europe

SHW - General Directorate of State Hydraulic Works

TSI - Turkish Statistical Institute

UCTEA - Union of Chambers of Turkish Engineers and Architects

UNCED - United Nations Conference on Environment and Development

UNEP - United Nations Environmental Program

USDOE - United States of Department of Energy

USGS - United States Geological Survey

WB - World Bank

WCED - World Commission on Environment and Development

WGC - World Geothermal Association

CHAPTER 1

INTRODUCTION

1.1. Problem Statement

Acknowledging the ultimate importance of energy, especially in the last century, this thesis focuses on the interaction between land-use planning and the energy. Within the context of this thesis firstly present planning approaches are criticized and existing problems of insufficient relationship between energy and planning are analyzed. Then, the issue is questioned in the particular case of geothermal energy utilization. Disintegration problem is defined based on three major subjects such as geothermal energy district heating system (GEDHS) which includes geothermal capacity, geothermal infrastructure system, land-use planning and related policies.

Improvements in effective use of energy and existing renewable energy sources have been one of the major research topics for sustainable urban developments. In this context, The process of World Energy Conference in Munich (1980), the preparation of "In Our Common Future- Brundtland Report" by World Commission on Environment and Development (1990), the "Earth Summit" by The United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro (1992), Agenda 21 in Geneva (1992), Framework Convention on Climate Change (1994), World Climate Conference (1995), Habitat II Conference on Human Settlements in Istanbul (1996) and the "Kyoto Protocol" (1997), the other international conventions started all over the world because of the wake of the oil crises (1973) and Chernobyl Accident (1986) and the "low energy path" is proposed as the best way towards a sustainable future for energy efficiency and renewable energy concept.

However, the energy concepts are not well integrated into planning process in detail with all parameters, such as effective energy consumption, efficiency, equality and conservation as the indicators for the relationship between energy and planning process in all levels; form, design and planning (Odell 1975, Owens 1986, Sadownik and Jaccard 2001, Means 2004, Peker 2004). There is strong relationship between energy and planning issues such as land-use, built form, transportation and urban form-infrastructure systems; (1) Planning decision of land-uses and the form of the built environment affect the intrinsic energy needs: low density urban sprawl generates a greater need to travel more than a compact pattern of mixed land-use where the physical separation of activities, as well as infrastructure costs (Hemmens 1967, Owens 1989, OECD 1995). (2) The pattern of land-uses, transportation and infrastructure is fundamental to local transport energy demand and its environmental effects (Beck 1973, Clark 1974, RTPI 1996). (3) The other important concept is the design of built environment both at urban and building scale for energy efficiency and energy consumptions (Bergman 1976, CHP Group 1977, Jessop 1978, Turrent, et al. 1981, Jebson 1981, Lundqvist 1985, Owens 1986, Fanchiotti 1993).

In the special case of geothermal energy use, inadequate planning of energy efficiency is the most important problem. Still, the issue of energy and especially geothermal energy is not included within the studies of problem definition in planning in all scales such as from urban to regional.

The capacity, efficiency and the location of geothermal reservoir have been one of the most important issues of the land-use planning of the geothermal energy. The number of users to be benefited from the existing capacity and the location choice of the settlements are another basic component of the problem definition of this study. First of all, the use of geothermal energy should be studied in relation to planning in all scales such as regional planning and urban design. The thermal fluid of geothermal energy can be used in many area; direct heating in residential (space heating, bathing, swimming), agricultural (greenhouse- farm heating, aquaculture pond heating, agricultural drying) and industrial functions (cooling, snow melting, chemical refrigeration). These applications can partly dictate the form of land-use planning (residential, agricultural industrial regions) that should be considered in all scales of planning. Therefore, wrong functional choices that are not suitable to these classifications cause many sorts of costs and constitute problems in the effective provision of the geothermal source.

The changes in the regulations and laws and the innovations in the nation-wide technological improvements in geothermal infrastructure development are other related subject of the land-use planning of the geothermal energy. The energy dimension is not well studied with all dimensions in both planning laws, regulations and geothermal energy related laws, regulations at national and local government levels (Serpen 2003). The concern is confined only to the problems of energy transmission lines and transformers, etc. On the other hand, being a site dependent issue, the field of geothermal energy concept has some improvements on legal issues such as developing at least reserving a special "zoning" as "geothermal conservation zone" and usage of the underground geothermal reservoir. However, the legal judgments about the planning of these renewable energy types related to their regions have some insufficiencies. Moreover, it should be stated that the delay of geothermal law up to the middle of 2007 and the development of the related regulation have some major impacts (Kutluca and Gökcen 2007).

Another important subject is the equity matter; who are to be benefited from the resource, and its rent distribution which constitutes another dimension of planning and effective distribution of the resources, politics of central and local decision makers and addressing to the needs of the stakeholders that take part in participation of the provision, or other legal rights, Non-Governmental Organizations (NGOs) and local community leaders. Thus, the projects about geothermal energy should involve integration of local and international decision makers or policy makers. Since the end of twentieth century, although there are valuable progress on renewable energy issues, particularly, on geothermal energy, there is neither a mechanism and nor a world organization that can effectively manage this integration. Therefore, the lack of this mechanism and any organizational limitations are an obstacle for the international projects and researches on geothermal energy.

The Central Government's viewpoint has a primary role in making of effective policies at national scale. For example, in today's political view, natural gas supply which also is not free of dependency on foreign energy makes foreign politics more sensitive. However, this situation lets negligence for the support of geothermal energy which is more national and local resource.

At local level, mayors' or managers' vision play important role, in relation with the central governments vision and their stance whether sharing the same idea with the government. Currently geothermal energy is the hot topic in the media (here reflection of the international developments to media have an important effect.) Moreover, the subject is also a political voting material in the hands of local politicians and managers.

In addition to these mentioned political overview, other pressure groups of decision making are the chambers and Non-Governmental Organization (NGOs) which rather interested in creating livable environments. The participation of these groups is also very important to enable "public interest awake", as being the main principle of planning. NGOs should play an active role in developing an agenda of energy. However, most of these groups, except The Association of Geothermal Users, located in the boundaries of the site, neither effectively deal with the subject nor put forward proposals about the solutions. The disinterest of these groups should be further investigated for better participation and the quality of the geothermal projects.

Consequently, participation of local community plays a crucial role both at political dimension and for land-use planning of the geothermal energy. The awareness of people living around and the facilities is very important for the sake of developing valuable projects and ensuring the public participation.

1.2. Aim of the Study and Limitations

Based on all argument and mentioned issues stated in the previous section, it is clear that major problems of effective integration of urban planning and the effective service provision, include (1) lack of regional level and national policies for effective use of geothermal resource, (2) mismanagement of geothermal resource and infrastructure system, (3) misguided local politics and worries and (4) inefficient land-use allocation and planning process. Therefore within this thesis' context, the utilization of geothermal energy in the all four areas can be interlinked, and then the alternative development plan for case area can be proposed with a set of and principles of local planning. Scheme for the concepts which constitute the main three parts of the thesis are the land-use effects, socio-economical effects and political effects of geothermal energy utilization in development plans for the area concerned that are already said to be less discussed subjects in the planning literature.

There are some specific variables which is the explanatory input of the relationship between urban planning and geothermal energy district heating system (GEDHS) in this thesis. The variables (independent, intervening and dependent) of geothermal energy and urban land-use plan concepts are determined and classified based on the Creswell's (2003) qualitative research method techniques. This qualitative data is then analyzed as an instrument so that research questions can be observed that relate to positive and negative explanatory variables.

More NGOs interest, related local agenda, established geothermal infrastructure system, advanced geothermal technology, adequate geothermal capacity and sufficient heat load density of buildings are defined as positive explanatory independent variables.

Inappropriate land-use allocation and zoning, inadequate communication, inadequate laws and regulations, misguided developers' interest, imbalanced market, less participation (decision makers/policy makers), less community perception and interest on the project, incompletion geothermal conservation zone map, private land ownership, congested parcel size and vacancy, unused residence and office ratio (mixed land-use), less residence equivalent (RE) and existing building ratio and untidy land block density (user energy density) are defined as negative explanatory independent variables in this study.

The independent variables determine the dependent variables which are "effectiveness", "adoption" and "fidelity". The effectiveness concept shows that the degree of relationship between GEDHS and land-use allocation and planning process, and the adoption concept shows that the degree of relationship between GEDHS and all related participants/actors (community, NGOs, local and central governors, decision makers/ policy makers and developers). In this study, the fidelity of plan proposal is the degree to which it is accurate the existing development (implementation) plan.

Collecting all variables and the analysis method are key points in this thesis, and due to available data on the geothermal case area and infrastructure dimensions, socio-economic dimension and land-use dimension, the three points are detailed in the geothermal energy district heating utilization in geographical analysis perspective; (a) socio-economic effects on society (raising the life standard, new job opportunities, increase in house and land prices, socio-political organizations, socio-cultural problems), (b) spatial or land-use effects on the natural and built-up environment, and (c) policy effects (the stakeholders' or actors' viewpoint and approaches, relationship between geothermal energy and planning Laws and Regulations). Thus, planning process requires a new theoretical and practical reconsideration to tackle the issue.

The thesis aims and contributes to general literature in;

- Understanding the effects of geothermal energy input on planning process and determining the allocation use of land. Two most important dependent variables are in the geothermal energy input concept are *adoption of participants* and *effectiveness of GEDHS's land-use decisions*.
- Examining the independent variable's factors affecting geothermal energy utilization on land-use plan in planning process. Although the possibility of any relationship of other planning inputs into energy, in the specific case of

geothermal energy, no value is assigned for other inputs net visibility of the affects of energy inputs and planning inputs concerned.

- Showing the *fidelity* concept of plan proposal evaluation approach with the simulation techniques in the case study of this thesis and the five different variables are combined and made syntheses. The variables/considerations of *Parcel Size and Vacancy for Drilling and Fault Line*, *Heat Load Density of Buildings*, *User Energy Density (Land Block Density Types), Residence Equivalence-Existing Building Ratio* and *Mixed land-use (Residence-Office Ratio)* are analyzed in detail.

The critical research question is: "what is the influence of effectiveness of land-use decisions to geothermal energy district heating utilization?" As a result of the critical question, other research question which is also constitutes the originality of the thesis is: "How much change can we endure on the proposed development (implementation) plans?" There are five supporting hypotheses in this research;

1) In the planning process, energy and sustainable energy parameters, geothermal energy in specific, are not adequately concerned for planning practice or there is not enough relationship between sustainability concepts, geothermal energy, and planning practice as mentioned in the problem statement.
2) There can be possible alternative planning approaches to integrate the energy inputs into development plans. Because, case area resources, case energy infrastructure systems (Balçova geothermal area, and Balçova GEDHS) and policy and planning process dimensions play very important roles in energy utilization in land-use context.
3) The participants or actors of GEDHS play a significant role in adoption perspective. National government, city government, local government, (decision makers/policy makers), developers, NGOs, local agency and local community are major keys.
4) Insufficient laws, regulations of geothermal resources and complex national political relations on energy resources are very important problems behind the geothermal energy utilization in land-use plan. These should be urgently are assumed to be solved before our method proposal. But, these are unused parameters, here, that can't be considered within the limited scope of this study.
5) In the development of decision support systems, the new model approaches and available technologies can help explaining how to integrate the energy

parameters over existing plans; such as, geothermal energy district heating utilization in land-use plan. The fidelity of geothermal energy district heating integrated development plan is an important point for existing development plan.

However, the methods are subject to change from one place to another. Authenticity may be necessary for special needs of the place where problems and solutions may vary dependently.

Within the scope of this thesis, two significant contributions appear in the literature concerning; geothermal energy into socio-economic concepts, geothermal energy into land-use concept.

For these socio-economic literature, the main reason for selecting these two projects of socio-economy and geothermal energy relations from Kenya and Greece was the fact that data collection and questioning methods, as used by land and questionnaire studies performed in the section of socio-economical analysis and described all relevant parameters, have similarities with socio-economical analysis and GEDHS literature. In Kenya Study (Mariita 2002), the socio-economic survey analysis method for environmental, cultural, health impacts and general attitude factors were used in Maasai case area. In Greece Study (Manologlou, Tsartas and Markou 2004), the statistical data collection process survey method which is capable of reflecting experts' method was used for Milos Island.

The parameters for the land-use literature, which were highlighted by Pasqualetti (1986) using land-use data associated with geothermal utilization in land-use planning, were considered together with the economical, social, administrative and legal status of the country; some of which included the different land-use parameters which was described site-specific concept, were also included; and geothermal energy was used as an input that energy density, parcel ownership, parcel size, parcel vacancy and zoning, to integrated land-use planning modeling.

On the other hand, in this thesis, there are some limitations which determine the conceptual framework of the research. First, geothermal energy are chosen as a sole test ground. Although the sustainability concerns and their types are briefly provided in this thesis, the case of geothermal energy is exceptional amongst the renewable energy types by itself. The geothermal energy includes quite special relations and contradictions in the land-use planning process than the other renewable energy types.

Accordingly, the district of Balçova in the province of İzmir is determined as the "case area" because it is one of the best researched and settled area in Turkey with regard to the ever existing relation between geothermal energy source and built urban environment; there have been many academic researches regarding the condition and potential of geothermal energy; and because it has an advantageous location in terms of accessibility to the area during household questionnaire surveys. This study has a tripod relationship between resource, land-use and consumption patterns. Six neighborhoods in Balçova district are chosen as case study area. There is the prescience dimension that different geothermal regions have different land-use relations in capacity, location and flow rate of geothermal water, because of the environmental characteristics that chemical, biological, physical and socio-economical effects, of geothermal energy. The map covers region includes 6 of 8 quarters throughout Balçova district.

The predominant locations of the geothermal fluid wells and existing urban settlement (one under the other) structure cannot be altered is this study. Therefore, this type of case Balçova Settlement is chosen.

District Heating System (DHS) is chosen as the other limitation of the thesis. The concept and various design aspects were examined and electricity production and power station, thermal utilization, industrial utilization and greenhouse heating types of geothermal energy are bestowed but not detailed in this thesis.

Finally, the scale of land-use plan is to be decided to relate area calculations with the geothermal energy and planning discipline. So, data collection, data analysis and model development are successive components to be considered in this study.

1.3. Research Method

The approach is based on two-objective optimization problem here, which are expected to constrain each other usually. Particularly, the methodological novelty, rises on the simulation and plan proposal evaluation approach where the "fidelity" to original (base) development plan "ideals" while the cost effective use of geothermal energy integrated development plan (land-use plan) are provided; ideals mean. Thus, while energy efficiency comprises one objective, the fidelity to original development plan decisions comprises the other. In this direction, the methodological framework used in the scope of this thesis may be defined in brief as follows:

- Definition of the thesis Research Question based on the review of the related literature and determination of the variables (the independent, intervening and dependent variables),

- Choosing the main thesis method is the “Mixed Research Method” which is developed by Creswell (2003). It is used for proposed, collecting and analyzing data with the test methods “Survey Method” and “Case Study Method” to prepare an alternative land-use plan using the information from the specific measuring variables related with the geothermal energy and land-use.
- Comparing the existing alternative variables with the “Simulation Method” and the “fidelity” to original plan, recommending and finding out geothermal energy district heating utilization in land-use plan, includes questioning the process and inputs, their continuity, the ability to interfere and articulate within the process with feedbacks.

The literature survey of this thesis is classified energy, renewable energy and geothermal energy levels and the definition of the related variables on relationship between geothermal energy and land-use planning. In the content of literature review, energy requirements of the city, ways of energy consumption, the role of urban density on the energy consumption, present planning approaches are criticized and the studies on geothermal energy utilization, district heating system, etc. are examined. Afterwards, the definitions of inputs and outputs (independent variables, intervening variables), dependent variables are explained. It is required to test with a method which is the variable diagram (causal modeling).

Literature review aims to explain the need for lack of regional level and national policies for effective use of geothermal resource, mismanagement of geothermal resource and infrastructure system, misguided local politics and inefficient land-use allocation and planning process in geothermal energy utilization, and to investigate the issue of adoption, and effectiveness contexts.

Second, within the data collection and analyzing process “Mixed Research Method”, “Case Study Method” and “Survey Method” are used. It is useful to consider the full range of possibilities for data collection in any study, and to organize this method, its use of closed-ended versus open-ended questioning, and its focus for numeric versus non-numeric data analysis. The variables obtained have a peculiar quality in land-use planning literature with regard to mixed research modeling studies in which the data from related institutions and organizations, and these analysis’ results are used as inputs.

Thirdly, in the proposed simulated approach, there are two-constraint optimizations to be integrated into planning; (1) to maximize energy efficiency, (2) to maximize fidelity to the development (implementation) plan. But, as an approach, it is given priority to the first maximization constraint over the second, as a guiding measure. That's accepted to get away from "fidelity" to the plan's land-use proposals only if the discrepancy is reported, because, while energy is one important input into planning, there are also other than energy to be satisfied.

Simulation method is used as the testing method for the evaluation of "new plan proposal" and existing plan. Because the case studies are the preferred strategy when the investigator has little control over events, and when the focus is on a contemporary phenomenon drawn from real-life context. The geothermal energy district heating utilization in land-use planning is concerned together with the discussions of locality and their integration to general plan-making process. The proposed method can help us to research the relationship between district heating plans and urban development plans.

In Balçova, it is difficult to obtain sufficient and correct data due to the observation of very few parameters till recent years. Therefore, all the archive data are collected from different public and private institutions and organization. In the data collecting and data analyzing process, site surveys and interviews are conducted within the six neighborhood of Balçova district (Korutürk, Onur, Fevzi Çakmak, Teleferik, Eğitim and Çetin Emeç Neighborhoods) aiming to get data about the buildings and their relation to land-use plan. Approximately, 486 building blocks are analyzed with 22000 building examination.

For the purpose of collecting data for socio-economical analysis, questionnaires (face to face interview technique) have been conducted focusing on to collect the existing data from local administers and government agencies, and also previous studies' data is utilized. Thus, taking into account the aforementioned definition of the population is decided to a sample of 3% of household in case area of Balçova district. This number is approximately 500 household because of the 17000 household in case area according to Health Group Chairmanship of Balçova data in 2006. "Random Sampling" method is used during questionnaire studies applied in the study region; taking samples from each street at specific quantities. The results of the surveys formed a database and are extensively analyzed after tabulating on a thematic basis. As far as the primary data processing is concerned, the "SPSS for Windows" soft-ware is used.

The discussion that the geothermal energy in İzmir can be used in a much better way are the subject of investigation in adopted and effective accordance with the usual planning process; thus the way an existing master plan can be revisited, for example, the energy based input. Taking few criteria, geothermal energy district heating utilization in land-use plan are proposed and the net effects of specific five variables (the Parcel Size and Vacancy for Drilling and Fault Line, Heat Load Density of Buildings, User Energy Density/ Land Block Density Types, Residence Equivalence (RE)- Existing Building Ratio and Mixed land-use/ Residence-Office Ratio) are investigated in the AutoCAD software program for calculating the land-use areas of all related variables on digital maps and ArcGIS software program for land-use proposals.

In the content of thesis following the introduction section with problem definition, and explanation of research method and hypotheses, second section includes a literature review on the past and the present studies on relation between energy and land-use planning, renewable energy, geothermal energy, and sustainable urban concepts by utilizing the studies performed heretofore. Relations are sought to establish between the independent, intervening and dependent variables, and variables diagram definition is provided thereby. Third section comprises a detailed definition of methodology of thesis. It relates to how the geothermal energy utilization in land-use plan conception may be articulated to the methodological framework, and how our optimum plan may be reached by employing the relevant data obtained through the proposed processes. Forth section gives the detailed determination of data to be used in the case study. This section in which the data as obtained from different institutions and organizations in the study area mentioned in the previous section are integrated and provided as the input to the modeling chapter, and in which the studies are performed for reaching the effective and adopted among alternative plans based on present plans and the use of geothermal energy district heating context. This section may be referred to as the collection, grouping, interpretation and analyzing of data. The fifth section outlines the comparison of the existing and an alternative land-use plan according to the variables defined. The differences are shown between existing and alternative plan related with the specific and measuring variables of geothermal energy utilization approach. The findings such as parcel size and vacancy for drilling and fault line, heat load density of buildings, user energy density (land block density types), residence equivalence- existing building ratio and mixed land-use (residence-office ratio), are discussed in order to test the thesis hypothesis. Lastly, the sixth chapter draws some major conclusions obtained through whole study and the approaches evaluated based on energy productivity and general principles directed towards energy utilization in land-use planning conception.

CHAPTER 2

THEORETICAL BACKGROUND ON RELATIONSHIP BETWEEN ENERGY AND URBAN LAND-USE CONCEPTS

In the last quarter of the twentieth century, the world economy saw major unsteadiness, including serious problems and depressions. In addition, urban functions (industry, commercial, residential etc.) affected the national political perspectives. Therefore, the transformation to an urbanized society involves structural changes which have important impacts on energy use. And then, relation among energy forms, energy policy, energy resources, energy efficiency/consumption concepts, energy policy plans and related land-use decisions came into prominence.

According to famous scientist Max Planck, energy is the capacity of a system to produce external activity. As a physical and economic (production factor) view point, the energy appears in two different separate forms; primary (solid, liquid, gaseous, hydropower, nuclear, solar, biomass, wind ocean and geothermal) and secondary (electrical and thermal) energy sources. Renewable (solar, hydropower, wind, geothermal and biomass) and non-renewable (oil, coal, natural gas) energies are the other distinctions (Kleinpeter 1995).

The urban area is a system which includes the different inputs (social, physical etc.), system process and outputs (welfare). As the outcome of this system, welfare is produced. So the energy concept which especially includes the energy efficiency and energy policy planning concepts are the very important input variables in this system and they produce this system.

Energy policy planning is the most key factor in energy concept due to the scarce energy reserves in a short, medium and long-term assessment, and some concepts are important such as; resources, price, policy etc. According to Kleinpeter (1995), energy policy planning has several basic criteria for the cost minimization, guarantee of supply and demand to be met, environment, co-operation efforts and new technical progress systems for energy efficiency; to include the relevant system (complexity, accuracy, etc.) for features of the planning methodology, (1) to evaluate the major input, (2) to influence forecasting process in political situation, economic appreciation and other assumption, (3) to evaluate both quantitative and qualitative elements, (4) to formulate methodological choices in technical process but disregarding the dangerous political approximations (5) to derive long-term effective policies.

Therefore, according to Owens (1980), planners should be responsive to energy integrated development systems and energy conservation and energy efficiency of urban pattern. In this urban pattern, the economic, social and environmental benefits affect the dynamic interaction between energy systems and urban pattern (see Figure 2.1).

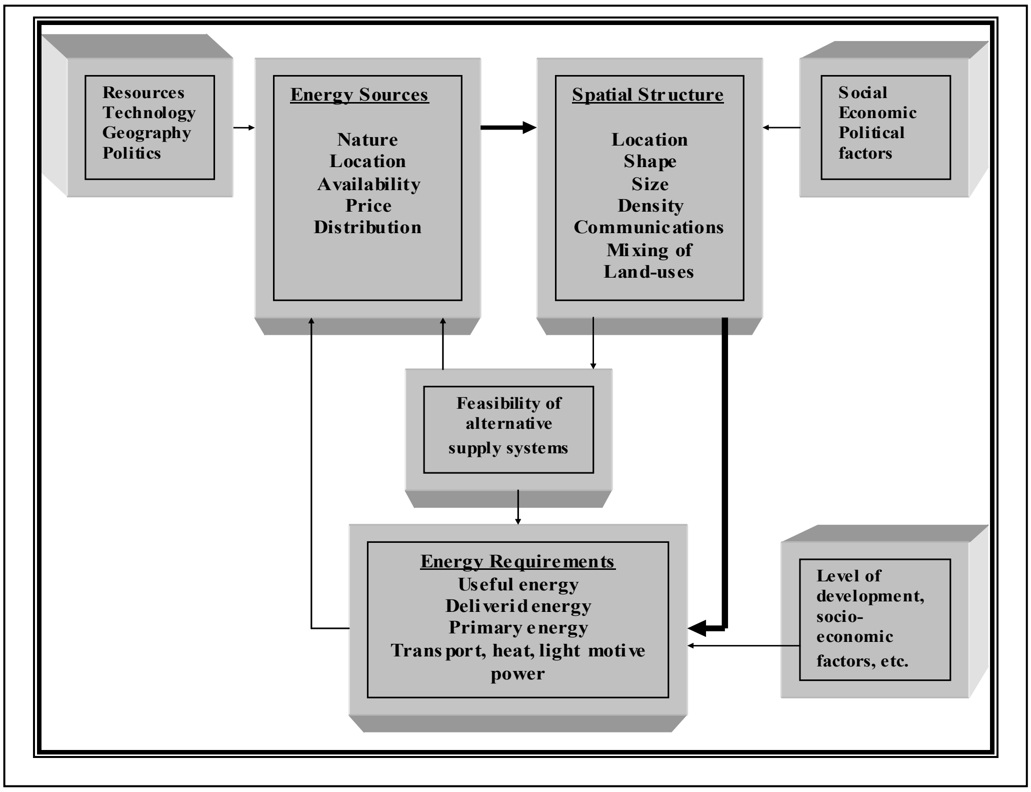


Figure 2.1. The relationship between the energy system and spatial structure

(Source: Owens 1986)

In the context of this research, relationship between energy and land-use allocation are examined in two different parts. Firstly, literature reviews which include land-use concept in three different scales from energy context to geothermal energy context. Terms of energy integrated land-use plan, renewable energy and land-use plan terms are described subsequently. Geothermal energy, which is a special sort of renewable energy addressing to local needs, is examined in detail.

And the second part, the variables about relationship between geothermal energy and land-use concepts are determined and explained then these variables are grouped in three main titles; geothermal resource and development dimension, policy dimension and planning dimension. Then, dependent variables (effectiveness, adoption and fidelity) concepts are established in correlation to the intervening variables. Finally, variable diagrams that will be included in the framework of the thesis are formed about geothermal utilization in land-use plan. This chapter include that it is to present a theoretical and practical background of "energy (geothermal energy) integrated land-use plan" within urban planners view point.

2.1. Literature Review on the Relationship between Energy and Urban Land-use Planning System

Energy is social issue impacting living conditions, human health, personal security and quality of shelter. It reflects the level of improvement of cities. It is not only addressed as the input to developments but output, as well. Acid rains, nuclear disasters, environmental hazards, global warming, pollution, and ozone depletion are the costs of energy consumption (OECD 1995).

Forecasting energy development, supply and demand had become a large industry in the wake of the oil crisis in 1973. World Energy Conference in Munich in 1980 was held following the oil crises in 1973 and in 1979. Mid-1980 when the Chernobyl (1986) disaster occurred was the very important break point for energy usage of international perspective. First of all, World Commission on Environment and Development (WCED) prepared Brundtland Report "In Our Common Future". The report influenced the concept for energy efficiency and renewable energy: "a low energy path is the best way towards a sustainable future" (Peker 2004). The United Nations Conference on Environment and Development (UNCED) also known as the Earth Summit, which was held in 1992 at Rio de Janeiro, Brazil, aimed to organize the sensitivity of international governments to tackle environmental problems. It was stated that the future of energy would be misty, that energy prices would not fall and fossil fuels would not lose their importance, and that there would be an increase of 50-75% in energy consumption till 2020 although alternative energy recourses would come into the agenda.

Then, in 1994, the Framework Convention on Climate Change (FCCC), which was interested in measures of greenhouse gas emissions, said the climate change issue should come in the first group of policies for developed countries and new sustainable policies for the energy context should be developed. According to the solution of FCCC, in 1995, World Climate Conference was held in Berlin, then the most important international legally binding commitment was organized in Kyoto, Japan, in 1997 (Byrne, et al. 2001). In this protocol, a major use of renewable energy technologies might offer a good change to slow down resource depletion and to diminish environmental pollution, contributing to three fundamental objectives: greater competitiveness, safety energy supply and environmental protection.

In the meanwhile, another important organization, Habitat II Conference on Human Settlements, was organized in Istanbul, Turkey. Although the main title in this conference was settlement policy, the relationship among sustainable development, human habitat and urban environment was integrated whole process. This inclusion of the study outcome of this organization was the first sustainable development concept and energy context relations in planning literature.

Nowadays, there are different cities which contact the relationship between energy and land-use plan. In accordance with Portland in USA, a run-down city centre was transformed in a lively and attractive part of the city. Rennes in France, Goteborg-Newcastle-Upon-Tyne in UK and Stockholm in Sweden, developed strategies to integrate land-use planning and energy issues. Mainz in Germany developed planning policies to overcome poor city centre air quality. Aarhus in Denmark, Turin in Italy, revised their Master Plan to promote a large-scale city-wide combine heat and power (CHP) scheme- very good examples about the potential contribution of land-use planning to context of energy conservation and planning process.

In the evaluation of energy needs of cities researches is the other important subject of energy and cities concepts. Studies about Beijing (China) and Florence (Italy) give detail about approximations of some statistical and mathematical models.

2.1.1. Energy Integrated Urban “Land-use” Planning System

Transportation, density-urban form and infrastructure concepts are the very important criteria about the energy integrated urban planning system in international area. The relationship among transportation systems, form of city, low or high density and infrastructure technologies effects the land-use decisions.

Especially, in the area of transportation, there are a lot of researches in general literatures. In 1975, Odell explained two main problems of cities; transport systems and electricity/ heat systems. He proposed the participation of such major actors as local government leaders, city planners, architects, economists, etc., to restructure the form of cities and to develop the new alternative about energy conservation context (Odell 1975, Owens 1987, Owens 1989, Peker 2004). There came out extensive work to catalog the transportation energy impacts of urban environment (Longmore and Musgrove 1983, Anderson, et al. 1996, Kenworthy and Laube 1999, Holtzclaw, et al. 2002). Theoretically, general consensus about circular settlements which are inefficient in terms of transport and energy requirements and linear or rectangular forms are advantageous (Owens 1987).

The usage of urban technical infrastructure systems (water, electricity) has long been known that typical suburban Greenfield development requires greater material inputs for infrastructure than comparable development in an already urbanized area. The methods for planning an environment with relatively low intrinsic energy requirements by reducing the need to use energy for given purposes (transport or heating), and for meeting unavoidable energy requirements in efficient ways by obtaining the greatest possible use out of a given primary energy input, contributed in achieving energy efficiency in the built environment (Owens 1986). In 1980 researchers examining new ultra-efficient low-density residential development in Davis, California showed that it had far greater resource needs than their "run of the mill" central city counterparts (McGeough, et al. 2004a). In Burchell's study, in a recent comprehensive national study of the costs and benefits of sprawl, researchers again found similar results for building materials as well as urban services such as water and wastewater provision, roads, and other public services (Lantzberg 2005).

Energy integrated urban density concept influences compact form of city development, and may have positive energy effects. There is a lack of controlled studies on its non-transportation energy effects. There are different relations among energy and urban density studies, for example, Keys made cross-sectional analysis about density and energy consumption in different existing geographical areas, approximation. According to Keys, energy consumption would be decreased, if the urban density was increased (Owens 1986, Owens 1989).

Work by Stone and Rodgers (2001) to analyze the urban heat island effect of urban form shows that low-density residential development patterns contribute more radiant heat energy to surface heat island formation than more compact alternatives. Looking specifically at electricity consumption, Lariviere and Lafrance (1999), which was used as a dataset of the 45 largest cities in Quebec, Canada, showed that electricity consumption would decrease by 7% if the cities with residential densities of less than 360 persons/square mile increased their densities to 1.080 persons/mile; the equivalent change would yield a 50% reduction in energy demand for transportation.

Hui’s (2000) analysis of low-energy building options in Hong Kong’s dense urban environment reaches similar conclusions and also suggests that care should be taken in promoting densification as an energy efficiency strategy. Steiner (1994) suggests that there may be instances where well-planned, low-density development is preferable, such as in desert climates, to allow for more efficient water management practices through the use of native vegetation and on site storm water retention, as well as solar efficient urban design.

Concepts of energy and local energy planning on which a number of engineering studies are conducted mainly by the Department of Energy engineering has not been a subject dwelled on in terms of Urban and Local Planning Department in Turkey as a whole. A Doctorate thesis on the “Use of Energy and Planning for Settlement Areas” completed in 2002 in Mimar Sinan University (Erbaş 2002) is the academic study conducted by the Department of Urban and Regional Planning in Turkey. This study takes conceptually as a subject the importance of energy and its use in cities. The second study that “Integrating Renewable Energy Technologies into Cities through Urban Planning: The Case of Geothermal and Wind Energy Potentials of İzmir” was occurred by Peker (2004) in Department of City and Regional Planning in İzmir Institute of Technology.

2.1.1.1. Tools of Energy Integrated Urban “Land-use” Planning System

The success of energy saving in urban planning process and development could be measured in terms of the extent to which it helps minimize the cost of meeting the social and economic needs of urban areas, where cost includes the environmental externalities of urban energy consumption. Energy integrated urban planning, sitting and building regulations contribute directly to this objective by reducing energy demand. Energy demand (usage and potential) and local energy planning concepts influence the urban planning process and land-use planning system (see Table 2.1).

Table 2. 1. Energy demand of different urban functions
(Source: Owens 1986)

Influence of Land-use on Energy Demand		
Planning Variables	Energy Link	Effect on Energy Demand
Shape of urban Boundaries	Travel Requirements	Energy use variation of up to 20%
Shapes and sizes of land-use designations	Travel Requirements (especially trip length and frequency)	Variation of up to 150%
Mix of activities	Travel Requirements (especially trip length)	Variation of up to 130%
Density/clustering of trip ends	Transit feasibility	Energy savings of up to 20%
Density and mix	Space conditioning needs and neighborhood heating/ cooling cogeneration feasibility	Savings of up to 15% Efficiency of primary energy use improved up to 30% with neighborhood heating and cooling
Site layout "orientation" design	Solar use feasibility	Energy saving of up to 20%
Sitting "landscaping" exterior materials	Microclimate improvements	Energy saving of at least 5% more in exposed areas

The Figure 2.2 lists land-use and design variables that can significantly affect community energy efficiency. The Objective of the lists is to identify and describe these potential efficiency gains for urban planning participants and to help them select the best combination of efficiency strategies for their local circumstances.

There is strong relationship between energy and urban planning concepts (Land-use, built form, transportation and urban form-infrastructure systems) (Table 2.2).

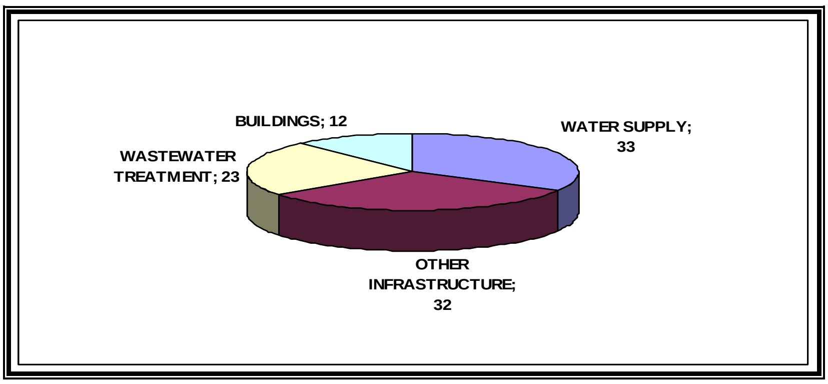


Figure 2. 2. Typical energy use in urban context
(Source: Means 2004)

Table 2. 2. The tools of energy integrated planning system
(Source: Adapted from Sadownik and Jaccard 2001, Owens 1985)

Area	Strategies
Land-use planning	- Land-use planning control resulting in more coordinated development. - A tendency towards mixed land-use and the maintenance of dispersed business centers. - A tendency towards maintaining a relatively high density, but not to the detriment of local environmental quality.
Transportation management	- A greater emphasis on public transportation development. - The facilitation of bicycle and pedestrian transportation. - The development of transportation management strategies to discourage automobile growth. - The development of employer sponsored commuting services and other high occupancy vehicle travel.
Urban and building design	- Building to maximize the shape coefficient. - Ensuring that buildings are built so that they can be easily and economically for neighborhood - Heating and/or cooling. - Sitting (in relation to microclimate), orientation 8 of buildings or groups of buildings), layout, density - Open space necessity - Urban areas to be served by a CHP systems - Size, shape communication networks of settlement.
Energy supply and delivery systems	- The replacement of decentralized and uncontrolled coal combustion in individual apartment blocks and houses. - Encouraging the interaction of industrial energy provision with residential uses. - A faster introduction of new fuels and technologies (such as neighborhood cooling, waste heat). - Increased gas penetration for cooking and heating.

Land-use planning

The arrangement of land-use directly affects energy consumption primarily in the transport and space heating sectors (Owens 1986). The arrangement of land-uses and the form of the built environment affect intrinsic energy needs: low density urban sprawl generates a greater need to travel than a more compact pattern of mixed land-use where the physical separation of activities is small. Urban structures also influence the efficiency with which energy needs can be met; for example CHP, are most viable with higher densities and mixed land-uses. Combined heat and power provides a clear example of an energy technology which is not equally viable in all forms of urban development. The implications for urban development arise mainly from the need to lay heat distribution networks in urban scale schemes. Density, built form and the mixed land-uses are all important variables in this context.

Transportation management

The pattern of urban land-uses and transport infrastructure in an area is fundamental for local transport energy demand and its environmental effects. Generally, land-use changes cause the more feasible and friendly transport mode. There are some variables in these relations; density and the degree of different mixed land-uses. Different urban functions (business, education, health, leisure and recreation) have been rationalized into larger units to perceive economic efficiency gains.

Department of the Environment and the Department of Transport in England (1993), published a report which included reductions in travel demand, the use of more emissions- efficient modes of travel and changes in the emissions for efficiency of transport processes. Then they adapted these result to urban planning major departments which were the focusing of development in urban areas, the maintenance and revitalization of existing neighborhood, town and city centers and constrains on the development of small settlements and the extension of villages within the commuter belt (RTPI 1996). This separation shows the usage areas of the energy input in urban sectors in planning process.

Urban and building design

The other important concept is a design which includes both urban scale planning and building scale for energy efficiency and energy consumptions. Appropriate measures are the concern of urban land-use planning at the neighborhood scale and of building regulations; the important requirements is that both work together to achieve a common objective. Energy consumption in the building sector is characterized by a dynamic evolution. Though needs and consumption rates are very different in the various areas of the planet, energy consumption parameters are mainly determined by living standards, economic growth rates, actual energy prices, technologic developments, whether conditions and increased population.

In a building or housing perspective, a whole-of-life approach is required to obtain a balance between environmental impacts due to the contributions of the construction of a building and those due to its operation (Tucker 1996). Within the housing industry, sources of carbon dioxide are mainly due to energy usage. Energy is consumed both in the daily operation of the house and in the manufacture and supply of materials used in the construction and maintenance of the house.

In past theoretical and practical experience, the built form exerted a periodic influence on energy requirements for space heating. So the built form is the very important input for energy efficiency like terraced housing or low rise flats. Integrated energy-efficient building design also needs to incorporate passive solar design (PSD). The built form and the design of the windows, walls, roofs conservatories and atria, and landscape opportunities are the major input for PSD. In this perspective, optimum use of solar gain and microclimatic conditions to minimize the usage concepts are the most urgent things. Passive solar design principles relate with building regulations (technical and theoretical) and planning (micro-scale energy consumption in urban structure and more conventional standards of thermal insulation) (RTPI 1996, OECD 1995).

The relationship between energy conservation and efficiency and urban design is planned at four different urban scales; regional, sub-regional, individual settlements and neighborhood. Environmental, climatologically and topographical data collections are used at each scales. Especially, urban patterns form and size in regional scale; settlements size, shape and communicative network in sub-regional scale; Communicative network within settlement in individual settlement and land-use relatives in neighborhood scales, relations are research in urban design concept (Owens 1995, Peker 1998).

In OECD study of Urban Energy Planning (1995), energy consumption and urban development concepts are thought together in CHP perspective. CHP system is a good example of more efficiency in all forms of urban development. Heat distribution networks are important for urban development in urban scale. Having the power to require and particular user to be connected to the heating network is important too. Thus, built form, density and the mixed urban land-uses are main data in this context. In an ideal world, CHP system which should be relatively dense, useful all scale, serve the urban environment.

Energy supply and delivery systems

Urban infrastructure systems which include water and electricity systems, fuel, heat and power systems are the other tools of urban land-use planning process. Mainly, energy efficiency concept is an important as economical and environmental perspectives of urban settlements. The benefits of more efficient energy use are reflected directly in the local urban scale overall expenditures and are a direct motivation for cost effective improvements. The most obvious focuses for local governments are those facilities and operations that are under their direct control, and a great deal has been written by independent researchers. These areas include: facilities, water supply, waste water treatment and disposal, and electricity systems (Lantzberg 2005).

According to Means (2004), drinking water delivery and treatment are large energy users; energy is required throughout the diversion, pumping, transmission, treatment, and disposal process. Drinking water and wastewater systems account for about 4% of the nation's electricity demand. Water systems comprise approximately 56% of a city's total energy use and the cost of pumping constitutes the largest portion of a water system's energy demand which is affected by population growth, degradation of source watersheds, declining availability of fresh water supplies, and greater pressure for energy-intensive advanced treatments. The balance (32%) of a city's electricity consumption is for other capital infrastructure, such as streetlights and traffic lights which comprise up to 67% of that amount and traffic safety and cost savings are key motivations for traffic light improvements (Lynch and Kahn 2000).

2.1.1.2. Models of Energy Integrated Urban "Land-use" Planning System

There are a lot of mathematical, economical, social and statistical energy integrated models about different urban land-use scale. According to Owens (1989), regional, urban and local scale models are used for urban land-use scale classification of energy context. Though there are different methods (empirical, intuitive etc.) for investigation of energy and urban land-use planning. Although, the models have the different advantages, there is substantial doubt because of lots of variables and stakeholders.

London metropolitan region commission researched energy supply/demand which was modeled future energy planning, environmental planning and transportation planning as energy conservation view point (Ball, et el. 1981). The other same scale study was prepared by Nijkamp (1983) who described economic models based on represented energy supply-demand. Island of Gotland, Sweden (Jansson and Zuchetto 1978, Zuchetto and Jansson 1979) and for Hong Kong (Boyden, et al. 1981) examples were the other regional scale models. Though the models gave the good solutions, the most problem was boundary definition for using data availability.

At urban scale, energy budget models, dynamical systems models and linear programming supply models (the modification of urban spatial interaction models) are used. Energy efficiency urban form and transportation realities were emphasized by Beaumont and Keys (1982), optimizing version of the Lowry model which is the developed form of trip decision of transportation systems in urban environment. Propped up transportation cost preparations of Romanos (1978) and Dendrinos (1979), right along with, the location of shopping center researches of Beamumont (1981), Poston and Wilson (1977), Wilson and Oulton (1982) were based on the kind of retail system.

On the other hand, Energy efficient urban form studies were developed with different models. Hemmens' (1967) and Owens' (1981) papers on alternative development patterns for existing geographical areas, Beck's (1973) and Clark's (1974) studies on the using combinatorial programming in travel systems, de la Barra and Rickaby (1987) and Rickaby and de la Barra (1989) research based on random utility function and a comparative cost- benefit analysis of energy use in transportation and urban heating systems.

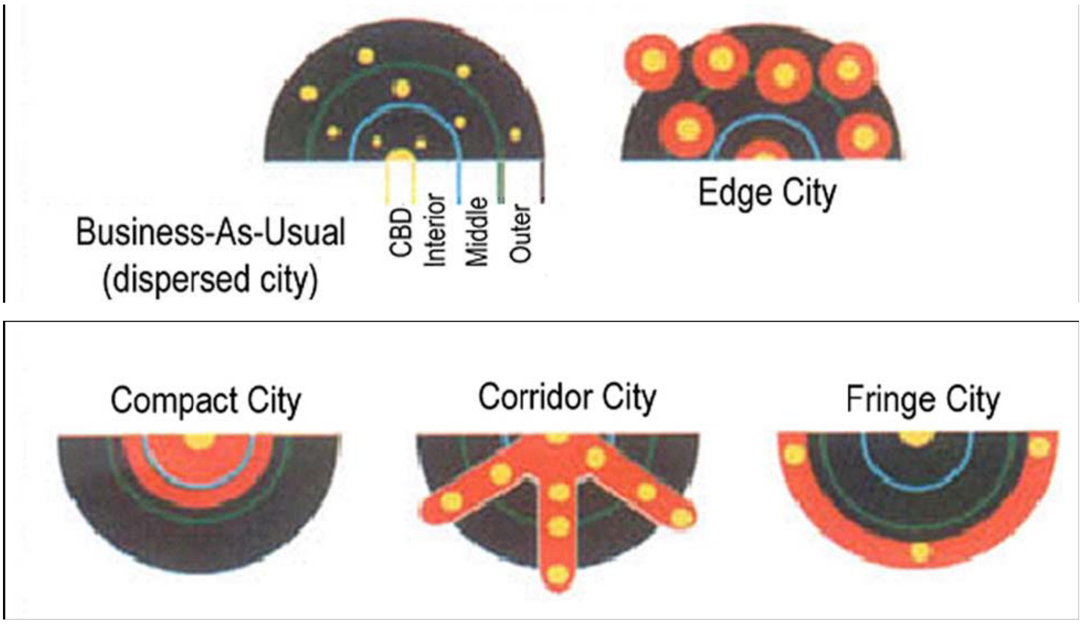
2.1.1.3. The Relationship between Urban Models and Energy Integrated Urban Land-use Planning System

Cities are distinctive ensembles of people, businesses and institutions and are easily distinguished by the number and density of economic, social and cultural activities that take place within them. The most visible characteristic of urban areas is the form of their built environment (city's center, outlying areas of manufacturing and distribution, residential areas and other activities define patterns of urban land-use).

General models devised to understand the overall patterns of urban built environment, none of them can accurately describe patterns of urban land-use in all cities. The models are static; they describe patterns of urban land-use in a generic city, but do not describe the process by which land-use changes. Despite these criticisms, these models continue to be useful generalizations of the way in which land is devoted to different uses within the city.

The minimization of the useful energy requirements is the major point for energy efficient urban form concept. Transportation and urban density concepts have been very important inputs in the theoretical studies about urban form and energy efficiency relations. In Owens studies (1996), especially, reducing the travel and providing a relation of land-uses compatible with energy efficient modes of transport thoughts could be goals in district heating system.

Alternative urban land-use and development patterns for different geographical zones have put forward an idea by Hemmens (1967), Stone (1973); Edwads and Schofer (1975) (see Figure 2.4). However, aside from these urban settlement types, the most direct energy-related impact of urban growth is in the area of transportation and urban infrastructure elements (water, electric etc.) and there has been extensive work to catalog the transportation energy impacts of urban growth patterns (Longmore and Musgrove 1983, Anderson, et al. 1996, Kenworthy and Laube 1999, Holtzclaw, et al. 2002). Apart from transportation energy, there is a growing body of research to understand the broad range of social costs and benefits of alternative growth scenarios (Wievel and Schaffer 2001, Burchell 2002, Agyeman and Evans 2003, Sturm and Cohen 2004). Urban infrastructure systems (pine, storage, etc. infrastructural elements) are the other important direct impact for residential, commercial and the other urban functions like transportation.



Business-As-Usual	Extrapolation of current sprawling development patterns into the future*
Compact City	Increased population and densities of inner suburbs
Edge City	Increased population, housing densities, and employment at selected nodes within the region that are connected by freeways
Corridor City	Focus on growth along linear corridors emanating from the central business district and supported by public transportation investment
Fringe City	Additional growth predominately at the fringe of the city

* CBD – Central Business District

Figure 2. 3. Alternative urban forms

(Source: Institute for Energy Engineering 2002)

In this Figure 2.3, the light yellow circles represent current centers of development and the darker orange areas represent new growth. New growth is accommodated in a variety of different scenarios, depending on the planning decisions made by the region's citizens and officials. Each alternative urban form will have a different energy use profile.

Relationship between urban density and urban form is the other major subject about theoretical urban form studies. According to Sassin (1981), although the urban land-use density of energy demand may well be reduced in future, urban settlements could exist on the basis of distributed energy sources and will require at least some degree of centralization of energy supply systems (see Figure 2.4 and Figure 2.5).

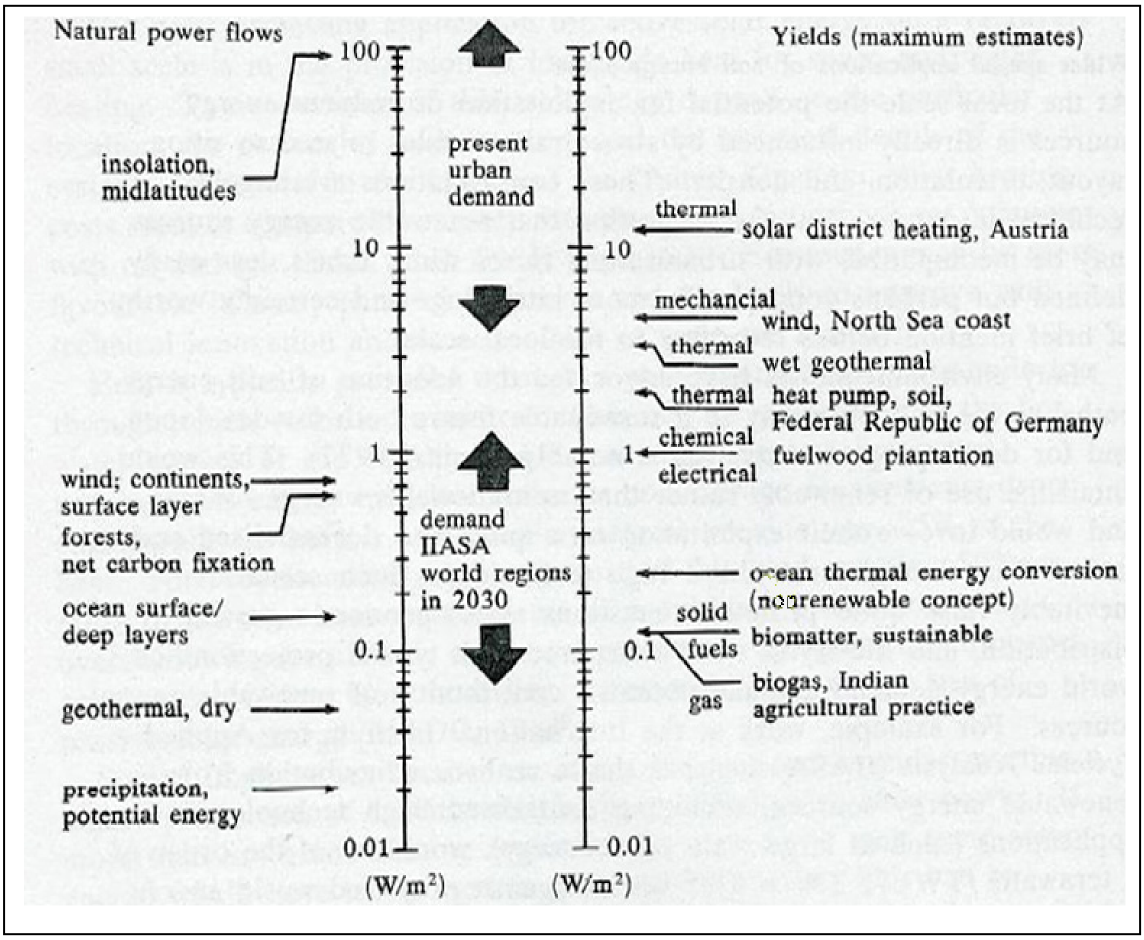


Figure 2. 4. Energy supply densities

(Source: Owens 1986)

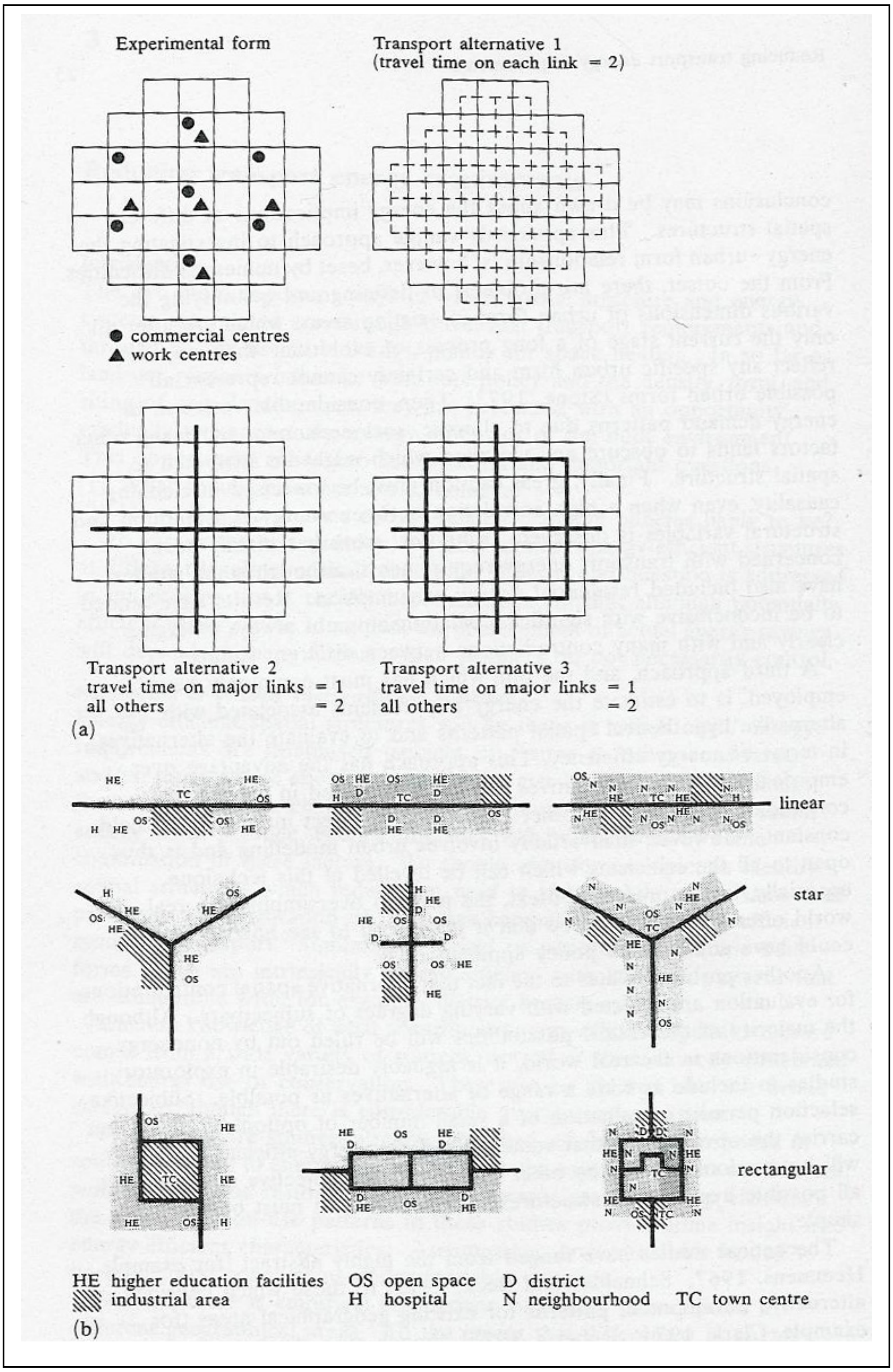


Figure 2. 5. Hypothetical urban forms about relationship between urban land-use pattern and travel/transport energy requirements by (a) Hemmens (1967), (b) Stone (1973) (Source: Owens 1986)

The number and size of buildings in urban area are among the concerns of energy efficiency. “Compact City” (Dantzig and Saaty 1973) and “Archipelago City” (Mathieu, 1978) concepts are the very extreme samples in energy efficiency context (see Figure 2.6). Compact City has the high densities and integration of activities would be achieved by containing the functions of a large city in too small urban area. Walking distance and bicycle scale main ideas of Archipelago City has the nucleated urban sub-unit. Although, this pattern is very useful for small scale settlement or land-use, high population settlements cannot be built up this type of areas because of the energy efficiency problem, the insufficient local employment and local service opportunities for households.

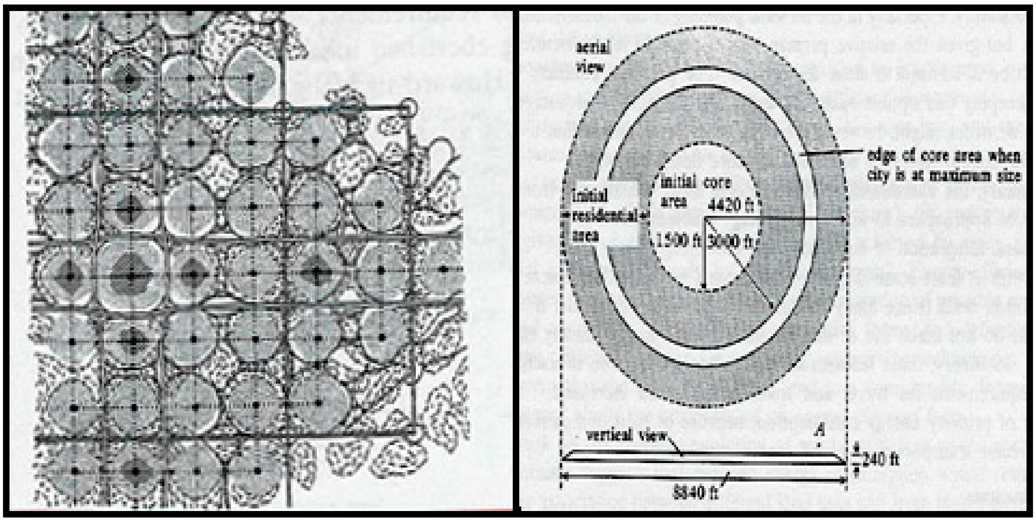


Figure 2. 4. Hypothetical urban forms about relationship between land-use pattern and urban densities; “Compact City” by Dantzig and Saaty and “Archipelago Pattern City” by Magnan and Mathieu (Source: Dantzig and Saaty 1973, Magnan and Mathieu 1975)

In addition, it is known that compact and connected urban form reduces the demand for transportation and infrastructure energy, the overall extent of non-transportation energy impacts of urban form and increased densities is uncertain. Steiner (1994) suggests that there may be instances where well-planned, low-density development is preferable to allow for more efficient water management practices through the use of native vegetation and on site storm water retention, as well as solar efficient urban design.

According to Rickaby (1979), linear grid structure is a most suitable structure. This structure combines the energy advantages of higher densities and integration of activities with access to open land and the potential for a wider range of life styles and energy systems. According to Owens (1987)'s study was *"It permits a high linear density of development in which integration of land-uses is achieved by concentrating origins and destinations of trip onto a small number of routes".* Finally, Anderson (1996)'s research exposed a new concept which was called archetypal form (see Figure 2.7) It occurred with integration of concentric and radial city (Peker 1998).

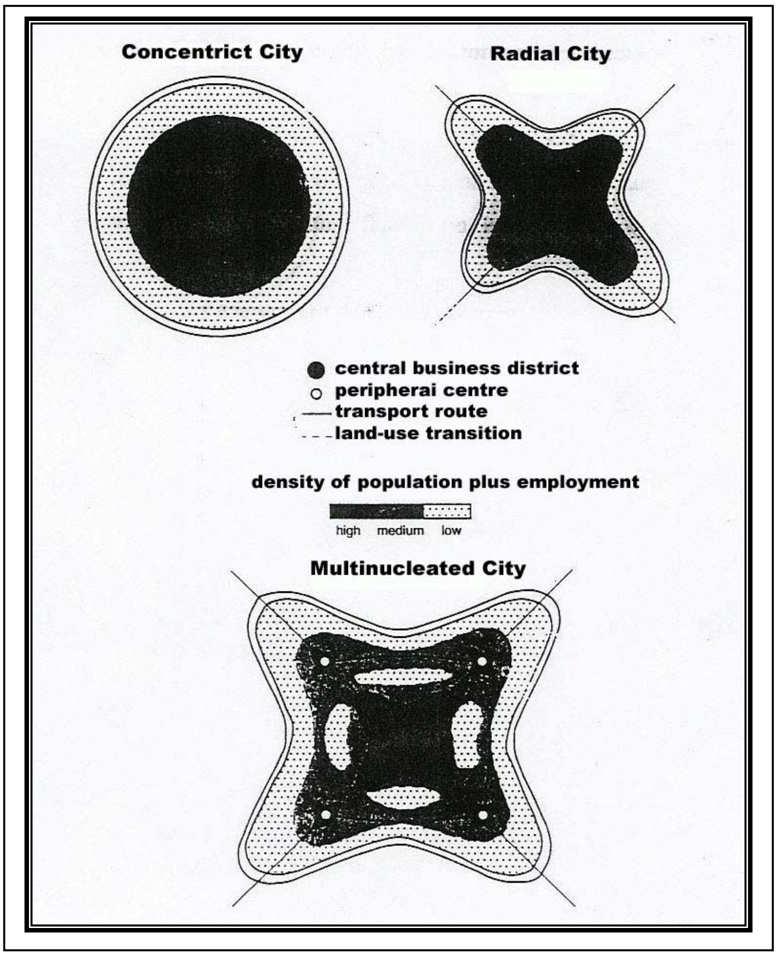


Figure 2. 5. The archetypal forms

(Source: Anderson, et al. 1996)

2.1.2. Energy Integrated Urban Land-use Planning in Renewable Energy Context

The relations between renewable energy and land-use are correlated under sustainability context, so the first group of definition terms is sustainability, energy sustainability, urban sustainability and sustainable development concepts.

The term *sustainability* means different things to different people. The Brundtland Commission first articulated the most basic definition in 1987 as “meeting the needs of the present without compromising the needs and opportunities of future generations” (Naess 2001). In sustainable approaches, it influences a plethora of environmental, economic, and social titles. However any sustainability strategy must address energy generation, distribution, and use as a social good, as well as an input into the economic production process.

According to California Consultant Report (2005), the other significant concept, *energy sustainability* means the harnessing of resources that: are not substantially depleted by continued use; do not emit substantial pollutants or other hazards to the environment; and do not involve the perpetuation of substantial health hazards or social injustices. Up till now, there is no environmentally cost even renewable technologies such as wind, solar, geothermal, and bio-fuels require industrial infrastructure and life cycle energy inputs. As such, energy sustainability is a relative, rather than absolute concept.

Taken further, *urban sustainability* can be understood as the ”balance of urban land-use systems, with their long term environmental base” through linkage of economic development objectives such as long-term resilience, competitiveness, employment, and equitable resource distribution with social progress measures such as security, public health, education, cohesion, diversity, and equity (Ravetz 2000).

Growing evidence of environmental problems is due to a combination of several factors since the environmental impacts of human activities has grown dramatically because of the sheer increase of land-use activities such as: world population, consumption, industrial activity, etc. Achieving solutions to environmental problems that we face today requires long-term potential actions for sustainable development and land-use planning. In this regard, non- polluting renewable energy resources appear to be the one of the most efficient and effective solutions. That is why there is an intimate connection between renewable energy and sustainable urban land-use planning (Dinçer 2000).

According to Kleinpeter (1995), *renewable* concept includes technology, green techno-economic paradigm, sustainable technology and ecological modernization. *Renewable energy* is the term used to describe a wide range of naturally occurring energy sources. The exploitation of renewable energy sources is an essential component of sustainable development.

Ravetz (2000) explains that, the context of global sustainability and sustainable development in land-use concept is based on five interconnected site: (1) human well-being depends on the health, stability, and productivity of the earth's natural life-support systems; (2) the scale of human activities is beginning to affect the integrity of these systems; (3) population and consumption growth are major impact drivers; (4) population growth is predictable for decades; (5) economic growth will and must continue in order to provide for this population (Lash 1999).

2.1.2.1. International Renewable Energy Cases and Energy Integrated Urban land-use Planning

In 1990's many Congress or International Conference (World Summit Conference in 1990, The United Nations Conference on Environment and Development in 1992, World Climate Conference in 1995, habitat II in 1996, Kyoto Protocol in 1997) were organized about sustainable development and renewable technology usage of urban environment.

In the World Summit Conference, all the world states brought into agenda a radical change in the issue of energy. The concepts of global warming and changes in climate were begun to be discussed. In the United Nations Conference on Environment and Development (UNICED), economic growth, energy prices, government policies being followed and the future energy needs were determined and it was stated that a period of 5-15 years is needed to develop alternative energy resources.

Aftermath the World Climate Conference, industrially developed countries (North America, Europe, Japan, Australia, and New Zealand) signed the Kyoto Protocol in 1997 in the light of this conference. According to Kyoto protocol, all these countries took a decision aimed at decreasing their carbon gas emissions seriously till the period of 2008-2012. Within the same period, issues of renewable and alternative energy resources that show land-use development were started to be considered together with the concept of sustainability at the Habitat II Conference.

Generally, European Union (EU) policies have significant influence on national policies and practice in energy and planning sectors which specially include the land-use planning and development. International Energy Agency (IEA) and The Sustainable Energy Europe (SEE) have an active part about sustainability concept in the world. The SEE aims to showcase and promote municipal pioneer programs and projects in any field of sustainable energy production or use, to contribute to their recognition and stimulate their replication across Europe (Sustainable Energy Europe 2007).

In addition, International Council for Local Environmental Initiatives (ICLEI) Local Governments for Sustainability is an international association of local governments and national and regional local government organizations that have made a commitment to sustainable development. More than 475 cities, towns, counties, and their associations worldwide comprise ICLEI's growing membership. And the Center for Renewable Energy and Sustainable Technology (CREST) and Energy Cites research all renewable energy types, resources and technologies. Energy Cites is the association of European local authorities for promotion of local sustainable energy policies (Energie Cites 2005).

Especially, there are some organizations which are interested in sustainable city and integration of renewable technologies and land-use concepts. The United Nations Environmental Program (UNEP) developed the new energy program, and it is interested in the energy integrated land-use perspective in urban land-use scale. The aim of the this program is to provide leadership and encourage partnership in caring for the environment by inspiring, informing, and enabling nations and peoples to improve their quality of life without compromising that of future generations.

Developing Institutional and Social Capacities for Urban Sustainability (DISCUS) was a research project co-financed by the European Commission. It began in December 2001, and ended in November 2004. Its central purpose was to understand the conditions leading to the emergence of efficient governance for urban sustainable development in Europe. Then, the last one is Smart Communities Network which include the sustainability concept in urban environment, as well (Local Governments for Sustainability 2008; Smart Communities Network Creating Energy Smart Communities 2008).

Furthermore, individual publications were prepared in 1990's, sustainable city vision subjects of Throgmorton (1987) one of the early issues for renewable energy integrated urban land-use planning. Research by Hull (1995, 1995, and 1997) included specially wind power, wind-farm which is the reflection of urban form of wind power systems, and their planning policy. In 1995, The Sustainable Silicon Valley project and San Diego-Tijuana border region project are related with development of an urban environmental management systems and renewable energy resources contexts. The paper which had sustainable agriculture concept, include optimization modeling in energy planning for rural land-use development (Raja, et al. 1997).

In 1998, the other wind power study was conducted by Christensen and Lund. It was about the balance of natural conservation and wind power in planning process. Renewable energy maximization of urban planning and land-use program in Rome researches were studied by Ostia (1998). The publication which emphasized the different energy sources planning in India (Iniyan, et al. 1998).

In the 2002, European Commission issued the sustainability study which examined programs and policies of European Commissions about sustainable city. Khan (2003)'s paper took in Swedish wind power policies. The other publicans in 2003, the paper which said wind power systems and wind energy development of England, written by Beddoe and Chamberlin. Reddy and Balanchandra (2003)'s study researched the energy, environment and policy analyze concepts in India samples. The study of passive solar design based on the book titled "GIS technologies for planners" was published by Gadsden, et al. (2003). Center of Urban Planning and Environment Planning of Hong Kong University prepared the renewable energy usage in urban land-use subjects' paper (2004).

In Japan, samples were interested in the renewable energy systems designing in rural areas of Japan (Nakata, et al. 2005). California Commission published the Consultant Report of Sustainable Urban Energy Planning written by Lantzberg (2005). And the World Council for Renewable Energy prepared the "Solar Habitats in Cities and Villages" in 2005, in Bonn, Germany.

Under such circumstances, it is then imperative to identify a comprehensive set of criteria and indicators for what constitutes energy sustainability, and then develop an agenda to achieve energy sustainability through a combination of incentives and regulatory measures for conservation and efficient use, research, and development of advanced technologies and methods (Bajura 2002). This process is naturally political, dynamic, and shaped by a variety of socio-economic, physical, environmental and technological factors of renewable energy utilization of urban land-use planning system.

In Turkish case, a lot of sustainability and renewal energy sources and technologies were issued, but only a few studies were related with planning system and land-use decision perspective. Erbaş, in 2002, in doctorate thesis, researched the relationship between energy useful and the planning of urban settlement. According to Erbaş, there are some criteria's about relations of energy integrated urban planning. The doctorate thesis on the "Integration of Renewable Energy Technologies into Urban Planning" completed by Peker (2004) is the academic study conducted by the Department of Urban and Regional Planning in İzmir Institute of Technology (IZTECH) taking Turkey as a basis. The general information about renewable energy types, especially wind, solar and geothermal energies, and general approach of renewable energies related with urban planning are defined in this study.

2.1.2.2. Renewable Energy Technologies and Energy Integrated Urban Land-use Planning

The utilization of renewable energy sources is an important component of sustainable development in urban land-use. There are three major reasons for this.

- Renewable energy sources have potentially low environmental impact in comparison with other sources of energy
- Renewable energy sources are critical for sustainable development; their energy cannot be depleted, dissimilar fossil fuel and uranium resources.
- Renewable energy sources favor power system decentralization and locally applicable solutions more or less independent of the national network, thus enhancing the flexibility of the system and the economic power supply to small isolated settlements (OECD 1995).

According to Dinçer (2000), renewable energy technologies produce marketable energy by converting natural phenomena into useful energy forms. Renewable energy technologies consist of solar energy, biomass energy, hydro energy, wind energy and wave energy (impact of the Earth). Two other sources of energy which are usually included as renewable are tidal energy (gravitational forces) and geothermal energy (the heat of the earth's core). Though geothermal energy is not regarded strictly as a renewable energy source, it is often categorized as such because of the originally derived from a flow of energy.

Technological development, economic feasibility, commercial viability and social and environmental acceptability are the most important factors for convenience. Wave power, hot dry rock geothermal energy, certain forms of biomass researches and development are very good examples for technological development. Economic feasibility concept, do not prevail for renewable energy because of the difficulties it creates in comparing the economics of renewable energy technologies by widespread markets. The availability of appropriate technical support for the installation and operation, and the provision of capital are the major input for commercial viability concept. Renewable energy sources have unknown environmental impact such as breaking the balance of the eco-system, but, generally, environmental effect s of renewable energies affect in local scale, like noise and visual impacts in urban land-use area (OECD 1995).

There are a lot of renewable energy technologies which have potentially available, for using energy supply systems in the urban land-use area (see Table 2.3). Their use within cities and the surrounding areas is essential in terms of global sustainable development. The efficiency of renewable energy technologies in urban environments are measured by major energy demands of urban land-use areas (cooking and industrial process heating in developing countries, cooling in low-developed countries, space and water heating in high-developed countries, and transport in most cities).

2.1.2.3. Renewable Energy Technologies and Energy Integrated Urban Land-use Planning System in Sustainable Urban Energy Planning Approach

According to general literatures, the relationship between renewable energy technologies and land-use plans integrations into cities base on the urban energy policies, urban energy management, urban energy planning approaches and urban sustainability and sustainable city concepts. Therefore importance of sustainable urban energy planning concept are appeared due to the relationships among these approaches and main concepts.

Today's cities (or rather the metropolitan city and regions that constitute urban settlements) face deep challenges to achieving sustainability. Cities, in the developed countries of all over the world are intensely linked by myriad connections to global markets for their food, energy, raw materials, consumer goods, and economic output, and these long-distance transactions generate significant greenhouse gas emissions. Cities pull resources from outside in far greater quantities than are available within their own geographic areas and generate waste streams that exceed their own carrying capacities. In essence, cities externalize impacts by pushing out their environmental loads to larger geographic and temporal scales (Martinez and Alier 2003).

Table 2. 3. Renewable energy technologies by energy sources and final users in urban environment (Source: Capello, et al. 1999)

Sources Final Users (Urban Land-use Area)	Solar	Biomass	Water	Geothermal
Domestic Heating/cooling Hot water production Lighting Electric appliances	Passive solar Solar water heaters Solar systems Photovoltaic	Energy waste from combustion to be used in DH systems, Anaerobic digestion for biogas as fuel	Hydroelectric	Geothermal energy to be used in DH (District Heating) Systems with methane
Commercial Heating/ cooling Lighting Electric applications	Passive solar Solar water heaters Solar systems Photovoltaic	Energy waste from combustion to be used in DH systems, Anaerobic digestion for biogas as fuel		Geothermal energy to be used in DH (District Heating) Systems with methane
Urban transport system	Photovoltaic			
Urban waste management	Solar water heaters	Energy waste from combustion to be used in DH systems, Methane from disposals to be used in power plants, Anaerobic digestion for biogas as fuel		
Industry		Energy waste from combustion to be used in DH systems, Methane from disposals to be used in power plants, Anaerobic digestion for biogas as fuel	Hydroelectric	Geothermal energy to be used in DH (District Heating) Systems with methane

Yet the current un-sustainability of cities exists in tension with the growing recognition that cities are strategic sites for sustainable development. Any attempt to achieve more sustainable energy use must goal energy integrated urban land-use areas (Rotmans, et al. 2000). This pressure exists for three major principal causes. First, the irresistible amount of energy demand is the result of urban populations and the economy they support. Second and related to the prior point, the size of all decisions about the form and extent of new development occur in cities and cities themselves often have tremendous influence on those decisions. Third, because the majority of wealth is both generated and concentrated in cities, there exists the economic capacity within the private sector to undertake alternative energy approaches, particularly those soft path strategies that require investment in new and advanced technologies (McGranahan and Satterwhaite 2003).

Researchers have tried to integrate the economic, social, and environmental aspects at the core of sustainable development into other types of planning approaches for urban land-use areas where resource flows are the main organizing principle. While these planning efforts are often voluntary exercises and may have only marginal impacts on policy, they are included here in order to recognize the continual evolution of efforts to positively affect the impacts of human activities. Several notable efforts were identified during the course of this research. Ravetz (2000) describes the whole systems approach used to create an integrated sustainability plan for the Greater Manchester (UK) city and region that looks at the "metabolic" aspects of the city and region as a materials processor. Rotmans (2000) also describes an integrated planning tool that serves as both a real-time environmental information system and a dynamic planning model.

According to Peker (2004), the rationale of integrating renewable energy technologies into cities through planning can be defined as; planning with renewable energies for the purpose of achieving urban and environmental sustainability, promc 37 the utilization of renewable energy technologies through planning for the purpose of improving quality of life, enhancing environmental quality, providing efficient use of local resources, making provisions for local economic vitality, and creating new visions for the future of local development, and planning with renewable energy for the purpose of reducing their negative impacts on local natural, built and social environments, and achieving global environment gains.

Based on these approximations, Peker (2004) explained the relations with energy and urban planning concepts in three planes; policy, planning and projects.

Urban planning, land-use and design can shape communities for efficient energy production distribution and use of these resources. By intentionally conserving all forms of energy and promoting reliance on renewable resources in land-use and design choices, cities can simultaneously improve their economies, environments, and quality of life. These widespread benefits are due to the integral nature of energy in communities, where efficiency gains in one sector lead to related improvements in other sectors. However the economical level of cities effect the energy production and consumption, the selected energy types have to prevent environmental quality for they respond to ecological environment.

In accordance with energy supply and demand systems the fact that urban energy management includes an evaluation of the renewable energy resource potential in terms of available energy and costs in urban land-use area would be an important input. According to OECD data (1995), sustainability based view point should be aimed in future, and emphasize;

- Application of land-use planning and planning regulations to promote the use of renewable energy technologies,
- Establishing different utilities (special and full co-operation of existing) to take on the deployment of renewable energy technologies,
- Integration among energy supply, waste management, transport management and pollution control policies to increase the efficiency of renewable energy technologies,
- Devising the suitable building regulations to assist the wider application of renewable energy technologies,
- Developing and controlling the electrical power, combined heat and power (CHP) and district heating (DH) network to be used in a renewable energy technologies concept;
- Establishing the procedures to assist the direct involvement of communities in renewable energy technologies.

2.1.3. Energy Integrated Urban Land-use Planning in Geothermal Energy Context

The relations of land-use and geothermal energy context are changed in different case areas. Five specific results are found in the case area studies by Pasqualetti (1986);

1) Land-use characteristics (juxtaposition of allowable population densities and the temperatures of geothermal water) often play the deciding role in the success or failure of a geothermal development project.
2) Land-use evaluation can be used as a screening mechanism in the identification of those sites where institutional conditions of land-use (e.g. land ownership, zoning) are most compatible to geothermal development.
3) Sites identified by land-use evaluation to be most suitable should be given highest priority for development.
4) An approach should be devised and tested which would identify the best prospects among the hundreds of communities around the country that are co-located with geothermal re-sources (New Mexico Energy Institute 1980).
5) The land-use analysis should emphasize user energy density, zoning, parcel size, parcel vacancy, and parcel ownership.

On the other hand, geothermal energy is a specific renewable energy type because of the resources locations, and potentials. Especially, if an urban settlement is located the top of the geothermal resources, the land-use concept are very important point for the geothermal resource, geothermal infrastructure, policy and planning process context.

2.1.3.1. International Development and Regulatory Requirements of Geothermal Energy

Geothermal energy which is the heat derived from the earth, is a form of renewable energy. Geothermal energy is the natural heat from the earth's interior stored in rocks and water within the earth's crust.

The nature of *geothermal resources* and the types of *development* that may occur in order to predict and evaluate the environmental effects of *geothermal development* is the important point. Although geothermal sources all contain heated fluids trapped beneath the earth, the temperature and chemical characteristics of the resources can vary significantly, the geothermal resource temperature and size varies, so does the technology used to develop beneficial uses of the resource (Hietter 1995).

There are three steps in geothermal development process; preliminary exploration, deep exploration drilling and production and utilization. The surface geological mapping, geophysical studies, geochemical sampling and shallow temperature gradient and core hole drilling studies are conducted preliminary step. Identifying, defining and geothermal reservoir testing processes are included deep exploration drilling step, and lastly, production and utilization step include the defining the type geothermal resource and deciding the efficiency process.

There are four different classifications of geothermal energy; Temperature classifications (Low-Moderate-High), Fluid- Phase classifications (Vapor dominated, Liquid dominated and dry rock), heat- source classifications (deep circulation of groundwater and volcanic heat) and resource- application classifications (electric-power generation and direct use). The classifications of geothermal occur three parts as shown in Lindal diagram (see Figure 2.8); high temperature (more than 150°C), moderate temperature (90°C- 150°C), low temperature (less than 90°C). The thermal fluid of geothermal energy can be used for direct heating in residential (space heating, bathing, swimming), agricultural (greenhouse-farm heating, aquaculture pond heating, agricultural drying) and industrial functions (cooling, chemical refrigeration).

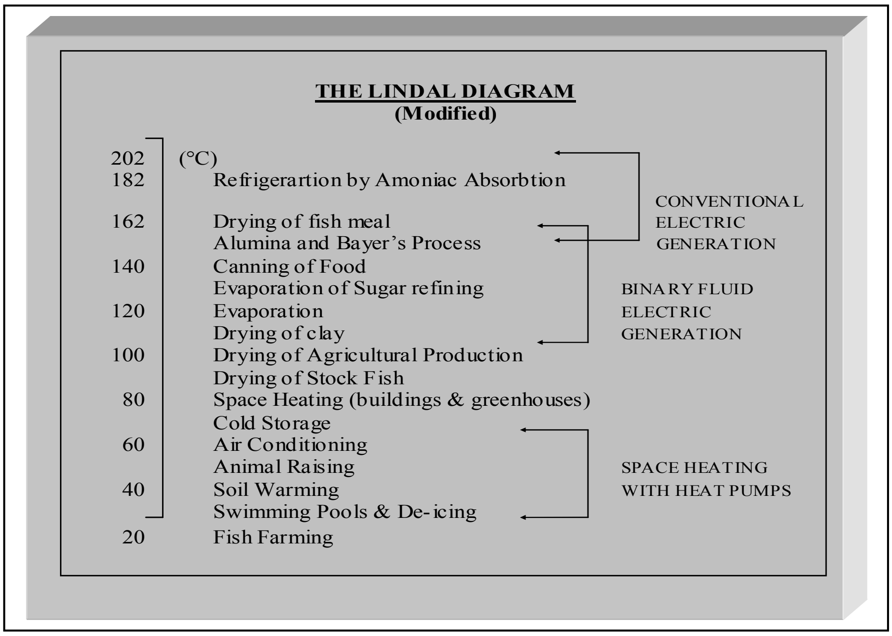


Figure 2. 6. The Lindal diagram on typical fluid temperatures for direct applications of geothermal resources (Source: GEA 1993)

These applications which determine the form of urban functions (residential, agricultural industrial regions), and settlement and planning policy, affect directly the urban planning systems. Localization is the very important concept in geothermal energy integrated urban planning (see Figure 2.9).

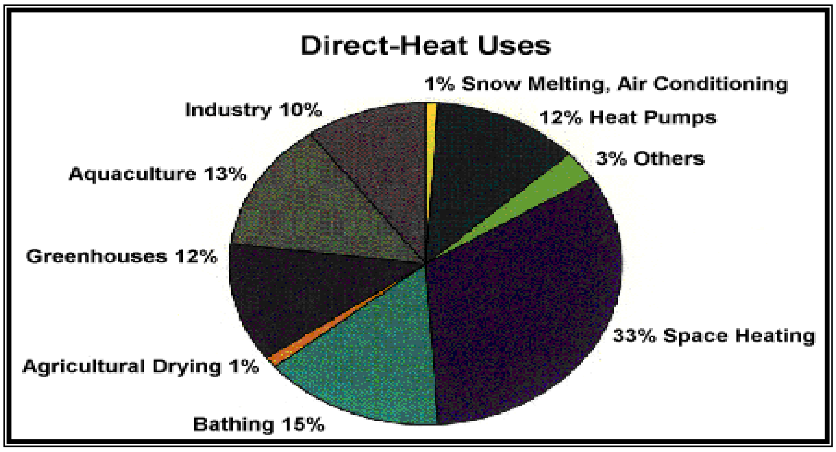


Figure 2. 7. Direct-use of geothermal energy different sectors
(Source: Geothermal Education Office 2006)

International Cases

In 1990's, after the International Conferences- World Summit Conference in 1990, The United Nations Conference on Environment and Development in 1992- a number of geothermal energy researches, conferences and congresses proliferated all over the world. Firstly, Geothermal Resource Council was organized by Geothermal Energy Association (GEA) in 1993.

The World Geothermal Congress was organized by the International Geothermal Association in 1995, in Florence, Italy. After that, in Kyushu-Tohoku in Japan, World Geothermal Conference (WGC) held in 2000. Lastly, WGC organized in Antalya, in Turkey (2005) by the International Geothermal Association.

Within the framework of all congress, a number of publications were issued on the subject of geothermal energy covering such titles as geology, economy, system structures, working principles and their contribution to the economy of the country, but still not a detailed study was conducted on the effects of physical planning in the cities where geothermal energy is implemented and socio-cultural effects on the people using this energy.

On the other hand, there are very important organizations about geothermal energy resources all over the world. The International Geothermal Association (IGA), founded in 1988, is a scientific, educational and cultural organization established to operate worldwide. The IGA which has more than 2000 members in 65 countries is a non-political, non-profit, non-governmental organization in special consultative status with the Economic and Social Council of the United Nations, and Partner of the European Union (International Geothermal Association 2006). The other important association is the Geothermal Resources Council (GRC) which has built a solid reputation as one of the world's premier geothermal associations. The GRC (1970) serves as a focal point for continuing professional development for its members through its outreach, information transfer and education services.

There are a lot of geothermal related papers and publications in literature, but in this study, literature surveys were concerned in relation to geothermal development and physical environment, concepts of socio-economic impacts, and any publication which covers all the subjects of urban planning.

There is only one paper which was prepared in 1980 by Gudmann and Rosenthall, in urban planning origins. According to this paper, the geophysical, technological and economic characteristics of low-temperature geothermal energy district heating systems (GEDHS) were analyzed and integrated within an optimization planning model aimed at minimizing total energy supply costs. The approach emphasized the spatial dimension of such systems and the interface between their spatial layout and the structure of the urban areas they are designed to serve.

The publications on physical environment related subjects, computational methods using in geothermal energy projects planning and evaluating process subjects' publications were written by Goumas, Lygerou and Papayannakis in 1999. In their paper, Sommer, Kuby and Bloomquist (2003)'s examined relations with the spatial economics of geothermal energy and small, low-density town, and Mammoth Lakes, California. In 2004, Coles and others conducted the research examined the spatial decision analysis geothermal resource site in Saint Lusia.

Socio- economic dimension of the issue is more concerned in geothermal resources and development concept. In 2002, Bw'Obuya drew up the socio-economic and environmental impact on the rural and poor areas in Kenya, then, in 2003 the same researcher wrote a paper on the impacts the geothermal power plant on rural and poor areas in Kenya. The latest study was conducted by Manaloglou, Tsartas and Markou (2004) and titled as socio-economic effects of geothermal energy sources in Milos Island and people are who live in there, wishes.

International Laws and Regulations

Most countries have embodied their environmental concerns in legislation and regulations. These regulations are remarkably similar, and many countries have regulations that require an environmental analysis of a proposed geothermal project, as well as specific regulations that define the quantities of pollutants that may be emitted to the atmosphere or discharged to land and water. There is, however, significant variation in the number of agencies involved in the environmental review of a project, and the amount of time required from application through to project approval.

Different types of geothermal field and geothermal development have varying impacts and legislation needs to cover all possible development scenarios. In general, as development proceeds, the legislative requirements move from environmental impact reports during the pre-development stage, to gaining consents for the development and finally a monitoring role during production (World Bank 2006).

Geothermal regulations prepared in different countries (United States, Philippines, New Zealand and Italy).

Regulations in the United States

Geothermal development in the U.S. is governed by a variety of broad legislation developed and implemented at three scale; federal (national), state and local. National Environmental Policy Act (NEPA), Geothermal Resources Operational Orders (GROs) and Specific Resource Protection Laws have a very important role in enacting the key law based on environmental aspects. The process permitting geothermal energy use in U.S. is concerned with the environmental review under NEPA.

The Geothermal Steam Act of 1970 was enacted to provide for the leasing of federal lands for geothermal exploration and development. Lands within National Parks were excluded from geothermal leasing. According to United States Geological Survey (USGS) (1980), The Geothermal Resources Operational Orders (GROs) were developed to define, specific operating requirements for the geothermal developers on federal lands. Main goals of GROs are preparation specific environmental protection procedures which include minimization of the environmental effects of drilling and utilization (USGS 1980).

Hietter (1995)'s study explain that, the other important official institution is The U.S. Department of Interior, Bureau of Land Management (BLM) which aims to lease federal lands for geothermal development, to conduct the environmental review, and to approve the plans for developing the geothermal resource. The BLM is the federal lead agency and is responsible for the final approval of the project. In addition, U.S. Department of Defense is interested in the location and developing the geothermal resources (see Figure 2.10).

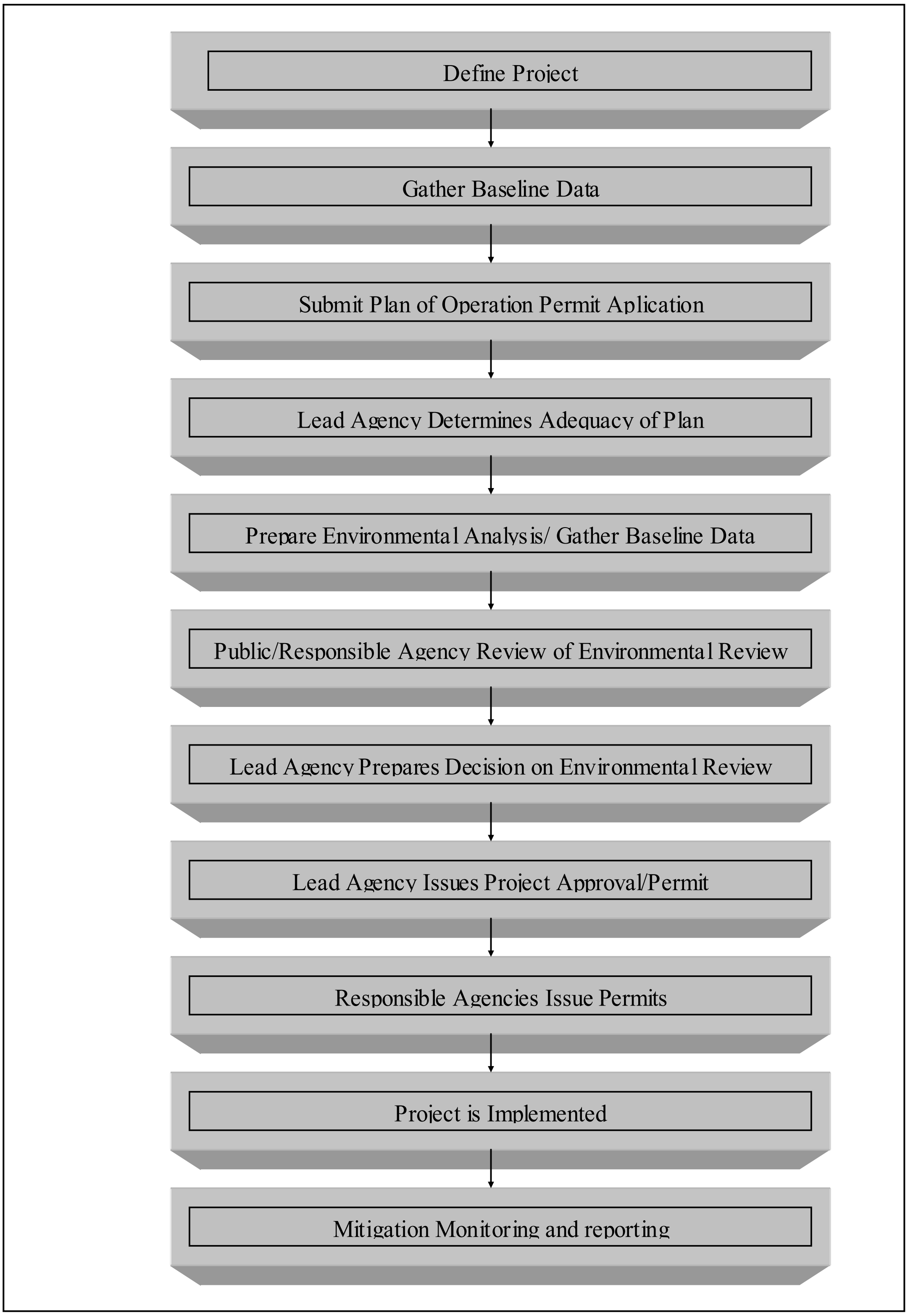


Figure 2. 8. Geothermal development permitting process in the U.S.
(Source: Hietter 1995)

Regulations of the Philippines

Established an Environmental Impact Statement (EIS) system (1982) and Amendments to the EIS System which are the Presidential Decrees, determine the environmental and geothermal laws in the Philippines. The Philippine EIS is the determinant institutions. The other important institution is the Philippine National Oil Company. It has developed a set of guideline for geothermal operations, because of the similarity of geothermal development technology with oil and gas drilling activities. Besides the institutions, there is a specific Presidential Decree (1978) which specified An Act to Promote the Exploration and Development of Geothermal Resource (Hietter 1995).

Regulations of New Zealand

The Deep Geothermal Wells Committee of the Standards Association of New Zealand researches the geothermal developments in New Zealand. This Committee develops a specific code titled "Code of Practice for Deep Geothermal Wells" and this code governs the geothermal drilling activities. The code which is the modification of oil and gas requirements explains the requirements of design and work practices (the safe drilling and operation) of geothermal resources (SANZ 1991), (see Table 2.4).

Table 2. 4. Topics in the code of practice for deep geothermal resources
(Source: SANZ 1991)

Section	Topics
Resource Design	Casing depts., diameters, materials, design and resource heads
Resource Sites	Access, location, design and construction, cellars, drainage and waste disposal, water supply, multi-well sites, safety and security
Drilling Equipment, Tools and Materials	Drill rigs, generators, pumps, wellheads, blowout preventers, drill pipe and tools, casing, cement, mud, testing and logging equipment
Resource Operation and Maintenance	Bleeding, discharge, maintenance, well integrity, work over, record keeping
Abandonment	Criteria, assessment, operations, maintenance

Regulations of Italy

In Italy, Geothermal regulations are distinct from the General Mining Law. The mineral deposits belong to the state which includes the geothermal resources. The State grants Exploration Permits and Mining Leases. The exploration permit is for the preliminary exploration step includes geological and geochemical investigations and resources drilling, with each activity requiring specific authorization. Development of geothermal resources is divided into categories as surface exploration, deep exploration, and development and exploitation (Castaldo, et.al. 1995, Hietter 1995).

2.1.3.2. Geothermal Potential in Turkey

The geothermal energy resources and developments are organized by Ministry of Energy in Turkey and geothermal wells are exploited by the General Directorate of Mineral Research and Exploitation (MRE).

Utilization of Geothermal Resources in Turkey

Turkey has a place among the first seven countries in terms of abundance of geothermal resources around the world, and among the first five leader countries in its geothermal direct use applications. There are, in Turkey, district heating systems, electric power plants, greenhouse heating systems and balneological applications.

The regional distribution of the geothermal well drillings is; 87% in western Turkey, 11% in Mid-Anatolia, and 2% in eastern Turkey. There are a lot of GEDHS in Turkey (Hepbaşlı and Çanakçı 2003) (see Table 2.5).

350MWt heating capacity equivalent to 50000 households (Forecasting potential 7700MWt equal to 1300000 households); 4500MW proven for electrical power generation in high enthalpy zones; estimated thermal energy capacity is 31000MW. The total geothermal energy potential of Turkey is about 2268MW in 1998; both for electrical and thermal uses are only 1200MW (Kaygusuz 2002a, Kaygusuz 2002b).

According to İzmir Geothermal Incorporated Company (2007), Turkey has significant potential of geothermal energy sources; direct use for heating applications is approximately 983MWt for 117000 residence (8300MWt capacity and 1250000 residences equivalent); 27MWe for power plant in Denizli- Kızıldere and Aydın-Salavatlı geothermal fields (1000MWe total capacity equivalent); in 215 spas for balneology purposes with a total capacity of 402MWt; neighborhood heating, thermal facilities and greenhouse heating (direct uses applications of geothermal energy) with a total installed capacity 493MWt (see Table 2.6).

Table 2. 5. City based geothermal district heating systems installed in Turkey (Source: Hepbaşlı and Çanakçı 2003)

Location	Area (m^2)	Capacity(MWt)	Location	Area (m^2)	Capacity (MWt)
Şanlıurfa	106000	24.5	Dikili	120000	24
Simav	120000	33	Gölemexli	1000	0.2
Sındırgı	2000	0.4	Seferihisar	6000	1.06
Afyon	5500	1.5	Bergama	2000	0.4
Kızıldere	10750	2.4	Edremit	49650	8.7
Balçova	100000	17.6	Germencik	500	0.1
Kestanbol	2000	0.4	Ezine	1500	0.3
Saraykent	2000	0.6	Naksar	500	0.14
Tekkehamam	8000	1.8	Kızılcahamam	5000	1.45
Yalova	600	0.12	Gediz	8500	2.1
Kozaklı	4000	1.2	Çanakkale-Tuzla	50000	9

Table 2. 6. Total area of greenhouse heated 565000m^2 by geothermal energy in Turkey (Source: Mertoglu 2003)

Location	Province	Year Com.	Capacity (MWt)	Geo. Fluid Temp.(°C)	Supply-return Temp.(°C)	Installed capacity Residence/house heated numbers
Gönen	Balıkesir	1987	32	80	-	4500/3400
Simav	Kütahya	1991	25	120	65/50	6500/3200
Kırşehir	Kırşehir	1994	18	54-57	48/42	1800/1800
Kızılcahamam	Ankara	1995	25	80	_	2500/2500
Balçova	İzmir	1996	72	115	85/60	20000/6849
Kozaklı	Nevşehir	1996	11.2	90	_	1250/1000
Afyon	Afyon	1996	40	95	60/45	10000/4000
Sandıklı	Afyon	1998	45	70	70/40	5000/1700
Diyadin	Ağrı	1998	42	78	78/45	2000/1037
Salihli	Manisa	2002	142	94	_	20000
Sarayköy	Denizli	2003	45	180	96/56	5000/2000

Legislation about Geothermal Energy Use in Turkey

Deficiencies and problems encountered in geothermal systems in Turkey can be basically grouped as three important area; (1) institutional ones originating from the absence of legal framework; (2) technological ones deriving from the absence of latest technology (Technical Issues: In this problem area, there are three important variables; resource related issues, reservoir related issues and plant design and distribution network related); (3) economic ones arising from project financing models (peak loads are not taken into account for two reasons: lack of knowledge and the problems on raising funds for the investment), which in turn results in the absence of new technological implementation.

Institutional problems arise due to the lack of local and national standards, regulations and laws that might serve as a guide in geothermal energy utilization project. The utilization rights of hot springs and mineral waters that have been used since ancient times for bathing and thermal spa were given to provincial administrations by legislation enacted in 1926.

Therefore, it is now very difficult to manage the geothermal resources in a sustainable way with a law enacted in an era, when geothermal energy was barely known and there was not energy crisis of environmental problem. A new law should be enacted to preserve the environment and natural geothermal features, to provide sustainable and efficient use of the geothermal resources and to define legal and technical authorities (European Commission 2003).

This deficiency causes different problems; the absence of legal framework creates conflict of interest between state institutions and between private companies and state agencies and therefore, hinders the development of geothermal resource (see Table 2.7). The other one is; private businesses were not able to participate in the construction of geothermal utilization systems. No major private investment on geothermal resources has benn realized. The lack of preservation of geothermal resources is the other important problem. In recent years, geothermal hot spring areas have being spoiled by excessive drilling without permission and without any exploration effort, such as geological, geophysical and geochemical studies. The problem of declining water levels is so dangerous in those natural state reservoirs draining the geothermal aquifers. This occupation is caused the gravity of the problems to increase.

In this disadvantageous position, regulations and laws which are direct geothermal energy subjects or related to its (alternative energy regulations etc.)

concepts, of Turkey are played very imported role. These national standards, regulations, codes and laws can be basically grouped as follows (see Table 2.8).

Table 2. 7. Legal, regulatory and institutional problems and proposal approaches in Turkey (Source: Energy Commission Report 2003)

Problems	Proposal Approach
Geothermal Energy Inherent Situation	
Lack of a data on Geothermal energy resources and a resource atlas	Assist in establishing data base and geothermal atlas
Insufficient legal, regulatory, and institutional framework to support geothermal energy development	Review frameworks and propose modifications in support of geothermal energy use.
Lack of standardization to assess economic geothermal resources.	Work with International Geothermal association (IGA) to develop economic standards to help estimate economically recoverable resources. World bank geothermal energy development fund (GeoFund) for ECA countries (Europe and Central Asia region) is the other important organization.
Density and mix	Space conditioning needs and neighborhood heating/ cooling cogeneration feasibility
Geothermal Energy External Situations	
Lack of cooperation between different government bodies and institutions 8 e.g., those in charge of Energy, water Environment, Natural resources, Agriculture, Forestry, R&D), etc. to help promote geothermal energy use.	Systematically review responsibilities of different bodies and foster cooperation.
Insufficient private sector presence in the energy sector.	Help promote sector privatization but in disciplinary system.
Insufficient legal, regulatory, and institutional framework to support GE development.	Review legal and regulatory framework with a view to improving them to allow geothermal energy promotion.

As can be seen from the above Table 2.8, investigation of the Laws, regulations and decisions of the Board of Ministers reveal that the history of geothermal energy (and other sources of alternative energy) dates back to 1926. According to the Turkish Constitution, of the laws for natural resources, water, petroleum, mines that belong to the public, the ones for geothermal energy have been matured in 2007 (see Appendix A).

Table 2. 8. National standards, regulations, codes and laws related to geothermal energy subject

Date	Name	No	Types	Law No
30.06.1926	The Law about Exploitation of Hot and Cold Mineral Waters and Thermal Spring Systems		Law	927
17.06.1942	The Law about Searching and Managing of Mines		Law	4268
24.05.1957	The Law of the Changing the Second Article of 4268 Law		Law	6977
14.06.1985	The Law of Appendix about Exploitation of Hot and Cold Mineral Waters and Thermal Spring Systems		Law	2809
27.10.1988	The Law about Appendix Article of Tourism Encouragement Law (2634)		Law	3487
31.12.1993	The Regulation about the Justice of Thermal Water Using and the Justice of Thermal Water Managing Procedure in Tourism Area and Tourism Center	21805	Regulation	
14.08.1997	The Law about the Changing of Energy Production Law		Law	9670
25.06.2001	The Regulation of the Preparing the Geothermal Energy Facilities Projects by Bank of Provinces	24443	Regulation	
28.06.2002	The Notification of Implementing the Essentials and Procedures about to research, to dig a well, to manage the well and to license the Geothermal Res. in İzmir	*2002/1*	*Notification*	
01.12.2004	The Regulation about Mineral Waters	25657	Regulation	
24.07.2005	The Regulation about the Changing of the Regulation of Mineral Waters	25885	Regulation	
18.05.2005	The Law of Using for Electricity Production of Renewable Energy Resources	25819	Law	5346
04.10.2005	The Regulation of Essentials and Procedures about the Document Given of Renewable Energy Resource	25956	Regulation	
2005	*The Proposal Law of Geothermal Resources and Mineral Waters*		*Low (Proposal)*	
2005	*The Proposal Regulation of Geothermal Energy for İzmir Governorship*		*Regulation (Proposal)*	
13.06.2007	The Law of Geothermal Resources and Mineral Waters		Law	5686
12.12.2007	The Regulation of the Development of The Law of Geothermal Resources and Mineral Waters		Regulation	

First (until 1980s), laws which were enacted in the form of regulations only for the use of hot spring resorts and other thermal usages were broadened, in the course of time, to include thermal energy with the increase in domains that thermal energy is used. During 1980s, it was included into the scope of the Law of Mines, but later on, due to the nature of the geothermal energy which is fluid and dynamic contrary to the minerals , it was excluded from the of Mines. In recent years (as of 2001), serious increases are observed in the number of the decisions of the Board of Ministers, regulations and laws but a law for the geothermal energy has not been yet constituted.

According to Erbaş (2002), with a change in the Law of Energy by the decision of the Board of Ministers in 1997, the concept of the discipline of urban planning legally reinforced the relationship between the concept of energy and discipline of planning, opening a sort of new page in this domain. Although this Law, which was enacted in 1997 within the main virtualization of energy, is a serious turning point in general, in fact, the concept of geothermal was included into the planning literature 1988 within the framework of the regulations for mineral waters. With the determination of the protection areas for the geothermal energy and the description of the precautions to be taken on the areas, it affected the planning studies and structuring conditions especially in settled areas.

According to the definition of the protection area written in “Geothermal Resources and Mineral Waters”, published in 2007 as a law, and with the series of precautions determined depending on any physical, chemical and biological pollutants that pollute, spoil and cause a loss in their renewable properties in “geothermal resources and the systems that these resources are connected to, and in order to protect from any external factors such as geological and hydrological structure of the area, climatic conditions, kinds and types of soil, border of the drainage area, settlement units, industrial plants around the resource and the well, topographic structure of the environment together the areas which are subject to the control and audit of the activities which are allowed to be conducted form the areas of protection” (The Law of Geothermal Resources and Mineral Waters 2007).

The Previous Studies in Turkey

Detailed technical and economic analyses, to perform for GEDHS, to measured usage power of geothermal power plant and to use in greenhouse and industrial regions subjects for Turkey have been studied by several researchers (Kaygusuz 2002, Hepbaşlı and Çanakçı 2003, Mertoğlu 2003).

But, physical environmental and socio-economical impacts of geothermal developments subjects in particular have not been detailed by researcher in Turkey. Only few publications (Mertoğlu 2002, Toksoy and Şener 2003) related with these impacts and geothermal development.

2.1.3.3. Environmental Aspects of Geothermal Energy Integrated Urban Land-use Planning System

Geothermal energy can be input in urban planning process and urban land-use planning system, because of the environmental aspects which include impacts on the physical environment and socio- economic impacts. Although chemical and biological impacts are included in environmental aspects, they not used as input for planners in this system and process.

Environmental impacts from geothermal development also vary during the various phases of development. The environmental effects of direct-use geothermal projects are generally related to very minor surface disturbance required for wells (Hietter 1995). Since geothermal energy is often a replacement for diesel or other fossil fuels, it has great benefits for people's health through improved air quality. There are atmospheric emissions from geothermal power plants which are predominantly CO_2 and H_2S. However, in the context of global climate change, geothermal has significantly lower CO_2 emissions than fossil fuels. Atmospheric emissions from geothermal plants average only about 5% of the emissions from equivalent generation sized fossil fuel power plants. The actual land-use for geothermal energy production is relatively small for both the fuel acquisition and the energy production. Geothermal plants also co-exist successfully with other land-uses (see Table 2.9).

Table 2. 9. Geothermal resource characteristics and the effects on development and the environment (Source: Hietter 1995)

Resource Characteristic	Effects
Temperature	Determines type of technology used: the type of technology (direct use, flash or binary power plant) determines whether there are emissions to the atmosphere.
Chemical composition	Chemical composition of the resource determines nature of air emissions (if any), and the nature of the fluids that may be discharged.
Depth	Depth to the reservoir determines size of drilling rigs required to extract the resource. Larger drill rigs are used to reach deeper reservoirs: the larger rigs require greater surface disturbance for larger drilling pads.
Reservoir rock formation	The type of rocks encountered during drilling determines duration of drilling. Difficult subsurface conditions can extend the drilling time and the associated effects of drilling.
Area extent	The size of the reservoir determines how many power plants may be developed, with the accompanying impacts and surface disturbance.

The Observed Impacts on Physical Environment

Exploration, development and utilization of a geothermal field can have a significant impact on the physical environment surrounding the resource (see Table 2.10). Opposition of communities often lies on the sitting of geothermal projects because of conflict in their desired resource/ land-use for the area and their adjacency to a potentially harmful project. The acceptable sitting of the project in turn is dependent on the adoption of a zoning plan agreed by all sectors. The zoning plan which is used for buffer areas around the resources, prescribes the rational utilization of land and the rational exploitation of natural resources.

In different countries which have developed geothermal systems (theory and practice), the zoning plan process was implemented. *Geothermal Zoning Plan* considers three components namely, the physical environment, the geothermal project itself, and the community. The interaction of a number of parameters will form the basis of the plan. These include the land-use, vegetation cover, land capability, erosion potential, population, rainfall, air quality, hydrology, and other factors. The result is a plan which is sensitive to environmental considerations and is independent of economic and political thrusts. Geothermal is one of the resources that zones are to be allocated in the plan. The plan becomes then subject to consultation with the local planning bodies, regulatory agencies, local authorities, non- governmental organizations, and the community.

Table 2. 10. The negative effects of geothermal wells on physical environment (Source: Brown 1995)

Potential Impact	Potential Effect	Mitigation/ Remediation Measures
Land requirement	- Vegetation loss - Soil erosion - Landslides - Land ownership	- Single drill pads-several wells - Re-vegetation programs - Adequate land compensation
Water take from streams/waterways for drilling purposes	- Impact on local watershed - Damming and diverting local streams	- Take from streams with high flow rates - Coincide drilling with rainy season not dry season - Build temporary reservoirs - Lease with local farmers to take their usage into account
Water take from reservoir	- Loss of natural features (see note below) - Increase in steaming ground - Hydrothermal eruptions - Lowering of water table - Increase in steam zone - Subsidence - Saline intrusion	- Avoid water take from outflows - Avoid areas where propensity for hydrothermal eruptions (which occur naturally also) - Careful sustainable management of resource, balancing recharge with take
Waste (brine and condensate) disposal into streams/waterways	- Biological effects - Chemical effects - Thermal effects	- Effluent treatment and removal of undesirable constituents - Re-inject all waste fluids - Cascaded uses of waste fluids e.g. Fish farms, pools
Re-injection	- Cooling of reservoir - Induced seismicity - Scaling	- Careful planning of re-injection wells outside main reservoir - Monitor flow patterns before re-injection e.g. Tracer taste - Anti-scale treatment of fluids
Drilling effluent disposal into streams/waterways	- Biological effects - Chemical effects	- Contain in soakage ponds or in barrels for removal
Air emissions	- Biological effects - Chemical effects - Localized slight heating of atmosphere - Localized fogging	- Effluent treatment and removal of undesirable constituents - Minimize emissions by scrubbing H^2S and treating other NCG's (Non Condensable Gases)
Noise pollution	- Disturbance to animals and humans - Impaired hearing	- Muffling of noise e.g. silencers

On the other hand, for power generation, in geothermal energy production, the land need is little for both the fuel acquisition and the energy production. Geothermal development requires land disturbance for well pads, roads pipelines, and the power plant. The average geothermal power plant occupies only 400m^2 to produce a GWh of electricity over 30 years (KenGen 2000).

Development and utilization of a geothermal field can have effects on the physical environment surrounding the resource. As geothermal development proceeds; drilling operations, pipeline routes and the power station cause some effects on the landscape. During the construction on the area, noise pollution may increase. Natural geothermal features may decrease or increase in activity, the local climate may be affected, large volumes of cooling water may contribute to thermal pollution of local waterways and some areas of land may be subject to subsidence (Brown 1995).

Socio- Economic Impacts

Social Assessment

The integration of social concerns into the decision, planning and management of any geothermal project is mandated by international protocols, individual state laws, and by the policies of different agencies and international financing institutions. Greater benefit can be returned locally in countries where landowners have some control over access to the geothermal resource. According to Geothermal Energy Council, The low marginal cost of the fuel source may mean that off-peak capacity from geothermal power plant can be cheaply used for regional development projects such as pumping irrigation water. Modest land requirements have meant that this energy source can provide direct benefit to local and regional communities while having a minimal impact on existing land-uses (see Table 2.11), (UNEP 2002).

The use of geothermal energy for power generation in developing nations and rural electrification results in improved quality of life through better illumination, better air quality, improved access to information and telecommunications as well as being a stimulus to business development.

If geothermal resource ownership and control is vested, at least partly, with local communities or land owners, then there is opportunity for partnerships between local interests and private power developers to develop geothermal projects with benefits feeding back to the local community. This is the common model for all recent geothermal projects in New Zealand where the indigenous Maori resource owners have formed partnerships with power developers for plant financing, construction and operation, leading to increased economic autonomy of the rural communities (Kleinpeter 1995).

As part of the general principles of the Earth Charter, social fundamentals are as valued as ecological and economic ones. Therefore, in development of any large scale projects, impacts on indigenous groups and societies must be taken into consideration and impacts assessed.

A well designed geothermal project includes the following social related aspects:

- Process that helps to manage change (social and physical environment) from intended and current policies and projects,
- Focus on individuals, groups, communities and ecosystems affected by change,
- Process which uses analysis, research, monitoring and management which incorporate methods of public involvement and consultation.
- Impact assessment procedure used to examine the social and environmental consequences, both beneficial and adverse, of a proposed development project and to ensure that these consequences are taken into account in project design.

Table 2. 11. Social assessment process of geothermal energy
(Source: UNEP 2002)

Scoping	Identification of issues, variables to be described/measured, likely areas of impact, study boundaries
Profiling	Overview and analysis of current social context and historical trends
Formulation of alternatives	Examination and comparison of options for change
Projection and estimation of effects	Detailed examination of impacts of one or more options against decision criteria
Monitoring, mitigation and management	Collection of information about actual effects, and the application of this information by the different participants in the process to mitigate negative effects and manage change in general
Evaluation	Systematic, retrospective review of the social change being assessed, including the social assessment process that was employed

An all too frequent failing of projects is the non-execution of environmental and sociological guidelines and recommendations established in the early phases of the project. Policy requiring that guidelines and recommendations be established (Environmental and Sociological Impact Assessment Studies) is in place, however, policy requiring implementation of the recommendations seems to be lacking, and most often the requirement for budgetary provision for implementation of these recommendations totally ignored.

Solutions are required which give priority to the identified development needs of the local people. In order to get the support of the communities there must be consultation, information, education and evidence that the lives of the rural poor are to be improved as a result of the geothermal development.

Socio- Economic Assessment

In general, geothermal development project include improving the socio-economic conditions. Improving the socio-economic conditions of the geothermal development is the remarkable input of the project. The costs and impacts of project on the intended beneficiaries become the yardstick of the acceptability and the success of the geothermal project (Jesus 1995).

According to Jesus (1995), the goal of the socio-economic analyses of the geothermal projects is to explain the change in the study areas. Geothermal analyses provide a guide on how the geothermal project can be kept in consonance with the socio- cultural and economic situations in the area. The analysis process includes three steps;

- A 10-year period trends secondary data,
- Surveys (telephone interviews, mailed forms and personal interviews form),
- Dialogues, focused group (NGO, public, local) discussions, multi-sectoral assemblies.

2.2. Overview on the Relationship between Energy “Geothermal Energy” and Urban Land-use Planning System

After all literature research revived, a few studies are chosen to be main inputs for this thesis.

M.J. Pasqualetti’s “The site-specific nature of geothermal energy: Its effects on land-use planning” and “Planning for the development of site-specific resources: The example of geothermal energy” documents are inputs for relationship between land-use plan and geothermal energy concepts. These publications were executed in Scottsdale, Arizona and covered the studies on considering geochemical and geological data and cost-benefit analyses together with energy density, parcel ownership, parcel size, parcel vacancy and zoning” parameters with regard to planning the development of geothermal energy in accordance with settlement.

Mariita (2002) and Manologlou, Tsartas and Markou (2004) documents are input for relationship between socio-economic analysis and geothermal energy concepts in this thesis.

The study in Kenya constitutes a model for heating with inexpensive energy for the settlement areas where poor people are living in underdeveloped or developing Far East and Southern American countries such as Indonesia, Philippines, Guatemala and Kenya, and for using this energy in different areas (electricity production, etc). The study uses the data sets such as the size of population and growth rates, education-health and cultural inquiries in the region, development and deficiencies in the infrastructural systems of region, unemployment rates, and immigrations, positive and negative effects of geothermal energy.

The study performed in island Milos- Greece focuses on which sector in the island should use the geothermal energy and on the expectations of its people. This study developer questioning groups consisting of governmental, private, civil society and entrepreneurs in the island other than applying the questionnaire method, and these shed insight into seeking a sectoral grouping in this study.

The studies of "The Energy Yardstick: Using Place's to Create More Sustainable Communities", which were performed with regards to providing the relation between energy and city with a simulation by a wide group for "Center of Excellence for Sustainable Development Office of Energy Efficiency and Renewable Energy U.S. Department of Energy" in 1996 with the partnership of Oregon Department of Energy, Washington State and California Energy Commission and under the presidency of William S. Becker, constitute the model editing and has been an input for this thesis. In their study they used the software called "Place's", and aimed to obtain an optimum plan oriented to energy-city relation as addressed to making currently used energy types more productive in urban study areas of different sizes in different regions of America. The parameters such as different energy consumption quantities in different urban sectors, building density and energy quantities consumed thereby, etc. were added to the variables obtained from socio-economical, land-use, case area and geothermal resource and geothermal development analyses in this thesis.

2.2.1. The Variables about Geothermal Energy Integrated Urban Land-use Planning System

The variables about the utilization of geothermal energy in land-use planning are formed in three groups. If the variables are arranged in a rows, these groups are happened: *independent variables*; adequate geothermal capacity, advanced geothermal technology, established geothermal infrastructure system, incompletion of geothermal conservation zone map, less community perception and interest on the project, related local agenda, less participation (decision makers/ policy makers), misguided developers' interest and imbalanced market , more non-governmental organizations (NGOs) interest, insufficient laws and regulations, inadequate communication, inappropriate land-use allocation and zoning, untidy land block density (user energy density), unused residence and office ratio (mixed land-use), less residence equivalent and existing building ratio, private land ownership, congested parcel size and vacancy and sufficient heat load density of buildings, *intervening variables*; geothermal case area and resource context, geothermal infrastructure context, policy context and planning process context, and *dependent variables*; adoption effectiveness and fidelity concepts in energy efficiency.

2.2.1.1. Independent Variables

Independent variables cause, influence or affect outcomes. The variables are also called treatment, manipulated, antecedent, or predictor variables (Creswell 2003). The variables are chosen from the literature surveys results and grouped into four intervening variables. In this part of the thesis, the variables are defined in detailed.

<u>*Adequate Geothermal Capacity*</u>

The capacity of underground geothermal reservoir is one of the most important inputs of the projects related to geothermal. It is compulsory to ascertain the capacity of the geothermal potential and to expose the limits. Moreover the type of the use and the most effective regions in the usage should be predefined to be able to take the maximum benefit of the geothermal source. It is very important to reuse the energy to provide the continuity of the capacity. The energy source should be re-injected to underground from the specific, appropriate points that are well-defined within the project process.

Advanced Geothermal Technology

It is very important to make an investment on geothermal projects that will also lead the technological improvements worldwide. Especially the most expensive part that is the first cost is well-drilling process. Equipments of the process, the organization of well gets cheaper within the time and provides the chance of getting deeper and therefore ensures the adaptation of the new sources to the existing reservoirs. Moreover, it helps to ascertain the real size of the existing reservoirs. Therefore, the technological improvements in the field of GEDHS are very important developments that will be beneficial in the process of geothermal energy integrated land-use planning.

Established Geothermal Infrastructure System

The region the GEDHS implemented should have a well-planned underground system to take the maximum benefit from the project. Because the existence of the underground project reduces the costs and moreover it helps execution of a well defined project management process that also provides the good working environment for workers and the inhabitants of the settlement. The existence of the infrastructure project will reduce the unexpected outcomes of the development process such as noise, bad smell, interrupted traffic, accessibility and car parking problems.

Uncompleted Geothermal Conservation Zone Map

Another important part of the geothermal energy integrated urban land-use planning approach is the formation of the geothermal conservation zones. The well locations and correct determination of these conservation zones and the adequate number of drilling and technical analysis should be complete and compatible, as shown as zones into plans in the scale of settlements plans. Otherwise inadequate and uncompleted projects in determination of the zones would result in adverse effect.

Community Perception and Interest on the Project

Community perception concept is the major part of the related actors of GEDHS and geothermal energy integrated urban land-use planning approach. Different values, interests and world views of people and the principle of the community's are affected by the project. Thus, public participation is the active involvement of the community in the decision-making process as long as they accept that they are benefiting from the resource. Social acceptability of the project is a key ingredient to the success and sustainability of the project. High participation rates require education of the citizens as to the benefits of renewable resources and community acceptance of district heating system (DHS) is intangible. According to Jesus (1995), the process of public participation is defined in seven levels; definition of public participation, information content and quality, approaches of communication, time of participation, levels of participation, empowerment and facilitating public participation.

On the other hand, community perception on the project in GEDHS in land-use contexts is related with cultural adoption, population changes in composition and number due to induced development leading to pressure on resource base and effects on aesthetic and human interest areas which include the scenic vistas, open space qualities, unique physical features, historical and archeological sites.

Related Local Agenda

It is very important to be always on agenda for GEDHS to take the attractions and attentions of the related actors such as decision makers, investors and the inhabitants. If it is succeeded to be on agenda both world and nationwide, then no suspect that there will be better projects integrated with the recent technological developments, multidisciplinary projects and the well informed inhabitants. Moreover to be on agenda would direct investments towards the geothermal based projects and would help executing within the land-use plans.

Less Participation (Decision Makers/ Policy Makers)

These actors, decision makers and the policy makers have an important politic role in the determination of these GEDHS. The representatives of central government as nationwide, local governments as the representatives of the central government (special provincial administration), related regional local governments such as metropolitan municipalities, town municipalities are the decision makers. Especially the politics of the central government is very important for the geothermal energy integrated urban land-use planning approach. The efficiency and the activity of the international agenda on renewable energy effect the conceptions of the central governments positively. However the central government of Turkey does not give importance to geothermal energy and has tendencies for other type of energy and in addition has agreements with other countries about these different energy sources such as natural gas. It should be mentioned that and the central government does not pay attention to land-use planning based on GEDHS and does not enact related laws and regulations.

Another important decision maker is the local government referring metropolitan municipalities, town municipalities, etc. These actors take part within the geothermal process depending on the location of the geothermal source whether inside the border of city. As other actors, local government also has important effect on the execution of the land-use plans based on geothermal energy. Moreover, the project's being on agenda and the pressure of the agenda on the local government, the politics of the local government and the consistency with the central government affect the process positively or negatively.

Misguided Developers' Interest and Imbalanced Market

The low profit margins of GEDHS typically have not attracted private developers. An interesting aspect of the economics of GEDHS is showed by a problem of the pattern from the base case. In the basing of the geothermal case, the larger market size is always more economical than the smaller ones, but with the lower market-capture assumption. In national perspective, nowadays, the project developers are came together with public facilities such as: the partnership of Greater Municipality and The Special Provincial Administration (SPA).

More Non-Governmental Organizations (NGOs) Interest

The other important stakeholder group is Non-governmental organizations (NGO). Social acceptability is a function of the accurate reading of the stake holder's perceptions and intentions. Subsequently, the social responsibility, social desirability, respect for indigenous peoples concepts are the other significant thoughts such as the Geothermal Usage Society in Balçova district have a major role about NGO's for GEDHS in land-use plan. In addition the different chambers view point about geothermal context effect the projects.

Inadequate Laws and Regulations

Two important problem limit to the GEDHS in land-use plan; first, passing the geothermal energy law is recently being drafted; second, geothermal energy integrated plan, the report of plan and plan note are not used in the national planning law and regulation systems. On the other hand, although the geothermal energy law is being passed, there are not any consideration which can be reference for the models of built environment, about relationship between geothermal reservoir and settlements. And there is not or limited any novelty about geothermal energy in planning law and regulations.

Inadequate Communication

Both the less-contact between geothermal infrastructure systems and the other infrastructure systems, and misconduct with geothermal project plans and land-use plans have affected in negative ways. Especially, the negative impacts of incomprehensive system in planning coordination crisis, the negative impacts of often geothermal infrastructure system troubles for the neighborhood population are the very important problems in the relationship between GEDHS and land-use plan context.

Inappropriate Land-use Allocation and Zoning

There are two important zone concepts, first, geothermal zone which relate the geothermal reservoir area, second, zoning which is the urban planning of different land-uses. While the land-use analysis is conducted, the geothermal zone is paid attention in the process. The zoning plan prescribes the rational utilization of land and the rational exploitation of natural resources. Geothermal is one of the productive zones to be placed on plan. The plan is then subjected to the evaluation of the local planning bodies, regulatory agencies, local authorities, NGO’s and the community.

According to Pasqualetti (1986), though perhaps not as significant in very small towns, zoning on surface is often important because it encompasses many environmental aspects of noise, aesthetics, and general disruption. It is related strongly to user energy density and its significance in site selection grows with population density. In terms of geothermal energy development (especially the drilling phase), industrial zoning is normally more acceptable than commercial, and commercial more than residential. Two consideration regarding zoning make it malleable in theory but rigid in practice. First, noise, aesthetic intrusions and general disruption are almost entirely the functions of the drilling phases of the project, a temporary disturbance. Second, zoning variances are always a possibility. Past experience indicates that neither option should be relied upon to mitigate the delaying influence current zoning can have on a geothermal project.

Land Block Density (User Energy Density)

District Heating development potential (e.g. in residential space conditioning or some other application such as greenhouses and industrial process) is related directly to greater concentration of energy use. User Energy density is the key element in the evaluation of a possible site of geothermal application. In basic terms this importance stems from the fact that a concentration of energy demand result in the need for a shortened total distribution length, which in turn lowers cost.

Residence and Office Ratio (Mixed land-use)

According to İzmir Geothermal Incorporated Company working, the efficiency of the geothermal infrastructure system is related with the number of the buildings. The specific building numbers are stayed on the new geothermal development areas for GEDHS in land-use plan.

Residence Equivalence and Existing Building Ratio

In the national system, residence equivalent are determined as the 100 m^2 and the building area is the very key element in the geothermal energy efficiency utilization. Therefore the building square meter affects the negative or positive dimension on the GEDHS in land-use plan.

Land Ownership (Private or Public)

A parcel being developed by the owner for private use will generally encounter fewer land-use problems than third-party arrangements. In addition, if the vacant land is owned by the user (a factory or shopping center with a large parking lot) and especially if the parcel is immediately adjacent, the arrangement would generally produce fewer interruptions.

The above considerations are the most significant in determining the best location for geothermal drilling. An idealized site would include: close proximity to a large vacant parcel, and ownership which lends to facilitate the advancement of the entire project. In short, the private parcel ownership situation effects to plan negatively.

Parcel Size and Vacancy

Vacant land can largely buffer the offensive aspects of noise, and general disruption. So, the size and availability of vacant parcels can play an important role in district heating development. Location of settlements is also important because drilling and production must be close to the potential user in order to minimize fluid transmission costs. The actual size required is partly a function of land needs of the driller and the depth of the well.

2.2.1.2. Intervening Variables

Intervening variables mediate the effects of the independent variable on the dependent variable (Caswell 2003). This variable type, organization of study, stands between the independent and dependent variables.

Geothermal case area and resource context, geothermal infrastructure context, policy context and planning process context are the major titles in this variables group; (1) Lack of regional level and national policies for effective use of geothermal resource, (2) mismanagement of geothermal resource and infrastructure system, (3) misguided local politics and worries and (4) inefficient land-use allocation and planning process. These intervening variables affect the dependent variables.

The geothermal case area and resource variables are affected by the five different independent variables; adequate geothermal capacity, advanced geothermal technology influence the positive or negative dimensions, incompletion geothermal conservation zone map and inappropriate land-use allocation and zoning influence the negative dimension parameters.

Geothermal infrastructure context include the five independent variables; developed the geothermal technology, established geothermal infrastructure system affect the positive dimension, less community perception and interest on the project and inadequate communication influence the negative dimension variables.

Less community perception and interest on the project, related local agenda, less participation (decision makers/ policy makers), misguided developers' interest and imbalanced market, more non-governmental organizations (NGOs) interest variables have the positive or negative affects and inadequate laws and regulations variable has the negative parameters to policy context.

Finally planning process context include the incompletion geothermal conservation zone map, private land ownership, inappropriate land-use allocation and zoning, unused residence and office ratio (mixed land-use) and inadequate communication variables have the negative dimension affects, less residence equivalent and existing building ratio, building and parcel ratio, untidy land block density (user energy density) and congested parcel size and vacancy variables have the positive or negative dimension parameters, sufficient heat load density of buildings has the positive dimension variable.

2.2.1.3. Dependent Variables

Dependent variables rely on the independent variables; these variables are the outcomes or results of the influence of the independent variables. Therefore both the independent variables and intervening variables have results in "adoption", "effectiveness" and "fidelity" outcomes of this approach. Fidelity (to original plan), adoption and effectiveness in energy use concepts are the dependent variables. And these concepts effect the thesis research questions directly. GEDHS in land-use planning view point can be analyzed the two approaches.

2.2.2. The Variables Diagram about Geothermal Energy Integrated Urban Land-use Planning System

The variables diagram is useful in explaining variables and their relations clearly. According to Creswell (2003), this model recast verbal theories into causal model which is advocated by Blalock in 1969, 1985 and 1991. This diagram shows the relationships among all dependent, intervening and independent variables. And the three important points are paid attention (Duncan 1985); (1) position the dependent variables on the right in the diagram and the independent variables on the left, (2) use one-way arrows leading from each determining variable to each variable dependent on it, (3) indicator of the relationship among variables. Use positive and negative valences that postulate relationships.

Finally, the variable diagram (causal modeling) is prepared about geothermal utilization in land-use planning context after the variables are collected (see Figure 2.12). And the variables in this diagram will be used in chapter four to collect and analyze the data and in chapter six for the purpose of comparing the existing and alternative usage of variables.

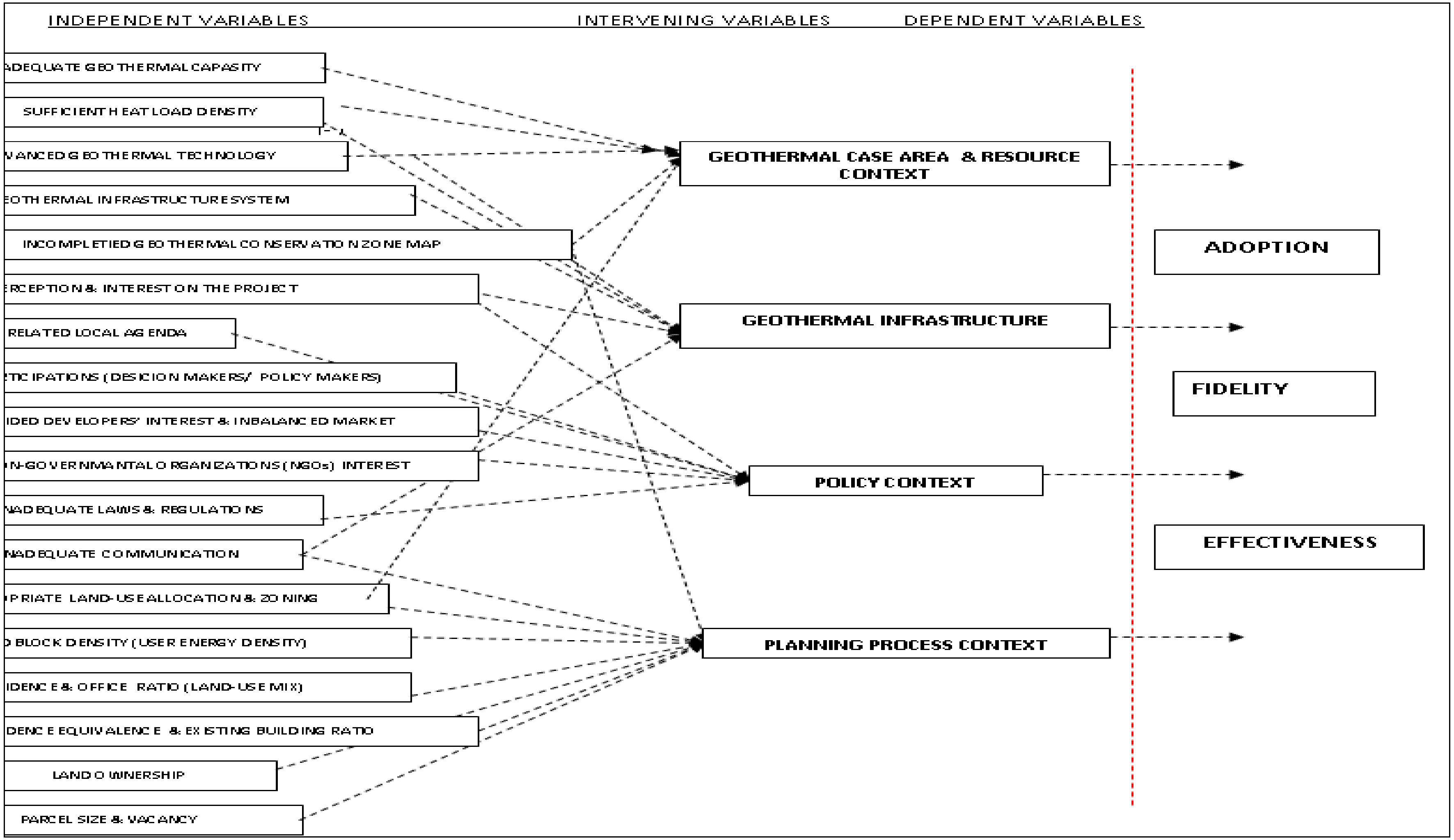


Figure 2. 9. The variable diagram of geothermal energy integrated urban land-use planning system

CHAPTER 3

METHOD

Creswell (2003)'s data gathering method "Mixed Research Method (MRM)" is adopted for the thesis research method. Mixed Research Method has been added to quantitative and qualitative data types. Collection of the data, analyzing the data process and the survey method are accepted as quantitative method. The comparison process of implementation plan and the alternative plan utilizing all variables determined using AutoCAD, ArcGIS and SPSS software programs.

"Simulation Method" is adopted for comparing the fidelity between the existing original plan and the proposed alternative plan. Therefore data collecting, data analyzing and model development are successive components to be considered in this method. The research context is limited with the geothermal energy, district heating system and land-use planning as the critical determinants of methodological section in this thesis study. The variables are determined from the previous literature.

3.1. The Framework of the Study: Methodological Novelty

The framework of this thesis consists of seven steps: (1) Defining the problem, (2) choosing and establishing the main research method, (3) collecting the data, (4) analyzing the data, (5) simulation of and systematizing the development plan, (6) comparing the existing and alternative variables situations, (7) findings and recommendations of existing and alternative approaches.

These steps are shown in the flowchart (see Figure 3.1), where research method is used for framework of GEDHS in land-use plan context. The model and methods are explained the following figure.

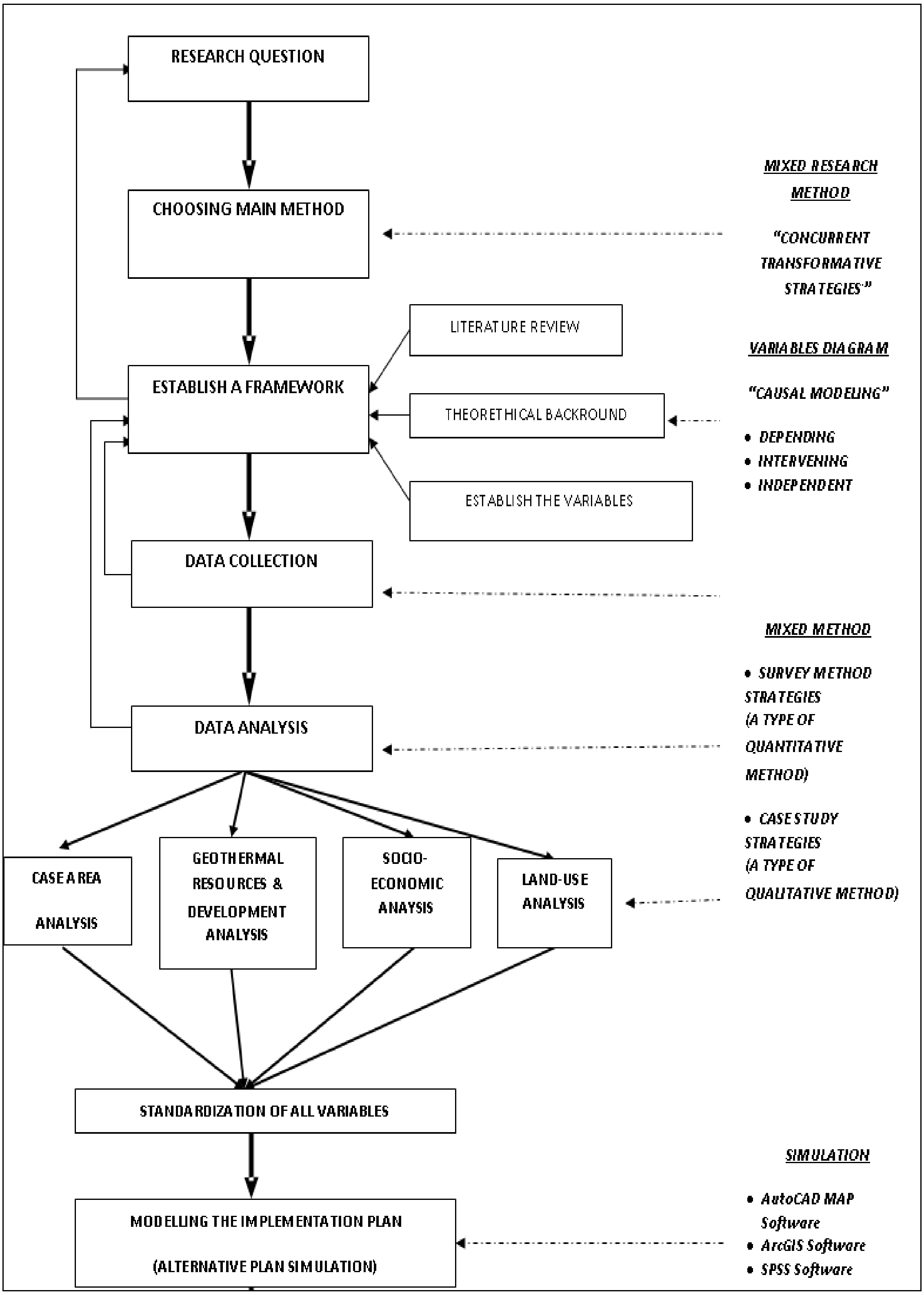


Figure 3. 1. The flowchart of the thesis "Geothermal Energy District Heating System (GEDHS) Utilization in Land-use Plan" framework

3.2. Defining the Problem

In defining the problem and solution space, independent, intervening and dependent variables have very important role. The purpose of this study begins with identifying possible variables for such a study, employing the variables diagram which is the picture of the causal modeling/visual theory, and it is useful to translate variables into a visual picture. I is used to clearly identify this process, and locating and detailing how the variables are measured in MRM. The order of the variables in purpose statements, research questions, and variable diagrams into each in turn cause and effect the presentations.

On the other hand, MRM studies need to have both qualitative and quantitative research question included in the studies to focus the purpose statements. Therefore, *"what is the influence of effectiveness of land-use decisions to geothermal energy district heating utilization?"* and in order to get a more efficient energy provision from the geothermal energy district heating system (GEDHS), *"how much change can we endure on the proposed development (implementation) plans?"* questions are defined thanks to the related literature survey and variable diagram.

3.3. Data Gathering Method

Mixed research method (MRM) is chosen for this data gathering because of being the most suitable for both problem statement of geothermal energy district heating utilization in land-use context. Mixed method includes quantitative and qualitative methods that falls short of the major approaches being used in the social and human science (Creswell 2003), and the MRM approaches associated with field methods for example, observations and interviews which are used for the qualitative data, are combined with traditional surveys which are used for the quantitative data (Sieber 1973).

According to mixed method researchers (Sieber 1973, Jick 1979, Tashakkori and Teddlie 1998- 2003, Mertens 2003, Creswell 2003), mixed method approach tends to base knowledge claims on pragmatic grounds. Its strategies of inquiry that involve collecting data either simultaneously or sequentially to best understand research problems. Focusing the broad survey with the aim of generalizing the results to a population and collecting the detailed qualitative, open-ended interviews from participant's techniques are very important in this method.

Mixed method inquirers draw liberally from both quantitative and qualitative assumptions when they engage in their research. This approach is free to choose the methods, techniques, procedures of research that best meet their purposes, and the questions "what" and "how" are looked to research based on its intended consequences. In addition, pragmatists agree that research always occurs in social justice, historical background, political aims, and other contexts (Murphy 1990, Cherryholmes 1992).

Therefore, in this thesis, (1) lack of regional level and national policies for effective use of geothermal resource, (2) mismanagement of geothermal resource and infrastructure system, (3) misguided local politics and (4) inefficient land-use allocation and planning process concepts are analyzed with qualitative and quantitative techniques of mixed method by collecting socio-economic, land-use, geothermal infrastructure and geothermal resources data from case area, related institutions in Balçova district.

3.3.1. Literature Review and Variable Diagram

The literature review process of this thesis has two phases. First, reviewing the literature conforming to concepts of qualitative and quantitative researches (mixed research design) related with the topic and second, over viewing the literature and determining the variable diagram (see Chapter 2).

The qualitative researcher use the literature in a manner consistent with the assumptions of learning from the participant, and not prescribing the questions that need to be answered from the researcher's stand point. Quantitative research, includes a substantial amount of literature at the beginning of study to provide direction for the research questions and the literature is often used at the beginning of a study to introduce a problem or to describe in detail the existing literature in a section titled review of literature in quantities study planning.

One or more groups receive the experimental treatment from the researcher (in the thesis; community perception and interest on the project, agenda, decision makers thought, projects developers interest and market forces, NGO's interest). Other independent variables may simply be measured variables in which no manipulation occurs in the thesis; user energy density, building parcel ratio, residence equivalent and building ratio, parcel ownership and parcel size and vacancy. Still other independent variables can be statistically controlled in the experiment. On the other hand, dependent variables are the response or the criterion variable that are presumed to be caused by or influenced by the independent treatment conditions.

3.3.2. Components of Method Procedures

Mixed research method has the four important procedures; (1) predetermined and emerging methods, (2) open- and closed- ended questions, (3) multiple forms of data drawing on all possibilities and (4) statistical and map analysis.

According to Creswell (2003), there is some checklist of questions for designing a MRM procedure. For the adaptation of this thesis:

- To choose the qualitative and quantitative research in geothermal energy district heating system (GEDHS) utilization in Balçova and to employ the literature survey, data collection and data analysis associated with both forms of data for basic definition of MRM,
- To analyze with two different research types for the potential use of a mixed methods strategy, and to chose the concurrent transformative strategy for this study,
- To determine the Balçova district case area (six different neighborhoods; Korutürk, Onur, Fevzi Çakmak, Teleferik, Çetin Emeç and Eğitim neighborhoods), the dimensions of geothermal infrastructure technologies, geothermal resources, geothermal politics, socio-economic structures and land-use situations for the criteria of mixed method strategies,
- To decide the concurrent transformative strategies for using related and independent two different research types (survey method and case study method),
- To use the related graphics, tables, figures and maps for visual models of mixed method,
- To implement the data collection and analysis procedures for survey and case study methods in Balçova district case area,
- To choose the random sampling method and sample of 3% of household for the quantitative (survey method) data, to analyze the 486 building blocks and 22000 building for the qualitative (case study method) in Balçova district case area.

Mixed method has three significant strategies in research process; (1) Sequential procedures, (2) concurrent procedures and (3) transformative procedures. In this thesis, concurrent transformative procedures are chosen as a suitable design, in which the researcher uses an overarching perspective within a design that contains both quantitative and qualitative data.

This approach provides a framework for topics of interest, methods for collecting data, and outcomes or changes anticipated by the study (see Figure 3.2). This strategy is based on the advocacy and participatory research ideological framework. And the process of survey and case study methods which are used in this strategies, continue independently and the results of these method analysis influence them together.

The data collection process of this procedure engages a concurrent approach. Concurrent procedures consist of the comprehensive analysis of the research problem. In concurrent procedures, the researcher collects both forms of data at the same time during the study and then integrates the information in the interpretation of the overall results. The investigator nests one form of data within another, larger data collection procedure that analyze different questions or stages of things in an organization.

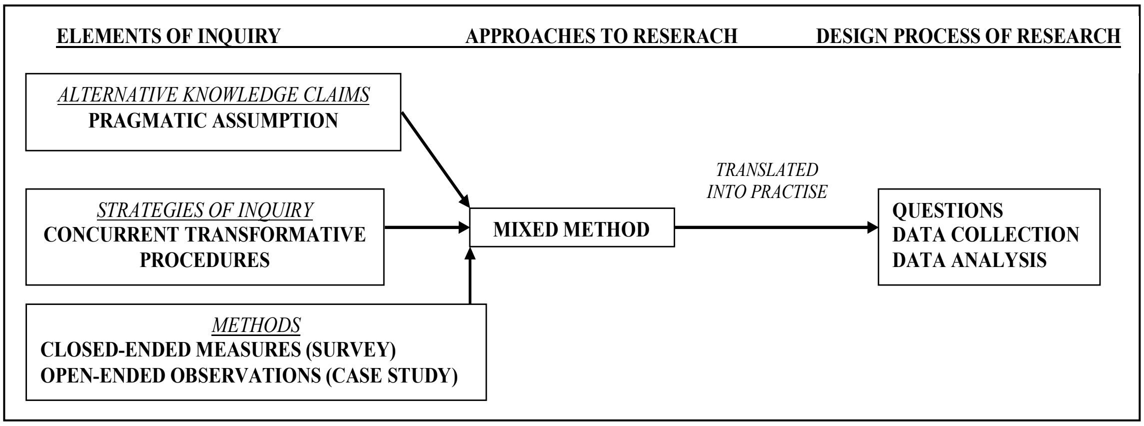


Figure 3. 2. The process of Mixed Research Method design strategies

(Source: Creswell 2003)

3.4. Data Compilation Procedures

In the holistic concept of “geothermal utilization in land-use plan”, and at the basis of geothermal energy precedent, collecting and processing data, and integrating these data with the land-use plans constitute the main kernel of the structure upon the mixed method strategy.

The mixed method has different research types; quantitative approach: experiments (Keppel 1991) and surveys (Babbie 1990), qualitative approach; ethnographies (Creswell 1998, LeCompte and Schensul 1999), grounded theory (Strauss and Corbin 1998), case study (Stake 1995, Yin 2003), phenomenological research (Moustakas 1994) and narrative research (Clandinin and Connelly 2000), but in this thesis, for data collection two different research types are used; survey method and case study method. When gathering the GEDHS in land-use plan data process, asking open-ended questions for qualitative analysis and closed-ended questions for quantitative analysis, analyzing the data to form categories, generalization of the results are used.

In the mixed method, a researcher may want to both generalize the findings to a population and develop a detailed view of the meaning of a concept for individuals, and then they first explore to learn about sample of individuals. In this situation, the advantages of collecting both closed-ended quantitative data and open-ended qualitative data confirm advantageous to best understand a research problem.

According to Babbie (1990), survey contains the special studies using questionnaires or structured interviews for data collection, with the intent of generalizing from a sample to a population. And the case study strategy is used for an event, an activity, a process. The case is bounded by time and activity, and researchers collect detailed information using a variety of data collection procedures over a sustained period of time (Stake 1995).

The other research type of data collection is case study. Single Case Study method which is the type of “Case Study Research” is chosen for this study. Because the case studies are the preferred strategy when “how” or “why” questions are being posed, when the investigator has little control over events, and when the focus is on a contemporary phenomenon within some real-life context. And the case study researches are used to identify some situations in which a specific strategy has a distinct advantage, like Balçova district GEDHS in land-use plan. The description of Balçova geothermal energy area, district heating utilization in land-use planning is dealt together with the discussions of locality and their integration will be realized. A methodology can help us to research, basically, the relationship among Balçova district case area, district heating utilization and land-use plan context.

Table 3. 1. The strengths and weaknesses of case study data collection
(Source: adopted from Creswell 2003)

Data Collection Types	**Options Within Types**	**Advantages of the Types (Strengths)**	**Limitations of the Type (Weaknesses)**
Observations	Complete Participant: Researcher conceals role - İzmir Greater City Municipality - Local Municipality (Balçova) - NGOs (Balçova Geothermal User Society) - Local Population	- A firsthand experience had been with all Balçova district participants - Information is recorded as it is revealed (such as; to answer the questions of local population) - Unusual aspects is noticed during observations (such as; to seen the irrelevancy of geothermal project in generally) - Useful in exploring topics that were uncomfortable for participants to discuss (such as; to take out the geothermal system related employee question)	- To be seen intrusive (such as; the aged population of Balçova hesitated to answer for questions) - "Private" information are not reported (such as; income level of local populations) - Certain participants present special problems in gaining rapport (such as; the problems from İzmir Geothermal Incorporated Company management)
Interviews	- Face-to-face: (486 building blocks are analyzed due to the 22000 building examination) - Group: (to interview the Balçova Geothermal User Society)	- Participants provide historical information (such as; there are a lot of aged local population lived in Balçova district), - Useful when participants are not observed directly (such as; The alternatives are given in questionnaire form)	- Provides "indirect" information filtered through the views of interviewees (such as; all unrelated problems are talked and time problem) - People are not equally article and perspective (such as; The households lived in Korutürk and Eğitim neighborhoods are very different income, education and society level) - The bias problem (such as; some answers are grouped and combined in Balçova study)
Documents	- Public documents: (*Health Group Presidency of Balçova; the documents of households, *General Directorate of Mineral Research and Exploration; the reports of Balçova district geology, *Balçova Municipality; land value reports, *newspapers) - Private documents: (*Balçova Geothermal User Society; meeting documents, *private books and journals)	- Enable a researcher to obtain the language and words of participants (such as; Balçova Geothermal User Society view point are used in this research) - As written evidence, it saves a researcher the time and expense of transcribing: (such as; Balçova Municipality and Health Group Presidency of Balçova documents are used)	- Uncompleted materials (such as; Geothermal Energy Conservation Zone Maps are very old) - Authentic and accurate documents: (such as; Balçova Municipality; land value reports have the authentic in formations) - Requires the researcher to search out the information in hard-to-find places: (such as; Health Group Presidency of Balçova has the organizational and political problems)
Audiovisual Materials	- Photographs: (the panoramic views of Balçova, streets and boulevards photos) - Computer software's: (ArcGIS, AutoCAD MAP, SPSS, Office XP software)	- An unobtrusive method of collecting data - provides an opportunity for participants to directly share their "reality" (such as; to use the photos for reminding the affects of geothermal energy DH system)	- The problems of taking photos (such as; disadvantages of local people view point) - The problems of software (such as; unused data collecting for ArcGIS, and AutoCAD MAP)

The data collection steps include setting the boundaries for the study, collecting information through unstructured observations and interviews, documents, and visual materials, and establishing the protocol for recording information (Creswell 2003). The participants and the site are the most important boundaries in the case study researches. And the two boundaries include the four aspects (Miles and Huberman 1994); the setting (where the research will take place), the actors (who will be observed or interviewed), the events (what the actors will be observed or interviewed doing) and the process (the evolving nature of events undertaken by the actors within the setting. The other important point of the case study method is the types of the data collection tactics; observations, interviews, documents and audiovisual materials and the strengths and weakness of the each type (see Table 3.1).

In Balçova, it is rather difficult to obtain sufficient and healthy data due to the observation of very few parameters till recent years. Therefore, all the archive data are collected from different public and private institutions and organizations:

- İzmir Geothermal Incorporated Company; written and visual data on its projects concluded heretofore and its targets, geothermal infrastructural plans in its projects applied, energy quantities and capacities provided to buildings,
- Greater Municipality of İzmir and Special Provincial Administration; future oriented projects from these governmental units which are the two partners of İzmir Geothermal Incorporated Company as well as the information obtained from the Greater Municipality of İzmir regarding the effect of geothermal energy on the Master Plan for the whole of city of İzmir,
- Balçova Municipality; physical plans to be obtained before/after the project, and changes (if any) in the physical plan decisions,
- General Directorate of Mineral Research and Exploration (MRE); reports and publications about Balçova geothermal regions, and knowledge about who worked in these areas for a long period,
- General Directorate of State Hydraulic Works (SHW); data on ground waters and aboveground waters of Balçova,
- Turkish Statistical Institute (TSI); data on population, labor force, economical structure for the year 2000 (recent data) as included within the neighborhood of Balçova and the whole of İzmir,
- Health Group Presidency of Balçova; information on the occurrence of health problems/accidents regarding geothermal energy use as obtained from local health clinics,
- Educational Directorate of Balçova district; socio-economical structure in Balçova based on education,
- Local Governors; examination on six executive offices in the application area, and change in population living in the vicinity before and after the project,

- Non-governmental organizations; their positions in project development, participation of people, education status,
- Local Real Estate Agents; information on the change in rental/sales values of buildings.

At the stage of collecting data, it is determined that subjects of planning and geothermal energy are in relation to each other in the assessment groups in the light of the literature studies. These are (1) case area and (2) geothermal infrastructure system assessment that the case study data collection method is used for where especially the survey data collection method is used for the socio-economic assessment and land-use assessment.

In the process of data collection, the following points were considered: studies should be conducted based on the interviews with the institutes and organizations involved, and collecting the required documents and information. Alongside with the plans, maps and written documents, household questionnaire survey takes place in the original part of the thesis. During the studies of questionnaire, surveys were composed of two main structures. In the first part, individual circles of household, and questions at a certain sample size aimed at determining a certain socio-economic state (this will be explained in detail in socio-economic assessment part), the second part involves in-depth surveys as observations and interviews with authorized people (the elected head of a village or a city or town, apartment managers) on individual buildings taking place in all the construction blocks of parcel.

3.5. Data Analysis Procedures

The data analysis process is to characterize the case area, resource and infrastructure setting, the land-use setting, and socio-economic setting of the area. Estimates of the impact are to be deduced from a comparison of this base-line data with information collected during geothermal development, project construction or operation. Data is collected in order to assess positive and negative impacts. Major areas of all data covered by the interviews, in socio-economic parameters and land-use parameters are listed below.

In data selection process of case area, questionnaire households of socio-economic structure are gathered in two groups. First is the household analyses of all members of a household, second is about the general characteristic of the household.

The first group data which are standard measures of socio-economy concept includes the general measures of socio-economic structure for household. The second group data which include information on energy use were brought together in two parts; (1) the measures of general characteristics of building where household live in, (2) the measures of household thoughts about geothermal energy, geothermal district heating system and willingness to participate.

Finally, in this study, there are three data groups; (1) case area, reservoir and infrastructure system context, (2) socio-economical context, (3) land-use context.

3.5.1. The Data of Balçova Case Area and Reservoir- Infrastructure Systems of Geothermal Energy

The systematic examination and study of the relevant issues required the utilization of case study methods that are capable of reflecting experts' views as well as facilitating the elaboration of those views.

For this purpose, an empirical investigation is undertaken and applies to a number of specified groups of data. The data are those individuals, who as a result of either of their professional occupation or their institutional responsibilities have proven the ability to express an all-embracing and through view on the issue under investigation. As such, the following four groups of data are formed: (1) local government representatives, such as; İzmir Metropolitan Municipality, the Balçova Municipality, Special Provincial Administration and İzmir Geothermal Incorporated Company (2) representatives of state agencies, such as; Ministry of Public Work and Settlement İzmir Directorate, Turkish Statistical Institute (TSI), General Directorate of Mineral Research and Exploration (3) trade unions, developmental policy making agencies and social agencies representatives, such as; Chamber of Trade in İzmir, the Geothermal Energy Usage society (local NGOs) (4) representatives of inhabitants (people who live in geothermal energy region).

- In this data collection process, many parameters are placed about socio-economic situation of inhabitants of Balçova district and land use plans of Balçova district. There are six major factor areas for case area and reservoir-infrastructure systems context; Demographic, governmental, physical, economic, social and infrastructural (technical and social) parameters are detailed briefly,

- Demographic parameters; Population densities and characteristics, Morbidity and mortality rates, Productivity levels, Community lifestyles, needs, and problems, Community perception on the project,
- Governmental parameters (socio-politic organizations); Local government structure and leadership, Institutional capabilities and linkages, Political affiliations, NGO's profiles, Local peace and order situation,
- Physical and land-use parameters; Geological and hydro geological map, Landscape and land-use plans, (indirect impact), Implementation and master plans, (indirect impact), Land value,
- Economic parameters; Prices of goods, Income and employment (status, job availability, income levels, spending patterns, and loan and credit facilities),
- Social parameters; Settlement pattern, Cultural Heritage, Alteration of archeological, scenic and aesthetic resources,
- Infrastructural parameters (social and technical); Housing supply, Status of adequacy of facilities for water, power, sewerage, and drainage systems, Water supply, electricity, gas, garbage and canalization, energy, transportation systems; public transportation, pedestrian way.

3.5.2. The Data of Socio-Economical Context

The main data are from the socio-economic survey. In such surveys, there are three parts of the social information namely, the unit of analysis or the respondent, the stimuli or question, and the response to the stimuli. According to Jesus (1995), the data collection of the social information follows three principles:

1) principle of comparability (same questions shall be asked of respondents),
2) principle of classification (respondent must check only one answers in a category),
3) principle of completeness (minimizing "no information" or "no answer" situations).

Sampling design, data collection and survey methods are the most important structure for socio-economic survey assessment (see Table 3.2). The most common method used for socio-economic surveys is the stratified sampling technique which applies to non-homogeneous populations. The population is divided into homogeneous groups called strata. Samples are then drawn from each group randomly. This method allows different research procedures to be used in the different strata (Jesus 1995).

There are generally three settings for the collection of socio-economic data in data collection process; Informal, formal structured, and formal unstructured settings.

Table 3. 2. Main forms of data collection
(Source: Galtung 1967)

Stimuli	Non-verbal	Oral verbal	Written verbal
Informal settings	observation	Conversation, use of informant	Letter, articles, biographies
Formal unstructured settings	Systematic observation	Interviews (open-ended)	Questionnaire (open-ended)
Formal unstructured settings	Experimental techniques	Interviews preceded	Questionnaire structured

A survey consists of questions raised to respondents and the recording of the corresponding responses for analysis. Questions can be asked through face to face interviews, via telephone, and mail or a combination of these. The choice of the survey instrument depends on the objective of the study. Telephone interviews and mail survey are used for inaccessible respondents and quick gathering of simple data. Personal interviews are more useful for socio-economic impact assessments as it allows extensive questioning and probing. A mixture of the three methods can also be considered (Jesus 1995).

In this context, the analysis and presentation of data, complying with the MRM, is organized into two categories; having an interview and collapsing the efficient data system are implemented the first three group, and the survey analysis are implemented fourth group. The rate of sampling is thought 3% of all buildings of Balçova district (according to Balçova Municipality data, approximately of total number of buildings are 10000 units). The results of the surveys are extensively analyzed after being organized on the basis of thematic axis basis. Data processing is done using "SPSS for Windows" software.

Socio-economic data/parameters for case area in Balçova district:

(A) the household analyses of all members of a household,

(1) the measures of general socio-economic condition,

a. the number of household population,

b. living time in case area,

c. sex,
d. age,
e. educational level,
f. occupation,
g. social safety,
h. income level,

(B) the household analyses only a household;

(1) the measures of general specifies of building in where household live;

a. the age of building,
b. size,
c. permit situation,
d. host owner/ tenant position,
e. technical infrastructure (especially, geothermal infrastructure system),

(2) the measures of household's perceptions about geothermal energy and system;

a. the pleasure from geothermal energy,
b. the relationship between geothermal energy and reason of living in there,
c. the knowledge about neighborhood heating system,
d. the use frequency of facilities,
e. the changes in populations and employment, real estate and land values after utilization of geothermal district heating system,
f. the complaint or the negative effects from geothermal development
g. the positive results of geothermal development,
h. the expectations from geothermal district heating system (see Appendix B).

3.5.3. The Data of Land-use Context

This category of data is very crucial for our simulation method: base of construing the major parameters. In spatial data type selection process of case area, land-use studies and building analysis was conducted for each building in the case area. Approximately, 21500 buildings were surveyed. In these analyses, the measures of specific data were collected from case areas and existing plans of Balçova district and the data of relationship between existing energy plans and existing land-use plan were analyzed and appraised in GIS software programs. Then, differences between development plan and proposed geothermal energy efficiency integrated plan were determined.

Spatial and land-use data/parameters for land-use/spatial analysis:

(1) User energy Density
- a. Building classification
- b. Building height

(2) Zoning
- a. land-use type

(3) Parcel Ownership

(4) Land Ownership

(5) Parcel size, building block size and vacancy

(6) Land and real estate value

(7) The number of units in building block
- a. Building size
- b. The number of building units
- c. The number of building floor units
- d. Consumption energy value

(8) The number of users in building blocks

(9) The number of existing buildings and residence equivalent ratio

(10) Office- Residence Ratio (see Appendix B)

3.6. Comparing and Measuring the Fidelity of the Energy Sensitive Plan Proposals

The simulation with the use of "fidelity" concept to original plan relationship between land-use and geothermal district heating usage context was used for comparing. The simulation method was used for testing the hypothesis or answering the research question. The processing of all these data along with the concepts of planning decision-support systems, energy utilization model of ArcGIS software and conducting proposal of geothermal energy integrated land-use planning studies were considered to take place in this step.

There are two different examinations; the first is the simulation and planning support system concepts, the second are the new model approaches and technologies available that can help explain how to integrate the energy parameters over existing plans; here in the example of, GEDHS in land-use planning. The fidelity of geothermal energy district heating integrated development plan is an important point for existing development plan.

And there are two important points in this study; first, the alternative plan can be evaluated in terms of in GEDHS in land-use plan context. Second, the new suggestion about geothermal energy integrated land-use plan can be produced for the similar problems in different areas due to the most important principles.

3.6.1. Simulation and Decision Support System for Planning

Modeling efforts and planning support systems are very important;

1) to see varying conceptual approaches, methodologies, and overall designs. Both aggregate and disaggregate models are presented, and there are a variety of perspectives on the need for and role of empirical data.
2) to see that is quite possible to construct a planning support system that projects the future in a various scenario approach and at different geographic scales. Models deal with alternative land development patterns and work at both the broad metropolitan level and for small communities.
3) to see the possibility to integrate the outputs of these models with different types of visual presentations.

Computer Aided Design (CAD) systems were developed mainly for architects in particular and engineers who need to create and analyze two and three dimensional designs keep up with a large capacity of design- related data and understand how a change to one part of the design will affect the whole. CAD systems also can be run on either a computer. But, they cannot relate multiple facts with multiple sites to answer complex questions or problems (The Energy Yardstick Report 1996).

AutoCAD Map 3D software which is the detailed and specific CAD programs was used in this thesis. This program was developed for creating and managing spatial data and it is important engineering and planning GIS platform. In this program, a map is divided into a set of layers, each of which represents a group of data from a particular source.

In this research, AutoCAD Map 3D (2008 edition) was used for accumulating, assemble, composing the related existing and development plans of study area and used generating the base plan for analyze in GIS software.

Geographical Information System (GIS) combines a computer's potential to classify and retain large amounts of data and speedily perform composite computation. By efficiently integrating mapping with location-specific data, GIS users are able to create maps and reports that use a community's own data to answer detailed and specific questions. So, GIS is a great tool for bringing information to decision makers in a format that answers the questions at hand. GIS also provides a central site for collecting and managing location-based information, reducing information redundancy among city departments and helping to ensure everyone is working with the most current data (The Energy Yardstick Report 1996).

ArcGIS (9.1) software includes two main sub-titles; ArcMap and Arc Catalog, are used in thesis research. ArcMap works geographically data, creates maps to convey cross-examinants the questions and shows result of works. Arc Catalog provides data access and spatial data management tools and includes the reading and creation of metadata. In this research, this program was used for analyze, query and mapping organizations related with input data which are output of the AutoCAD and SPSS software.

3.6.2. Energy Sensitive Alternative Planning Model

In implementation stage, the novel approach was used for the effectiveness of GEDHS based on the "alterability" of land-use decisions. Five related variables/parameters are cross-examined master plan of Balçova district.

The five parameters were used in measurement of variables which were the parts of independent variables of this research, the Parcel Size and Vacancy for Drilling and Fault Line, Heat Load Density of Buildings, User Energy Density/ Land Block Density Types, Residence Equivalence- Existing Building Ratio and Mixed Land-use/ Residence-Office Ratio.

These parameters/variables appeared in general literature;

- *The Parcel Size and Vacancy for Drilling and Fault Line* parameter (Pasqualetti 1986). According to this paper, Geothermal Wells Conservation Area was evaluated as 40m. (20m. Radius). The second study was a report written by

General Directorate of Mineral Research and Exploration in Turkey in 2006. Wells Conservation Area was evaluated 15m. radius for strong wells construction and 25m. radius for weak wells construction and Fault Line Conservation Area (the distance of fault line) was estimated approximately 30m.,

- The *Residence Equivalence and Existing Building Ratio* variable (Toksoy, et al. 2001). According to this study, 5490kcal/h value was estimated for Balçova (the average of heating degree is 22ºC), and for one Residence Equivalence (100 m^2). The value of one square meter was estimated 54.9kcal/hm^2.
- The *Heat Load Density of Buildings* variable (Gülşen 2005).
- The *User Energy Density (Land Block Density Types)* parameter was first suggested by Pasqualetti (1986).
- The *Mixed land-use/ Residence-Office Ratio* parameter (Sustainable Development Office of Energy Efficiency and Renewable Energy U.S. Department of Energy 1997).

In this thesis, all these variables were used together for the appraisal of existing development plan in the process of geothermal energy district heating integrated development plan. And the basic formulation which was related to energy usage and land-use was used. According to the formulation, f (K); the ratio of parameters (K1: Residence equivalent determinant, K2: Heat load density of buildings determinant, K3: User energy density determinant and K4: Mixed land-use determinant), E_{base}; total energy use (existing geothermal energy) E_{new}; proposed energy use were determined.

$$E_{new}= E_{base} * fx(K) \tag{3.1.}$$

3.7. Findings and Recommendations "Existing and Alternative Plan Analysis"

In the final stage, the general results were determined based on the comparison of all criteria applied simultaneously to existing and alternative plans. Yet, due to lack of regional level and national policies for effective use of geothermal resource, mismanagement of geothermal resource and infrastructure system, misguided local politics and worries and inefficient land-use allocation and planning process prevailed throughout this process.

Comparing the existing and alternative plans were the key point in this approach, and the steps are as the following; problem definition, determination of evaluation criteria, identification of alternatives, evaluation of alternatives, comparison of alternatives and assessment of outcomes.

In this process, all independent variables which were determined after the literature survey were explained in detail for suitable steps of this process.

.

CHAPTER 4

ANALYZING THE DATA OF GEOTHERMAL ENERGY INTEGRATED URBAN LAND-USE PLANNING IN BALÇOVA CASE AREA

In this chapter, independent experimental variables of the thesis subject which were presented in chapter two were analyzed separately in three major sub-titles; over the land-use analysis, over the socio-economic analysis and over the land-use analysis. After the analysis processes, the current variables state were determined.

4.1. Case Area Data Analysis of Balçova District

Balçova district was chosen as case a study area. There were many factors for choosing this area; (1) to extend the long period data because of being the oldest and the biggest district heating system in Turkey, (2) due to already conducted various researches available about Balçova district heating system by related institutes and universities, (3) due to protocols about open research in this system between İzmir Geothermal Incorporated Company and İzmir Institute of Technology.

Some independent variables such as geothermal capacity, economic viability of a project, advanced geothermal technology, geothermal infrastructure system, making the geothermal conservation zone fast, decision makers' or policy makers' thought, project developers' interest, market forces and laws and regulations were examined in this part.

There were general data which could obtained from particular institutions, associations and foundations about socio-economic, land-use and Balçova district heating system. These were Turkish Statistical Institute (TSI); İzmir Greater Municipality, Balçova Municipality, Local Head Authorities of Balçova, Health Group Presidency of Balçova, Local Governors; Non-governmental organizations (Geothermal User Corporation). The obtained data were intended to be used as the input for the detailed socio-economic and land-use researches in the next parts of this chapter.

4.1.1. Definition of the Case Area in Balçova District

Six neighborhoods were involved in the case area. These neighborhoods were Korutürk, Fevzi Çakmak, Onur, Teleferik, Çetin Emeç and Eğitim neighborhoods. Geothermal district heating system in Balçova region for geographical and land-use integrity of these neighborhoods, and for geothermal reservoir location was very important in choosing these areas (Balçova Municipality 2007).

İzmir- Çeşme Highway bounds the north side of the area; Dede Mountain is south side; Ilıca River which is separate entity between Balçova district and Narlıdere district is the west side; and İzmir highway is the east side of the case area. Two of the chosen neighborhoods (Korutürk and Teleferik neighborhoods) benefit fully from Balçova district heating system. Onur and Fevzi Çakmak neighborhoods benefit partly from Balçova district heating system. Eğitim and Çetin Emeç neighborhoods do not benefit from this system.

4.1.1.1. Historical Development of Balçova District

There is not clear information about the origin names of Balçova. In oldest historical studies, Balçova was explained with thermal resources and healthy experience. However historians of the following opinion are: After opinion of some historians a basin filled with mud developed in the area which was famous for its thermal resources. For this reason, according to Balçova Municipality sources (2005), the Ayesefit area mentioned was first called as "Balçik Havı" and then Balçikova and was transformed into our current language as Balçova. After another opinion, the name Balçova originates from the Persian one and was delivered until today invariably. The name of Balçova developed as follows: in the Persian “BAL” means the most beautiful troop, strength, and “ÇO” color. The final syllable “VA” is a conjunction and a Pluralendung (Arkoç 2006).

According to local studies, Balçova is as old as the history of the thermal quelling. Hearing the fame of the thermal quelling in Balçova, Agamemnon sent his soldiers and hts daughter, who were wounded on the way into the battle, there (Arkoç 2006).

4.1.1.2. Geographical Location of Balçova District

Balçova is one of the nine districts in İzmir. The total area of the covers 2890 hectares. Balçova is surrounded by Konak district to the east, Narlıdere district to the west İzmir Bay to the north. The district has 6 km. a long natural beach, in addition a Cengiz Saran dam and 5 brooks (with the names Yahya River, Sarıpınar River, Hacı River, Molla Kuyu River and Ilıca River). Because of the hill landscape of the circle in the north the settlement took place toward the east and the west.

The geographical location of the district facilitates the traffic as well. With the construction of a new motorway, the distance between Balçova- Adnan Menders Airport shortened to only 15 minutes. With the pier in Üçkuyular and the yachting port the connection by the sea route and regarding the road connections Balçova is situated in the center of an important place.

4.1.1.3. Social, Economic and Sectoral Developments of Balçova District

Balçova district, which is between Konak and Narlıdere districts, lies in the boundary of İzmir Greater Municipality. There are eight neighborhood in this district; Korutürk, Onur, Eğitim, Çetin Emeç, Fevzi Çakmak, Teleferik, İnciraltı and Bahçelerarası neighborhoods.

Social Structure

Balçova district is a tranquil, safe and reliable region and it is predominantly residential and planned area. Especially, retired people and university students prefer to stay in Balçova district. Generally, there are apartment blocks. On the other hand, single and garden buildings are seen where high income level people live, there are some special settlement sites, such as İş Bank sites in the centre of the settlement.

In addition, there are city hotels such as Crown Plaza, Princess Hotel, Balçova Thermal Hotel, big shopping centers such as Özdilek, Agora, Palmiye, Balçova Migros, Balçova Kipa, Balçova Koçtaş and Balpa, İzmir Economy University and faculties of Dokuz Eylül University, a regional entertainment park - Balçova Aqua city Park -, a thermal cure centre - Balçova Thermal Cure Centre -, are all situated in Balçova district.

Agriculture, Industry, Commercial and Tourism Structure

According to Balçova Municipality and İzmir Agriculture Head Office data, in 2007, total area of Balçova district is 2890 hectare and total agricultural areas are 550 hectare (383 hectare of them are watered). There are 107 hectare vegetable area, 64 hectare flower greenhouses, 10 hectare vineyard areas, 5 hectare fruit gardens, 199 hectare citrus tree areas, 130 hectare olive tree areas and 15000 olive trees, 35 hectare suitable agricultural areas are present in this district. And there are 144 glass panel unit greenhouses in 14.6 hectare areas, 541 plastic unit greenhouses in 57.6 hectare areas (Arkoç 2006).

There are not any high and middle-scale industries in Balçova district in literature of the Chamber of Industry in İzmir. Usually, automobile repair shops, furniture workshops and metal workshops are settled in light industry site which has 100 units and 16500m^2 areas, in Balçova, and small commercial units are prevalent areas in Balçova district (Arkoç 2006).

The Dede Mountain (500m.) in height is the south side of the district, the Balçova seaside in where is the north side of the district cause to the natural attractiveness of tourism sector in Balçova. Forests and thermal water sources can be added to the morphological aspects of the region. There is a Cengiz Saran Dam in the south of the Ilıca River and it takes place inside of the forestry area. All of them give some help to the tourism development, but the major factor of the tourism is Balçova Agamemnon Thermal Spring. Both native and foreigners use the thermal cure centre for health problems (Arkoç 2006).

Education Structure

There are eight elementary schools with a total student population of 6363, five high schools with a total student population of 2101, and a neighborhood education center in the Balçova district (Balçova Local Government 2007).

Health Related Facilities

There are 5 unit small scale healthy centers, an out penitent clinic, and a family health center in this Balçova district local area. On the other hand, the city scale high capacity healthy institutions stay in Balçova district; Research Hospital which is the name of Dokuz Eylül University Faculty of Medical Science, Dokuz Eylül University, Physical Cure Centre and Rehabilitation High School, Balçova Thermal Cure Center and Rehabilitation High School, SSK Balçova Clinic. In addition, a lot of special healthy centers are started to build around Balçova.

4.1.2. The Geothermal Reservoir and Geothermal Infrastructure System in Balçova District

İzmir geothermal district heating system is fed from Balçova Geothermal Field and is one of the important geothermal fields in Turkey. The Balçova Geothermal Field is located between Balçova and Narlıdere region, approximately 10 km. to the west of İzmir city center. Having the first geothermal well in Turkey, Balçova Geothermal Field has a different importance in Turkish geothermal history. Also first down-hole heat exchanger application was realized in nine shallow wells in this field in Turkey

Balçova district GEDHS is the largest neighborhood/ district heating (DH) system in Turkey, both planned and implemented. The first phase covers heating of 10000 residences. After completing the first phase, geothermal district cooling will be applied in the second phase. The large-scale neighborhood heating application came to Turkey with geothermal energy. The first large-scale neighborhood heating system was put into Operation in Gönen- Balıkesir. Before the utilization of geothermal energy most of the central heating applications were the governmental office buildings, block apartment – in which most of the families in Balçova live- and hospitals, which may be labeled as "space heating" rather than "neighborhood heating".

Commonly fuel oil and coal is used for heating in these small-scale central heating (space heating) applications. Fuel oil is mostly imported and coal is supplied from nearby coal mines, both contributing much to the air pollution and smog over the city. The geothermal waters of Balçova Agamemnon hot water springs have been used for balneology for thousands of years. With the first geothermal well drilled in 1981 in the Balçova Thermal Hotel vicinity, and the first application of down-hole heat exchanger, it became explicit that this energy could be used for heating purposes.

The Thermal Balneology Cure Center and İzmir Dokuz Eylül University campus followed this first application. The BD-I and BD-2 deep wells, which were drilled in 1994-1995, encouraged the local government to make use of these waters in neighborhood heating. These applications enlighten that, besides polluting the air, fuel oil and coal prices are not economic compared to the geothermal energy. In 1995, the first stage of "l5000 Residences Neighborhood Heating" project, which consists of 2500 residences, was started.

4.1.2.1. Geothermal Reservoir and System Features

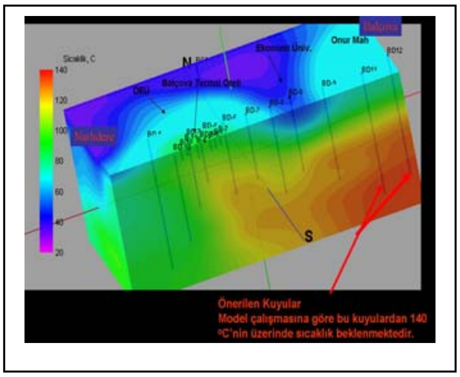
In order to determine the usefulness of the land-use factors will identify in chapter two, each will analyze and map separately for Balçova- İzmir. The maps will be prepared as overlays. The intent will be to locate sites within the city which has the best combination of user energy density zoning, parcel size, vacancy, and ownership. The specifics of each element and of the most compatible combination are given below.

Geothermal Reservoir Capacity and Geothermal Zoning Plan

In different countries where geothermal systems (theory and practice) have been developed the process of zoning plan was implemented. *Geothermal Zoning Plan* considers three components namely, the physical environment, the geothermal project itself, and the community. The interaction of a number of parameters will form the basis of the plan. These include the land-use, vegetation cover, land capability, erosion potential, population, rainfall, air quality, hydrology, and other factors. The result is a plan which is sensitive to environmental considerations that should be independent from economic and political thrusts. Geothermal zone is one of the zones to be marked on the plan. The plan is then subjected to consultation with the local planning bodies, regulatory agencies, local authorities, non- governmental organizations, and the community.

The geothermal conservation zone which came into existence through the regulation for Mineral Waters (1988) on the geothermal resources of Balçova district is determined in major constraints. The detailed information about regulation of conservation zone was discussed in second chapter.

According to the determined locations as a result of the geological studies many drillings have been executed, since 1963. In 1996, geothermal district heating system was launched to service and the system reached the 6500RE value in 2000, but there was not any result about resources reservoir capacity. After the determination of reservoir potential, the 3D modeling of heating distribution for case area was accomplished and the high degree resources were seen in east direction.



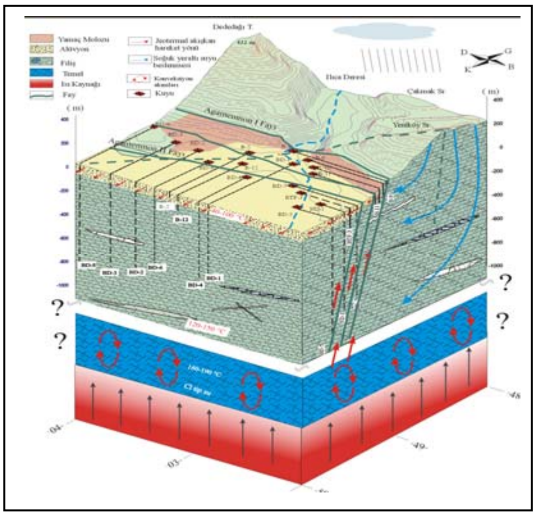


Figure 4. 1. Geological maps of Balçova geothermal field
(Source: Aksoy 2005)

At present, only thirteen wells are used for injection and reinjection wells. The locations of wells are shown on the maps which were prepared in 1984 and in 2006. According to information about geothermal field of Balçova district given by İzmir Geothermal Incorporated Company; (1) Balçova Geothermal Zone which has 100MWt power in 1593000 m^2 roofed area, is the one of the biggest areaa in terms of geothermal district/neighborhood heating system all over the world, (2) Thirteen wells are used for production in this area, five of them are shallow, and eight of them are deep well. In the winter of 2003- 2004, the pick charge of well was 1060m^3/hour geothermal water in 118ºC average heat, (3) In the winter of 2004- 2005, 1030m^3/hour geothermal water was taken from the same well alone, (4) In 2005- 2006 season, 1179m^3/hour geothermal water was taken at the very most. Normally, 1050- 1100m^3/hour geothermal water is used.

The study of geothermal energy district heating system for Narlıdere and Balçova districts was started thanks to the attempts of İzmir City Authority and resources of Special Provincial Administration in Balçova Thermal Tourism Area, in 1996. In 2005, İzmir Geothermal Incorporated Company was organized by İzmir greater Municipality and Special Provincial Administration.

Geothermal System Development Process

It is confirmed that Balçova thermal region, that the first technical researches were conducted in 1963, have shown significance improvements for the past 45 years and the site is stated as the biggest geothermal site of its kind providing multiple usage and usage capacity. Development evaluation of the site is given in the Table 4.2 as chronologically.

Table 4. 1. Geothermal wells situation in Balçova district
(Source: Hepbaşlı and Çanakçı 2003)

	THE STARTED VALUE OF THE PRODUCTION WELLS					
Number of Well	**Starting Year**	**Depth**	**The Pump Depth**	**Temperatures**	**Power**	**Volumetric flow rate**
		(m)	**(m)**	**(°C)**	**(kW)**	**(m^3/hour)**
S-1	1963	40	-	124	-	27
S-2	1963	73,5	-	102	-	11
S-3A	1963	140	-	101	-	1,25
B-1	1982	40	75	102,0	75	100
B-2	1983	150	-	113	-	-
B-3	1983	160	-	112	-	-
B-4	1983	125	60	100,0	55	60
B-5	1983	108,5	72	102,0	75	140
B-6	1983	150	-	93	-	-
B-7	1983	120	60	96,0	45	140
B-8	1983	250	-	93	-	-
B-9	1983	48,5	-	122	-	-
B-10	1989	125	48	97,0	75	200
B-11	1989	125	48	109	75	205
BTF-1	1989	121	-	101,8	-	2
BTF-2	1990	116,5	-	80	-	2,5
BTF-3	1990	100	-	98	-	11
BTF-4	1990	112,5	-	116	-	2
EMEK-84	1990	80	-	60	-	2,8
BD-1	1994	564	90	110,0	30	60
BD-2	1995	677	90	132,0	75	180
BD-3	1996	750	90	120,0	110	120
ND-1	1996	800	-	106,6	-	5,5
N-1	1997	150	-	95	-	2
BD-4	1998	624	100	135,0	110	180
BD-5	1999	1100	150	115,0	55	80
BD-6	1999	606	150	135,0	110	120
BD-7	1999	700	150	115,0	55	80
BD-9	2003	772	100	139	200	360
TOTAL						**2905**

Table 4. 2. Chronological development process of Balçova "Geothermal Energy District Heating System" (Source: İzmir Geothermal Incorporate Company 2007)

	The Chronological Development of Balçova Geothermal System
1963	First drilling in Balçova
1983	Heating to the Balçova Thermal Center with heat exchanger (inside the well)
1983	Heating to the Dokuz Eylül University Hospital with heat exchanger (inside the well)
1992	Heating to the Dokuz Eylül University Hospital with heat exchanger (outside the well)
1994	Heating the Balçova Princess Hotel
1995	Heating the 2500 housing in residential areas in first stage and cooling the 500 housing in residential areas
1996	Increasing the capacity 5000 housing heating, 1000 housing cooling
1996	Starting the İzmir Balçova Central Heating System
1997	Increasing the capacity of heating system (7680 RE)
1998	Heating the 1500 RE in Narlıdere district
2000	Starting the temporary acceptance organization
2000	Setting up to Balçova Geothermal Energy Limited
2001	Combining Dokuz Eylül University system to central heating system
2001	Combining the İzmir Economy University system to central heating system
2002	Opening the BD-8 Well / Reinjection well
2002	Finishing the new projects
2003	Opening the BD-9 Well
2003	Heating 3000 RE Özdilek Shopping Center, Crown Plaza Hotel, Faculty of Art in Dokuz Eylül University and 1720 RE Narlıdere Project
2003	The 1000 RE Balçova Appendix Project (Tuğsuz Sites and around there)
2004	The 980 RE Sahilevleri Project
2004	Opening the BD-10 Well / Reinjection well
2005	The 1500 RE Yeniköy Project
2005	Setting up the partnership with İzmir Greater Municipality
2005	Heating the 3917 RE Balçova Teleferik neighborhood Project
2006	Taking over the Seferihisar Wells
2007	The 4500 RE Balçova 2nd Stage Project

Table 4. 3. Heating areas and values of Balçova geothermal field

(Source: İzmir Geothermal Incorporate Company 2007)

GEOTHERMAL USAGE IN BALÇOVA REGION (29 JUNE 2007)

BUILDINGS	Building	Household	Subscriber	Subscriber m^2	Total Residences (Houses) Equivalent
Balçova + Narlıdere districts			10606	1282275	12823
Onur + Fevzi Çakmak neighborhoods			1406	150871	1509
TOTAL SUBSCRIBER			**12012**	**1433146**	**14331**
THE OTHER USER					
Public Institutions (School, Municipality etc.)					**265**
Princess Hotel	Heating + Hot water + Thermal				**571**
Balçova Thermal Hotel	Heating + Hot water + (Pools + Thermal Cure Center)				**653**
DEÜ Hospital	Heating + Hot water				**2459**
İzmir Economy University	Heating + Hot water				**273**
Özdilek Shopping Center and Hotel	Heating + Hot water + Thermal				**729**
DEU Faculty of Art	Heating				**365**
DEU school of music	Heating				**175**
Public student dormitory	Heating				**528**
					20349

Local District Heating and Greenhouse Localization

The energy obtained from the geothermal source in Balçova is used for heating of the houses, for hot water, heating of the greenhouses and for thermal health tourism. Geothermal system consists of 5 heating centers, 1 pumping station, 3 sub-heating center, 16 production well, 3 re-injection well, 4 observation well and approximately 200 km. of pipeline**.**

12000 subscribers, 6 greenhouse, Geothermal Princess Hotel, Balçova Thermal Center, Özdilek Shopping Center and Crown Plaza Hotel, Inciraltı Atatürk Dormitories, İzmir Economy University, Dokuz Eylül University Hospital, Dokuz Eylül University Medical Science Faculty, Dokuz Eylül Conservatory, Dokuz Eylül University Fine Arts Faculty, use geothermal energy for heating and hot water. There are 11057 Residence Equivalent (RE) unit houses and small offices and 5965RE higher capacity units (hospital, university, hotel etc.) in Balçova neighborhoods, in 2007 data (see. table 4.3, Figure 4.4).

In addition to house and work place heating, 600000 m^2 greenhouse areas belonging to private enterprise is also heated with geothermal energy. These greenhouses are used for agriculture such as floriculture, fruit-vegetables production. The thermal physical therapy and rehabilitation clinic enables 1500 patients to be cured each year.

Balçova Geothermal System reached 24500 RE system/installation capacities and 157 Megawatt-thermal capacities. (20500 of which are the existing situation). It is expected that by the end of 2008, new systems using the existing wells, will reach 31000RE capacities (190 Megawatt-thermal).

4.1.2.2. Geothermal Reservoir and System Affects

In this part, researches are conducted within the case study area in order to be able to observe the relationship among geothermal energy and changing the partial plans of Balçova and the real-estate sector. Aim of the research is to investigate whether geothermal energy sourced Balçova District Heating Center, (1) change a partial scale plan in Development Plan of Balçova district, 1/1000 scale, (2) has an effect on real-estate sector. The values of real estate and land context researches were conducted on two different subjects. First one was based on the simple surveys with the real estate agencies in 6 different neighborhoods within the case study area (see Figure 4.3). In the content of the survey the parameters affecting the real-estate values are questioned and the interviewees were demanded to make a classification depending on these parameters and consequently results were mapped using the information obtained from the surveys.

Within the case study area, since 2002, 5 development plan changes have been approved by the municipality for different neighborhoods and Geothermal Heating Centers (GHC) were constructed after the plan changes. These changes were confirmed for different neighborhoods such as Onur-Fevzi Çakmak neighborhoods GHC in July 2005, Teleferik neighborhood GHC in May 2006, Korutürk neighborhood GHC in 2006, Fevzi Çakmak neighborhood GHC in October 2006, and Onur neighborhood GHC in June 2007 (see Figure 4.2).

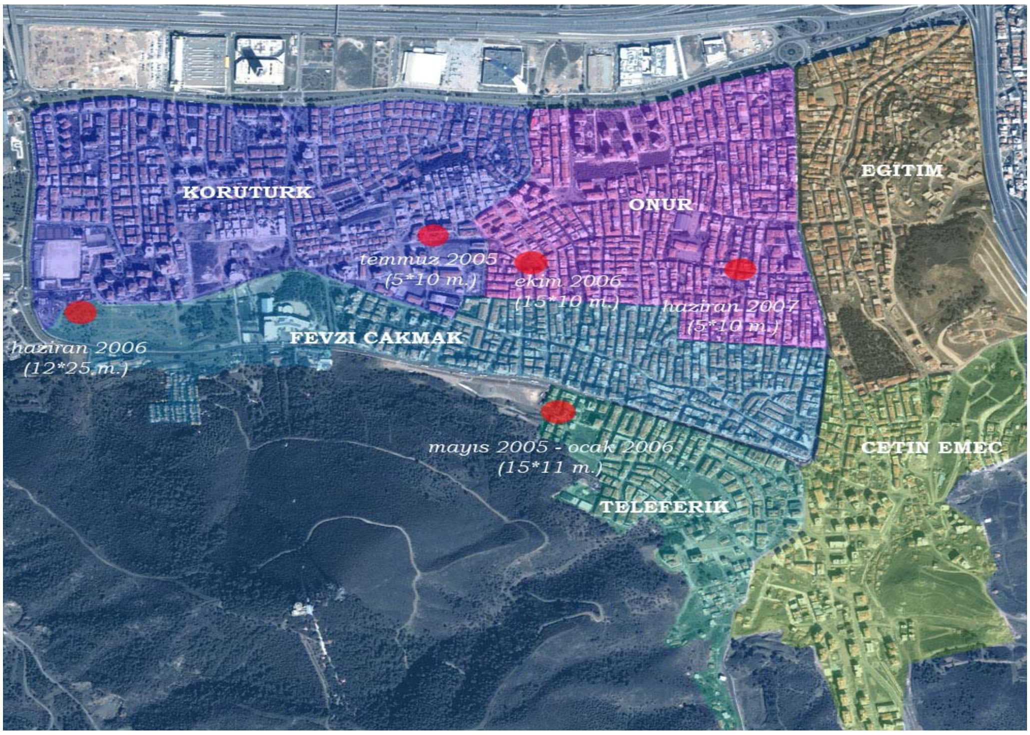


Figure 4. 2. The wells points and dimensions case area in Balçova district

The second research was conducted within the Department of Real Estate in Balçova Municipality to determine the local land values in between 1997-2006 and to make the localization of these streets. The beginning year of the research, 1997, was accepted as the time when the geothermal energy was used in Balçova district for the first time.

Within the study, two major questions were asked to local real-estate agencies; one was the main factor that affects the housing prices and the second one was ranking of these factors according to the importance level. The results of these questionnaires were used to make a classification depending on these effects of the housing prices.

Within the scope of the research 20% percent of 180 real-estate agencies, that is 36 agencies, were interviewed depending on the questions above. The number of the agencies was determined according to the number of house in each neighborhood and consequently 10 agencies from Korutürk neighborhood, 6 from Fevzi Çakmak and Eğitim neighborhoods, and 4 agencies from Çetin Emeç and Teleferik neighborhoods were chosen for the surveys. To determine the location of the agencies, random sampling method was used providing the equal distance between each agency. The aim was to get information from each street and each house. According to survey results, the factors influencing housing prices were classified in 4 groups (see Figure 4.3, Figure 4.4). These groups were defined as housing type, construction cost of housing, regional infrastructure and the location of the housing. According to results housing location is determined as the most important one affecting the housing prices (20 offices, with 55% percentage) and secondly regional infrastructure (10 offices, with a 27% percentage) and as third construction cost of housing, (4 offices, with 11% percentage) and lastly housing type was determined (2 offices with 5% percentage).

Although the results of the ranking the effects of housing prices were various it was possible to make groups of them as shown below (see Appendix C):

1) Location of the housing– regional infrastructure - construction cost of housing – housing type (14 offices with 38% percentage),
2) Location of the housing - construction cost of housing - regional infrastructure - housing type (6 offices with 16% percentage),
3) Regional infrastructure - location of the housing - construction cost of housing – housing type and regional infrastructure - construction cost of housing - location of the housing - housing type (4 offices with 11% percentage).

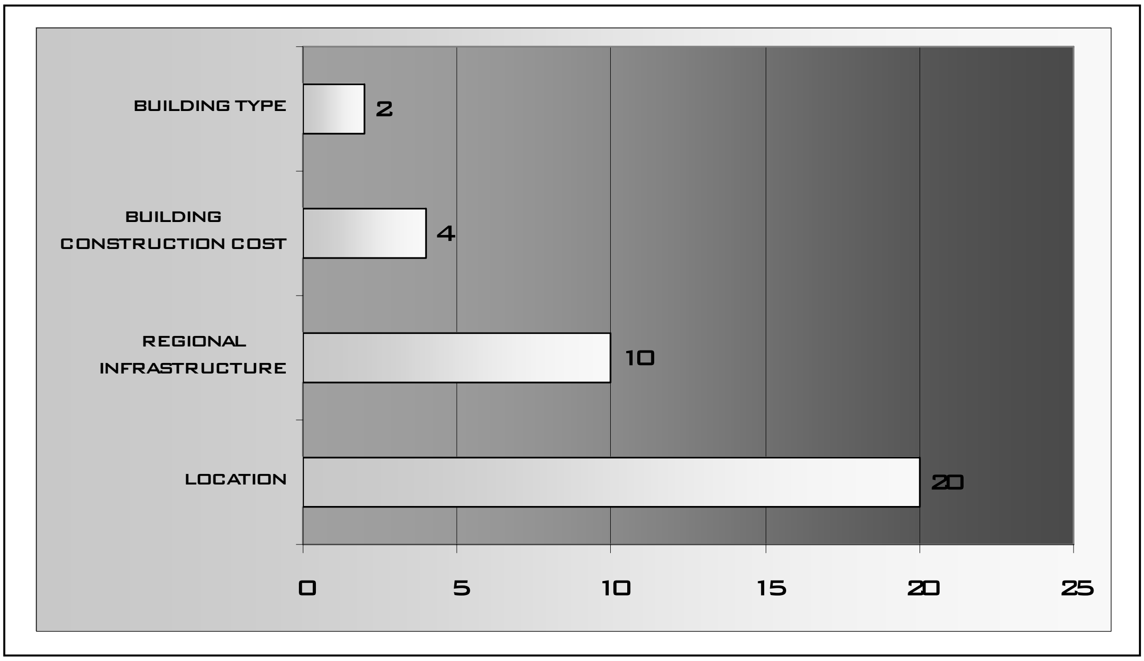


Figure 4. 3. A classification depending on these effects of the housing prices by local real-estate agencies in Balçova district

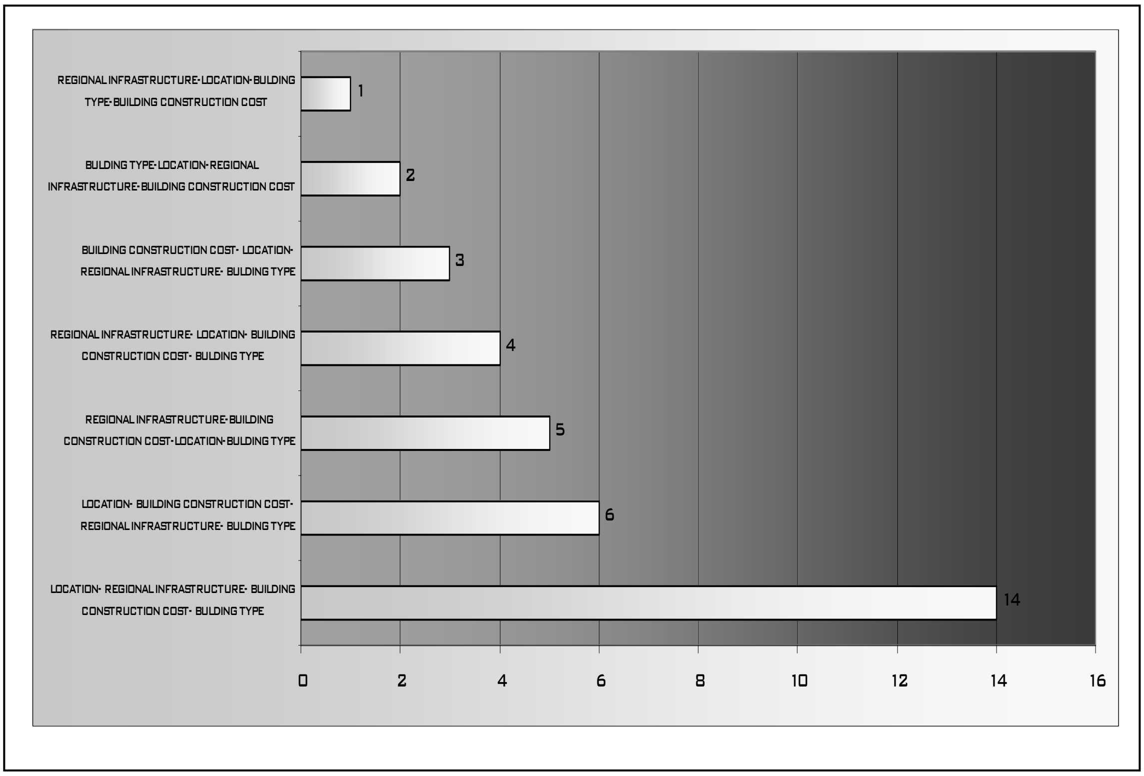


Figure 4. 4. A classification groups depending on these effects of the housing prices by local real-estate agencies in Balçova district

4.1.3. Socio-Economic Background of the Balçova District

The concepts of economic changes of geothermal project are the very important points and the socio-economic analysis is the other base point in these situations. There are some determinants about these changes; for economic changes: (1) increased employment and secondary trades with corresponding increase in per capital income, (2) reduction in resource base, (3) change of life style from rural to industrial/ economic setting, and for institutional changes: (1) cultural adoption (enables cultural communities to participate in national development, (2) Population changes in composition and number due to induced development leading to pressure on resource base, (3) effects on aesthetic and human interest areas (scenic vistas, open space qualities, unique physical features and archeological sites (Brown 1995).

So that, in this part, these data which collapsed demographic and socio-economic data, land-use and planning data and related geothermal energy data were collected by different related organizations and institutions about Balçova district. Especially, the data results which were prepared by General Directorate of Mineral Research and Exploration (MRE), General Directorate of State Hydraulic Works (SHW), Turkish Statistical Institute (TSI), Greater Municipality of İzmir, Balçova Municipality, Health Group Presidency of Balçova, Balçova Educational Directorate, Executive Offices of Neighborhoods, Non-governmental organizations, Local Real Estate Agents, Local Governor of Balçova, The Healthy Group of Balçova Local Administration, are added value to input in this part.

Especially, the 2000 Population Census (the last one) results prepared by TSI contributed in compilation of socio-economic data. The population census, which is the geographic and demographic inventory of the individuals, with its characteristics of being the only information source of the smallest residence unit, keeps its first plan position in our country where the registration system is just being improved.

In this part historical overview emphasizes the progress of total İzmir county, İzmir Metropolitan Area and Balçova district (in 2000 year administrative division of Greater Municipality of İzmir) in the demographic and economic structures of the population by presenting the user the information obtained from the 2000 Population Census in comparison with the information obtained from previous population censuses. This part consist of four sections, size of population and population growth rate by administrative division, sex and age structure by social and demographic characteristics, educational status and literacy rate and the last one, labor force, employment and unemployment situations by economic characteristics. These characteristics of İzmir City and Balçova district have been evaluated.

The data of demographic and socio-economic structure of Balçova district belong to the sixth out of eight neighborhood (Korutürk, Onur, Teleferik, Eğitim, Çetin Emeç and Fevzi Çakmak neighborhoods) and were obtained from the Balçova Local Governor, Local Administration of Balçova and The Healthy Group of Balçova Local (see Appendix D).

According to demographic literature about Balçova district, in 2000 data of Turkish Statistical Institution and in 2006 data of Health Group Presidency of Balçova, the majority populations live in Onur neighborhood and the live in Teleferik neighborhood. The numbers of populations of Korutürk, Fevzi Çakmak and Eğitim neighborhoods have similarity; where approximately 13000 people live in there (see Figure 4.5).

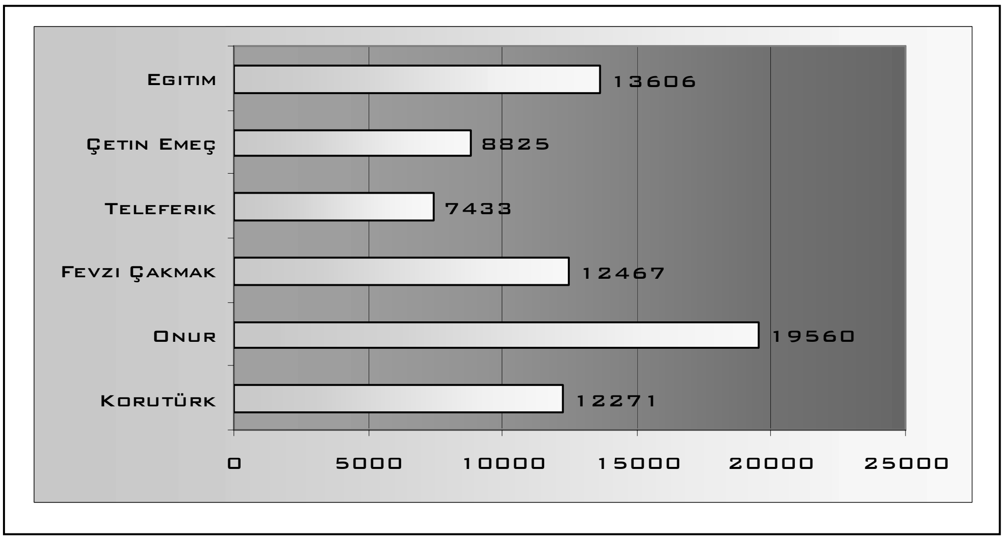


Figure 4. 5. Total population in case neighborhoods of Balçova district
(Source: The Healthy Group of Balçova Local Administration 2006)

The majority of the buildings are located in the Onur neighborhood, followed by Eğitim and Korutürk neighborhoods; Teleferik neighborhood has the least population. The numbers of the building in Onur neighborhood are nearly triple the numbers of building in Teleferik neighborhood (see Figure 4.6).

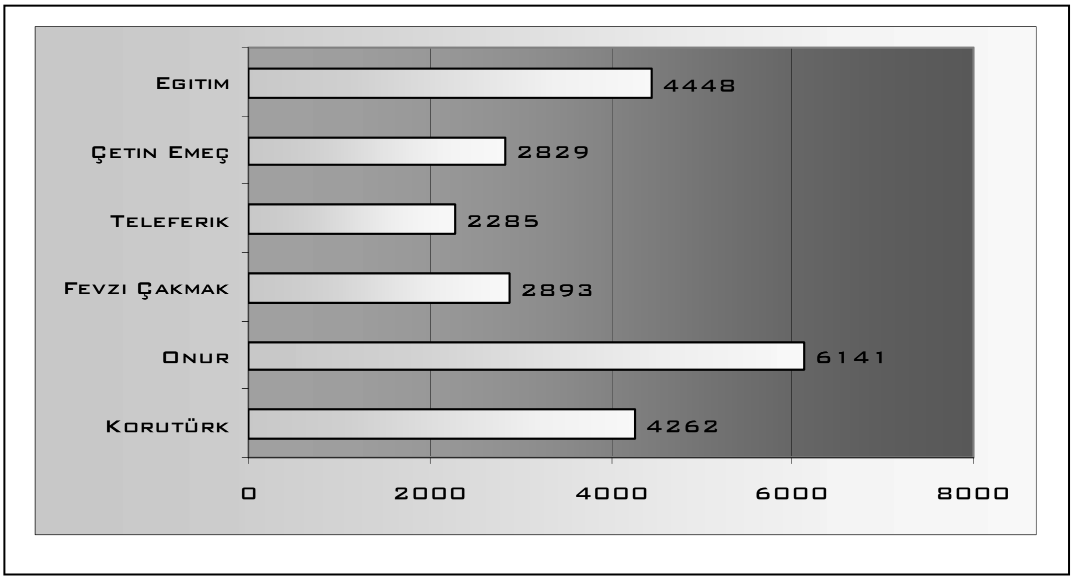


Figure 4. 6. Total household population in case neighborhoods of Balçova district
(Source: The Healthy Group of Balçova Local Administration 2006)

Total number of populations in neighborhoods and total number of buildings in neighborhoods have diversity respect of the family size and the Teleferik neighborhood has the most family size ratio (see Figure 4.7).

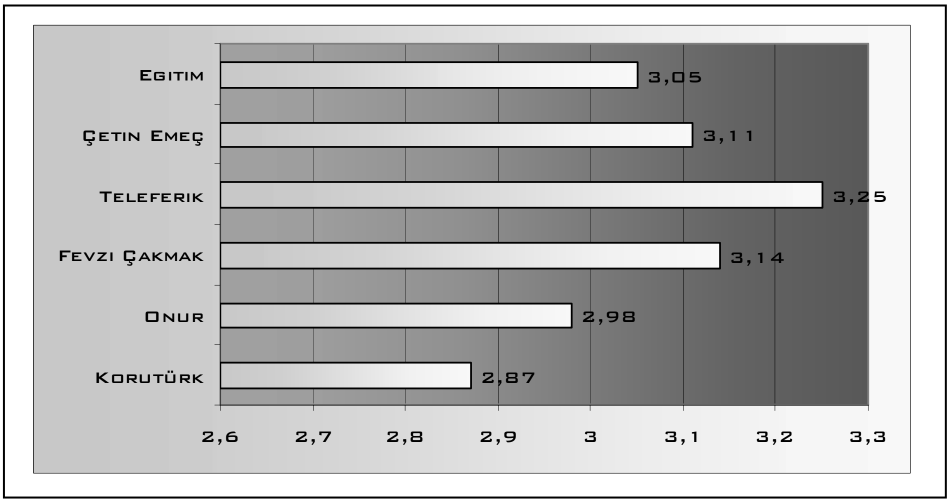


Figure 4. 7. The household size ratio in case neighborhoods of Balçova district
(Source: The Healthy Group of Balçova Local Administration 2006)

4.1.4. Urban Planning Background of Balçova District

1/1000 and 1/5000-scaled development and master plans for Balçova were made in 1989. They were planned according to the 1/25000 İzmir Master Plan that was made in the same year. When all these plans were investigated in the context of thermal energy, we come up with nothing but protection areas allocated to protect thermal springs present at that time.

The new Balçova 1/1000 Developments Plan, will be prepared after the finishing suitable relationship between İzmir Master Plan, in 1/25000 scale, and Manisa- Kütahya- İzmir Planning Zone Environmental Plan, in 1/100000 scale, after been put into force.

Prepared according to the current 1/1000 and 1/5000 development and master plans but not yet put into development 1/25000 and 1/10000 scaled İzmir Metropolitan and İzmir- Manisa- Kütahya Environmental plans and, the plan was questioned in the view of geothermal energy.

4.1.4.1. Development Plan (1/1000 Scale) and Master Plan (1/5000 Scale) of Balçova District

The Bank of Provinces made plans in 1981 for the Balçova district in the scale of 1/1000 Development Plan and 1/5000 Master Plan. We come up with no planning work about geo-thermal energy except for the presentation of the places of hot springs already present.

"Protection Area for Balçova thermal springs and Geological Map" were prepared for the first time in 1984 and they were recorded into plans as Protection Areas for Thermal Springs. Later on, in 1989, the Report of Balçova Thermal Springs Protection Area was released by General Directorate of Mineral Research and Exploration (MRE). In this report, it is stated in detail that this area is rich in terms of geothermal energy that it is necessary to establish geo-thermal protection areas, that what the areas of 1-, 2- and 3-degree geothermal protection areas encompass, and that what should be realized in these areas (see Chapter 2). The district was announced in 1995 as "Thermal Tourism Center and, the Construction Area for Tourism" and the protection areas were renamed as Protection Areas for the Construction for Tourism.

From 2002 onwards, new areas of wells were determined to include to the district heating system within Balçova district, with a Change in Plan of 1/1000 scale, five different wells were drilled during 2002- 2007.

Finally, with the 4.4.2007 dated and 41 numbered decree of Balçova Municipality Council, and with the 9.7.2007 dated and 35.0 0.10 04.301. 05.0.1.773 numbered endorsement of İzmir Metropolitan Municipality, the decree that a note should be added to the Balçova Development Plans to allocate place for the geothermal energy installations in necessary measurements in the entrance parts or in the basements of the constructions to be built.

4.1.4.2. Proposed İzmir Master Plan (1/25000 Scale)

According to The Law of Greater Municipality, Law Number: 5216 (2004), the name of, 1/25000 scale İzmir Master Plan must be prepared suitable for the Environmental Plan in two years. In order to make sub-region planning, the planning brief of country environmental plan, in 1/25000 scale, is aimed at procreating comprehensively the planning brief of the Environmental Plan, in 1/100000 scale. This plan was prepared and declared to take different suggestion from related institutions in 2006 and the process of pre-acceptation was started.

The case area of the thesis is located in İzmir Center City Program Area which is a part of the main regional plan (four pieces). According to the history of city planning in İzmir, sometimes Balçova district has been put on the agenda thanks to the thermal resources by the planning studies. But only in 1993, İzmir Balçova thermal region with 60.9 hectare was included in Thermal Tourism Center by Council of Ministers Decisions.

The first planning experience of İzmir was in 1925 and the plan was prepared by Rene and Raymond brothers who were the France planners. Another plan was planned to limit for small scale environment and fire areas by different France planner. The general strategies of the plans were geometrical structure, a wide avenue and the great park in the city centre. Later on, in 1955, the new plan which was chosen in İzmir Metropolitan Master Plan Competition in 1950 was acknowledged, but the number of population proposal of İzmir for 2000 but İzmir reached at this population in 1960. İzmir Metropolitan Master Plan, in 1/25000 scale, and plan report was prepared by İzmir Metropolitan Master Plan Office which was founded in 1965, was approved by Minister of Development and Housing, in 1973.

Under this plan, there was only one decision about conserving the agricultural area in Balçova- Narlıdere districts where the west axis of the İzmir City Center passes through. In 1989, The Revision of İzmir Greater Master Plan, in 1/25000 scale, was done thanks to the different scale actual plans because of the changing the major decisions, investment decisions and developments of the plans of 1973’s. According to the revision plan; 30hectar areas would be developed for urban lands in south and south-eastern side of the Balçova district and attention would be paid to the natural criteria in these side, then, in 2002, this plan became invalid because of the allegations that the “Greater Municipality did not have the plan in the scale of 1/25000”.

According to plan strategies, plan report and planning brief of İzmir Master Plan Proposal (2007), geothermal concept took part in two main idea: (1) relationship between geothermal energy and tourism areas, (2) relationship between geothermal resources and conservation areas, as well, Manisa- Kütahya- İzmir Planning Zone Environmental Plan was not given attention to although the planning process of İzmir Master Plan, was executed in the same period.

According to Environmental Plan for touristic facilities, the minimum parcel must be 1000m^2 and Floor Area Ratio (FAR) must be 60% and the limit of maximum floor of building must be 5 units for physical therapy and massage units.

For conservation uses involving natural, historical and urban conservation areas, the total area was divided into Ramsar sites, resources conservation areas of special environmental region of conservation and *geothermal conservation zones/ areas.* Dense building is forbidden around the sources for the purpose of not polluting clean hot water resources such as, biological, chemical and physical polluted. In resources conservation zone, there are three zone step and the rules of these conservation zones are similar to those of the geothermal conservation zones.

According to the report of İzmir Master Plan, geothermal resources conservation area is related with geological structure of the ground, it has high decree heat compared to atmospheric annual average heat of region, include the molten mineral and gases, has natural increasing of water, steam and gases based on the data obtained from General Directorate of Mineral Research and Exploration (MRE).

4.1.4.3. Proposed Manisa- Kütahya- İzmir Planning Region Environmental Plan (1/100000 Scale)

The Manisa- Kütahya- İzmir Planning Zone Environmental plan was finished by private planning office on behalf of Minister of Environment and forestry and was sent to the related institutions, in 2007 to take suggestions. The plan was the combination, comprehension and revision of the parts of the Environmental Plans for regions around İzmir.

In developing plan decisions, increasing, generalizing and encouraging the usage of sustainable energy resources and taking precautions for sustainability of resources were aimed in planning zone so that a balance between conservation and usage could be achieved. In this context, two main sustainable energy sources were envisaged in this environmental planning area; wind and geothermal energy. So that, determining and locating of the wealthy geothermal sources, thermal springs, thermal tourism, healthy tourism, electricity production, industrial using, greenhouse heating and neighborhood heating zones concepts were very important.

In this environmental plan report, seven major electricity production zones were determined depending on the data of General Directorate of Mineral Research and Exploration, General Directorate of Electrical Power Resources Survey and Development Administration and Electricity Generation Incorporated Company. According to the three institutions, Salihli- Caferbey Zone (150ºC), Salihli- Göbekli Zone (182ºC) and Alaşehir- Kurudere Zone (184ºC) in Manisa; Simav Zone (162ºC) in Kütahya; Seferihisar Zone (153ºC), Dikili Zone (130ºC) and Balçova Zone (136ºC) in İzmir resources were suitable for electricity production and the setting up of the geothermal power station was suggested with the exception of Balçova zone.

The other sector is greenhouse heating with geothermal energy for application in Manisa- Kütahya- İzmir Planning Zone Environmental Plan. There are two new terminologies about greenhouse heating in this environmental plan, Technological Greenhouses Zone and Organized Floristry Zone concepts. Technological Greenhouses Zone concept includes the specific area in which greenhouse application are actualized thanks to the use the geothermal resources. Organized Floristry Zone involves the setting up floristry greenhouses and using the geothermal resources inside. The report claims that the greenhouse applications are not suitable organizations in at present because of the unorganized setting of existing greenhouses. And new zones are determined in planned area; Organized Floristry Zone in Balçova.

Using thermal resources for industrial sector, especially for food industry segment, is pointed out because the quality and position in this environmentally planned region show consistency with the plan report. The waters of geothermal resources are used currently in food stuff drying sector, canned food production, fish drying, organic food drying (meat, vegetable, alga etc.) sectors, sugar and soil achieving sectors and the sector of growing mushroom, as well as. Geothermal resources can be suitable for use in sectors of clean water achieving, redounding the salinity ratio, cement drying and lumber drying. Sectors set up in the regions of prepared environmental plan. Geothermal resources energy is utilized by the firms in Gediz Organized Industrial Zone, İzmir- Bergama Organized Industrial Zone and Dikili Organized Industrial Zone, as well.

The final sector of related with geothermal energy and resources is, according to the report of Manisa- Kütahya- İzmir Planning Zone Environmental Plan, tourism sector. The planned area contains the Culture and Tourism Conservation and Development Zone and tourism Centers which include the coastal areas of Çeşme, Selçuk and Dikili. In the others geothermal zones which are outside of the Çeşme, Selçuk and Dikili, thermal tourism centers should be built and in this centers, the conservation of thermal resources should form the main idea. The development rules of planning decisions in thermal areas are determined in sub-regional environmental plans. The related institutions of sub-regional planning process will decide the building conditions of thermal tourism zones. In this report, there is an expression about planning system in 1/5000 scale master plan and in 1/1000 development plan, and the acknowledgement mechanism of the plan is based on this small scale plans and plan reports.

The other important point about geothermal resources in this environmental plan is the issue of the conserving the underground water reservoir. According to plan report, five main suggestions are emphasized about organizational structures; (1) making the comprehensive project related with setting up the system by General Directorate of State Hydraulic Works (SHW), (2) stopping the application of opening wells randomly for underground water usage, (3) making the conservation plan and conservation belts about geothermal wells in accordance with the related the laws of the land to protect the underground water resources which are used for drinking and using water, (4) determining the potential of the underground water by the SHW to prevent the underground water level in dangerous scale, (5) canceling or reorganizing the old assignment to protect the potential of underground water which is determined by the SHW.

4.1.5. The Local Regulation of Geothermal Energy in İzmir

However “The Law of Geothermal Resources and Mineral Waters” and “The Regulation of the Development of The Law of Geothermal Resources and Mineral

Waters" which are clarified in detail in chapter two, came into force in 2007, İzmir Governorship prepared to local regulation about geothermal energy in 2005. In this part this regulation is dealt with (see Appendix A). The proposal of Geothermal Energy Regulation in İzmir was prepared by İzmir Governorship, but so far, this regulation has not been activated and approved. The regulations are tried to explain in this part.

The aim of this regulation is stated as follows: "to determine the principles and rules for thermal energy resources already detected or to be detected *within the borders of the province in such a way that they would be presented to the service of the society and the country taking into consideration the interests of the country and to promote their operations by providing environmentally harmonious, sustainable and integer methods of business administration."* (The Republic of Turkey İzmir Governorship-Regulation for Geothermal Energy Resources 2007).

Other than the concepts defined on the subject of geothermal within the regulation, articles of regulation from 7 to 13 define the related institutions and their responsibilities. First, a technical committee (composing of persons in various professions and in expert on the subject of geothermal) is proposed under the title of "İzmir Geothermal Energy Higher Committee of Consultation" the task of this committee is to form and establish a "Policy for Geothermal Energy" and " Regional Plan for Geothermal Energy", to provide technical support in prospecting and operating geothermal resources, to do research on the events of contraction (collapse) in residential areas, to support studies on the geothermal subject, to conduct arbitration on the problems encountered on the subject of geothermal. Another proposal is to establish a "Data Collecting Center" royal to Special Provincial Department".

Regional Geothermal Energy Policy and Plan was formed in a structure that involves only geothermal systems. The fact that urban spaces in which the system takes place and socio-economic structures of the people living in the region fall behind these policies seem as a lacking point.

In article 26 of the regulation, encouraging those doing research on the subject of geothermal, and who are engaged in prospecting and operating, and giving financial support through "Geothermal Energy Fund" (this source is composed of revenues collected through various ways from operations in geothermal field) seem as an innovation.

In the light of all these social texts, although they do not seem to be sufficient regulations, legal activities that have been going on especially in recent years stand as an undeniable fact. Although we estimate that these studies will increase in the years to come, it is necessary that we know the real problems about geothermal energy that stay in the background. Studies for reservoir determination, which form the most expensive part of geothermal energy studies, cannot be realized in satisfactory level in our country. Restricted studies of boring do not present us correct information about the capacity of the reserves underground. As a result, thermal protecting bands much under the real capacity are determined and in the time course this situation causes problematic studies in residential areas out of protection bands.

Another big problem arises from preparing urban plan and the changes in plans. In plans realized without using sufficient data about geothermal resources, separately as a result of changes in plans, bring about the problem of lack in social infrastructure areas. These decreases in social infrastructure areas, combining with the problem of insufficient drilling studies, causes that we confront with a very serious problem of not finding a place to exercise drilling. Sometimes drilling is exercised in the parks in city blocks or even in the gardens of some buildings and these affects the environment negatively.

4.2. The Socio-Economic Data Analysis of Balçova Case Area about Geothermal Energy Integrated Urban Land-use Planning

The socio-economic analysis is the one of the two major key subjects (socio-economic analysis and land-use analysis) of this thesis because the socio-economic situations of the populations living in case area are the very important determinants for planners' view point. Socio-economic situations of population living in geothermal fields, both before and after the launch of GEDHS, are important issues for planning.

In this context, the specific independent variables are examined in socio-economic analysis thanks to the survey method first of whom is community perception and interest on the project, interests of non-governmental organization interests, miss communication and agenda in local scale.

In general, geothermal development project include improving the socio-economic conditions. Improving the socio-economic conditions of the geothermal development is the remarkable input of the project. The costs and impacts of project on the intended beneficiaries become the yardstick of the acceptability of and the success of the geothermal project (Jesus 1995).

In terms of socio-economic effect of the study, taking into consideration social issues in decision making, planning and management levels of a thermal project is an obligation brought by international agreements, protocols, laws and international finance organizations. Socio-economic parameters may change according to the scale of the project. Certain parameters or determinants are measured for the purpose of evaluating the effect. These can be stated as demography, type of living, needs and problems, housing and municipality services (running water, sewerage, electricity) and socio-politic organization (the structure of the municipality, political relationships, volunteer organizations) (Brown 1995).

According to Jesus (1995), the goal of the socio-economic analysis of the geothermal projects is to explain the change in the study areas where are not affected by direct and indirect impacts of the geothermal project. Geothermal analysis obtains a guide on how the geothermal project can be kept in consonance with the socio- cultural and economic situations in the area.

4.2.1. Data Compilation about Socio-Economic Survey

For this purpose, the sources of documentation, in-depth interviews and questionnaire are used for the collection of socio-economic data for Balçova case area geothermal energy region. The structure of the questionnaire is based on two thematic parts defined by 30 questions and 1 table. It consists of factual questions, opinion questions and open-ended questions. The factual questions refer to demographic and social characteristics of the interviewees such as location; gender, educational level, and occupation (see Appendix B).

The opinion questions form the core of the questionnaire, as it is on those on which the fulfillment of the goals of the investigation will be mainly be based. They include questions enabling the assessment and documentation of the effects of the concentration and operation of the desalination unit on (1) the day-to-day life of the local community, (2) the economic and productive activities in the Balçova case area and (3) the physical environment. The open-ended questions are used in order that the interview can freely articulate their views on the issues being investigated.

In this context, the face to face interview and questionnaire (open-ended) data collecting system was used for 486 sampling households (2% sampling rate) in Balçova district. This number of samplings was separated with rate of total houses number of neighborhoods (Koruturk neighborhood: 88 sampling, Onur neighborhood: 143 sampling, Fevzi Çakmak neighborhood: 81 sampling, Teleferik neighborhood: 55 sampling, Çetin Emeç neighborhood: 36 sampling, Eğitim neighborhood: 83 sampling). The case area are separated in three parts; using the geothermal energy district heating system (GEDHS) in settlement (Koruturk and Teleferik neighborhoods), partial using the GEDHS in settlement (Onur and Fevzi Çakmak neighborhoods) and not using the GEDHS in settlement (Çetin Emeç and Eğitim neighborhoods).

For these chosen areas, the socio-economic data were collected in two different groups; the questionnaire for all individuals in all sampled households, the questionnaire for only one person representing the whole household. The first questionnaire type include the general socio-economic structure of the household about number of household size, living period in Balçova district, sex, age, educational level, employment situation, social safety and income level of sampling households.

The second questionnaire type include the two related subjects; the measurements of structural and legal situations of building where sampled population live, and the measurements of thoughts and expectations of households about geothermal energy, technical and political investments of GEDHS, advantages and disadvantages of the system and deficiencies of the geothermal system.

4.2.2. The Evaluation of the Survey Data about Socio-Economic Survey

Results of data analyses which were conducted depending on the socio-economic surveys were evaluated separately for each district of the town in the direction of main titles formed during the process of surveying. General socio-economic situations, technical and legal situations of houses and expectations about GEDHS were examined on the sample and the relationship of the people living in the district with the GEDHS was revealed.

4.2.2.1. General Socio-Economic Indicators of Population

Within the sample study area geothermal energy district heating system was established with its entire infrastructure in Korutürk and Teleferik neighborhoods. Onur and Fevzi Çakmak neighborhoods are established in several ratios in neighborhoods. In Çetin Emeç and Eğitim neighborhoods no district has been heated. Consequently, giving study results based on the neighborhood gave us information on neighborhoods which do and do not use geothermal energy.

In limited number of studies that appear in literature on geothermal energy and its effects, while this sort of data were examined at a certain degree in a socio-economic concept study in a Kenya study (Mariita 2002), while general socio-economic data were not examined in this way in a study on Milos island (Manaloglou 2004).

The results obtained from questionnaires were examined in terms of subjects;

Household Size

Family size is an important factor especially when determining the number of people making use of geothermal energy. In underdeveloped countries such as Kenya, Guatemala, and Philippines, geothermal energy which is given special care as government policy for use in district heating in neighborhoods which can be considered as shanty shows that it has got important political outcomes since the family sizes are really big an so is the number of users in these areas. Especially in a study conducted in Kenya, families with the average a size of 19 people were encountered (Mariita 2002).

In Korutürk neighborhood, which is to the west of study area, in a family size survey encompassing 88 families, household size ranged from 1 to 7, a value of 3.23 was found as an average family size. Taken from 2007 data, average family size in the whole district was different (see Section 4.1.3). It is guessed that this different finding is due to the fact that the study was conducted during summer months and because of the weather conditions, people, especially the retired and elderly, lived outside the town.

In a study of questionnaire in the neighborhood, family size was found as 3.24. Minimum and maximum family sizes were observed as 1 and 7 respectively. According to the 2007 data taken from Health Group Presidency, this value is 2.97.

In Fevzi Çakmak neighborhood, as a result of a survey of 81 families, 3.29 were found to be average family size. Minimum and maximum family sizes were observed to be 1 and 6. The data of Health Group Presidency shows the value of 3.14 as the average family size.

Average family size in another neighborhood, Teleferik neighborhood, 3.31 in a sample size of 55 families, this being a close value the 3.29 which is a value found in 2007. This value being close to the 2007 value is due to the fact that Teleferik neighborhood has got a younger population than the previously mentioned ones and this may be the result of the fact that the number of people spending summer moths elsewhere is smaller. Minimum and maximum family sizes were obtained to be 1 and 6 in this neighborhood.

In a survey conducted on a sample size of 36 families in Çetin Emeç neighborhood, average family size was found to be 3.9, minimum and maximum being 1 and 6 respectively. In 2007 data of Balçova Health Group Headship this average is 3.11 people.

Finally, from the sample size of 83 families in Eğitim neighborhood average family size was found to be 3.15, this being 3.05 in the data of Balçova Health Group Headship. Minimum and maximum values were found 1 and 7 people.

Although the examination of the results shows little difference from those of previous ones, as an area in which geothermal energy is used in heating system, this value is under the average of both İzmir and Turkey in general. Although this result is observed as positive at first glance, in the context of GEDHS, it comes up as disadvantage in terms of the number of people making use of this system (see Figure 4.8).

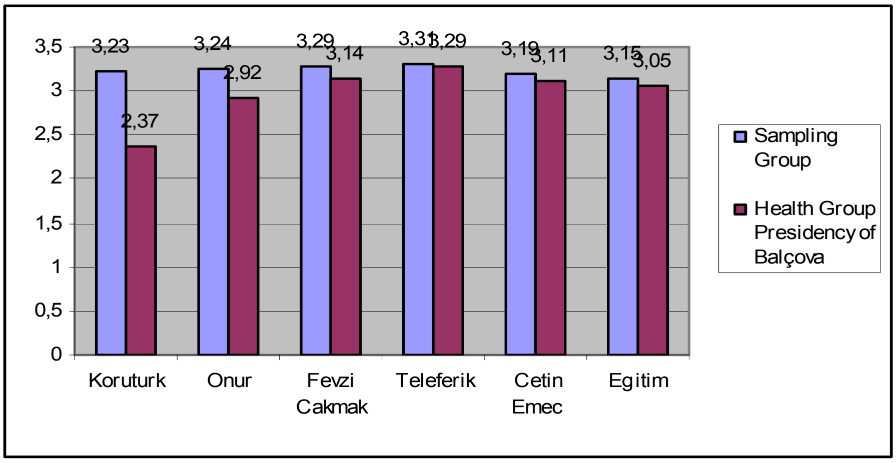


Figure 4. 8. An average household size for case area in Balçova district

Age and Sex Structure

Although there is not a one to one relation between age and sex and GEDHS, it may give us detailed information about the neighborhoods making use of GEDHS (see Figure 4.9).

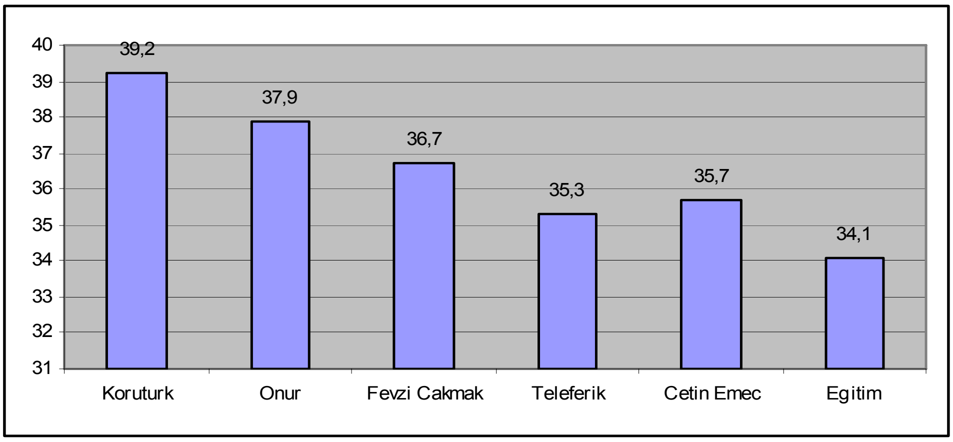


Figure 4. 9. An average age situation for case area in Balçova district

Educational Level

Jesus (1995) stresses the fact that the ratio of acceptability of the geothermal projects rises as level of education in public opinion and people living in geothermal regions increases. Consequently, the level of education bears value especially in providing the people's participation in projects.

Following this approach, when one looks at the study on the level of education, the following graphic comes into being in Koruturk, Onur, Fevzi Çakmak, Teleferik, Çetin Emeç and Eğitim neighborhoods (see Figure 4.10).

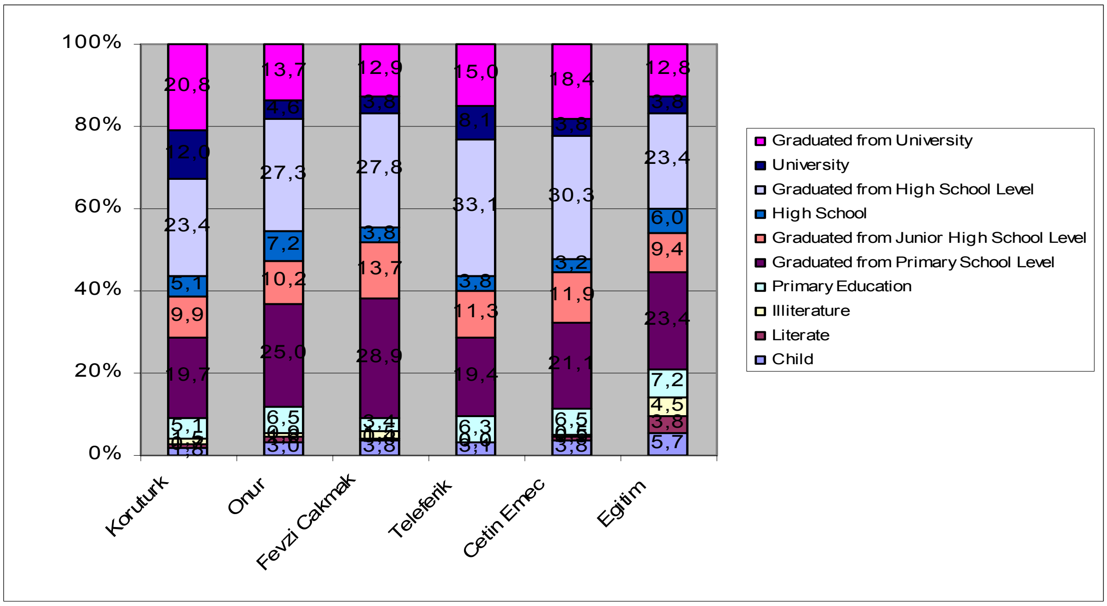


Figure 4. 10. The percentage of educational level for case areas in Balçova district

Employment and Income Level

Income levels and work branches of the people living in regions where geothermal projects are applied is an highly important factor because in geothermal energy district heating systems, the highest cost, which especially occurs during infrastructure works, is reflected to the users as the initial cost. For this reason, in areas where people are capable of affording these costs, development of these projects can take the priority.

As a result of sample size studies in neighborhoods in Balçova, the following results were obtained (see Figure 4.11).

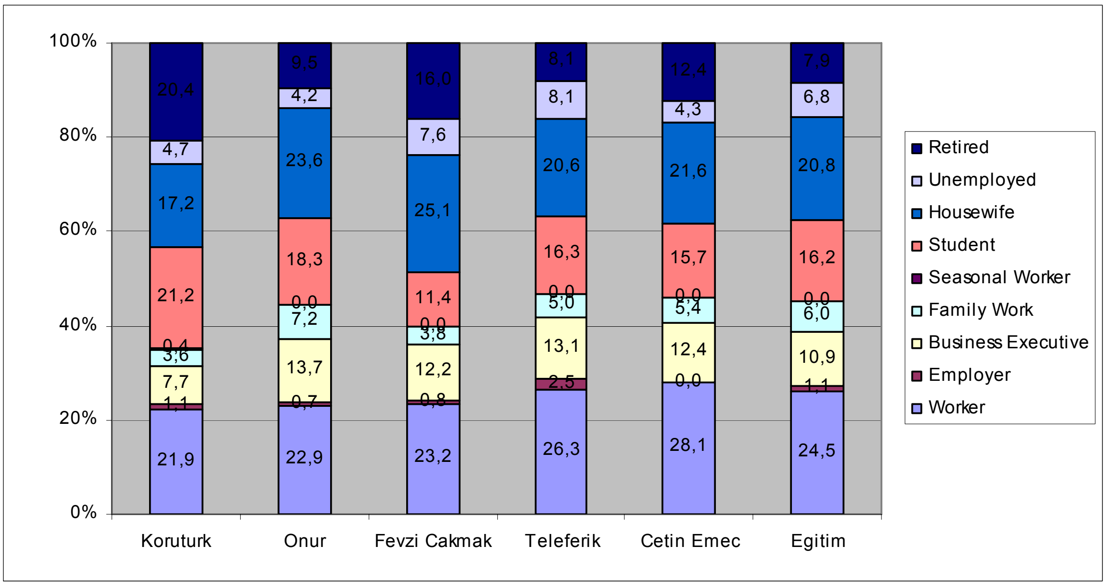


Figure 4. 11. The percentage of employment level for case areas in Balçova district

There is uncertainty in this section that the values found for average household incomes reflect reality. Especially in this evaluation which was realized depending on individuals own statements, it was concluded that insufficient information was obtained about real estate incomes of the people.

The fact that the ratio of unemployment is low brings forward a different example compare with those developments in underdeveloped countries. Alongside this fact, there exist certain material difficulties in that local governments convey the cost to users.

Social Assurance

Social safety, another variable of socio-economic structure, is directly related to the fact that people living in those areas adopt and support geothermal projects. Since social safety is related to job, work force and income situation, supporting ratios of those who have social safety is high.

In this context, when neighborhoods were examined in the sense of samples in the study area, it was observed that the percentage of those belonging to SSK (the Institution of Social Insurances) was 50%-65%, that of those belonging to Emekli Sandığı (Government Pension Fund) was 12%-30%, Bağ-Kur (Retirement Institution for Freelance) was 11%-20% (see figure 4.12). The number of those belonging to private insurance system is very low and the ratio of the uninsured is 10%.

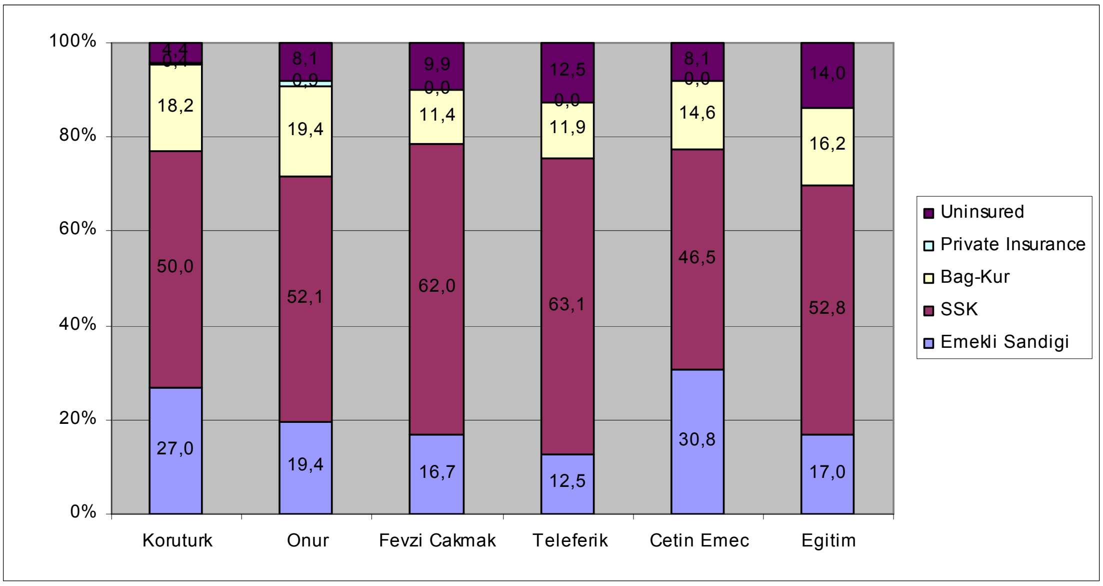


Figure 4. 12. The percentage of social assurance situation for case areas in Balçova district

4.2.2.2. Technical and Legal Situation of Buildings

Sample study which was conducted taking responses from one person in each family in the study area is related with physical state and properties of the families. In this study, sample study was realized in six different neighborhoods and it was gathered together in five titles. These titles are building age, size of the house, ownership situation, value of the building, use of geothermal energy, and the situation of technical infrastructure within the cost of the energy type the family uses.

Building Age

When the ages of the houses in the sample area were examined, it was observed that they could be gathered in the age group of 20 to 25 (see Figure 4.13).

There was an average 22.1 ages of houses in Korutürk neighborhood, 23.5 ages of houses in Onur neighborhood, 22 ages of houses in Fevzi Çakmak neighborhood, 21.5 ages of houses in Teleferik neighborhood, 21.2 ages of houses in Çetin Emeç neighborhood, 24.2 ages of houses in Eğitim neighborhood.

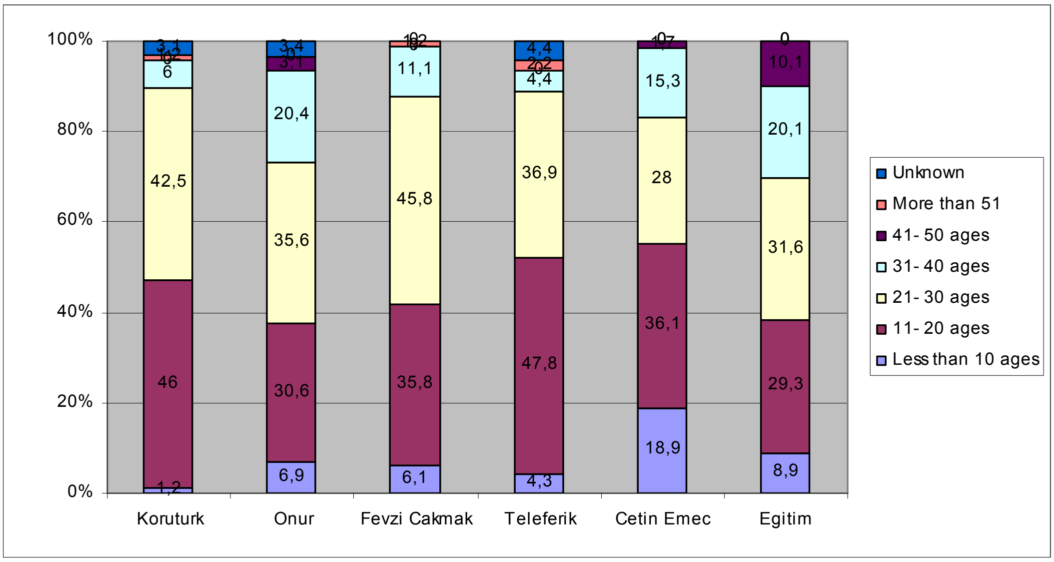


Figure 4. 13. The percentage of building age level for case areas in Balçova district

Building Size

The size of the building has got an important role in GEDHS. "Residence equivalent" concept formed by the firm to construct the geothermal system ($100m^2$) shows difference with the existing housing texture. So the ratio of units used for the purpose of heating with geothermal purposes in the district calculated on the basis of residence equivalent shows in fact how many of the houses use geothermal energy (see Figure 4.14).

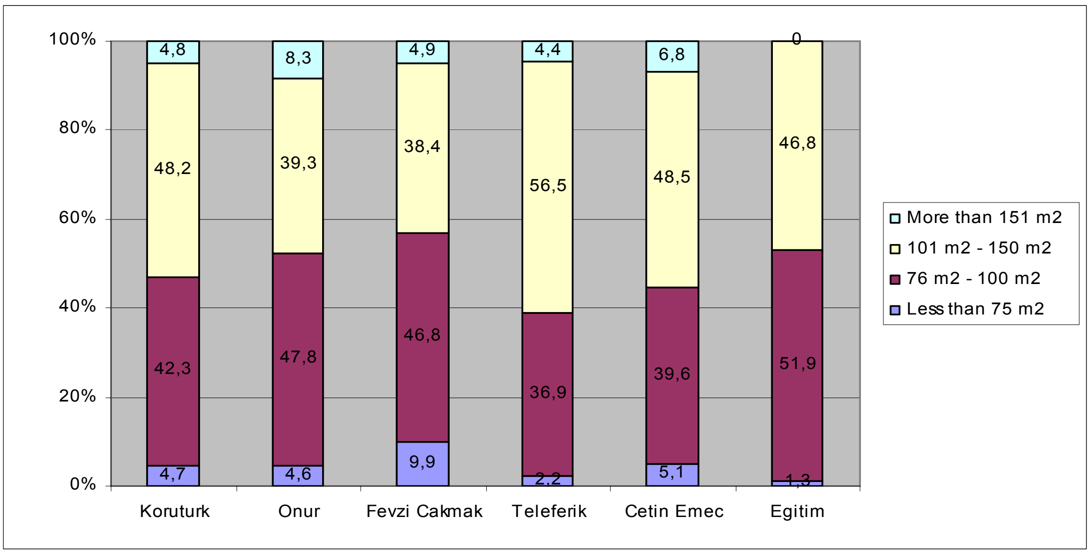


Figure 4. 14. The percentage of building size for case areas in Balçova district

Building Ownership Situation

The fact that the number of building owners in the study area in general is high is a positive indicator in terms of the use of geothermal energy. It is compulsory that the land owner sign a contract with the municipality for geothermal heating for the buildings within the GEDHS in Balçova (see Figure 4.15).

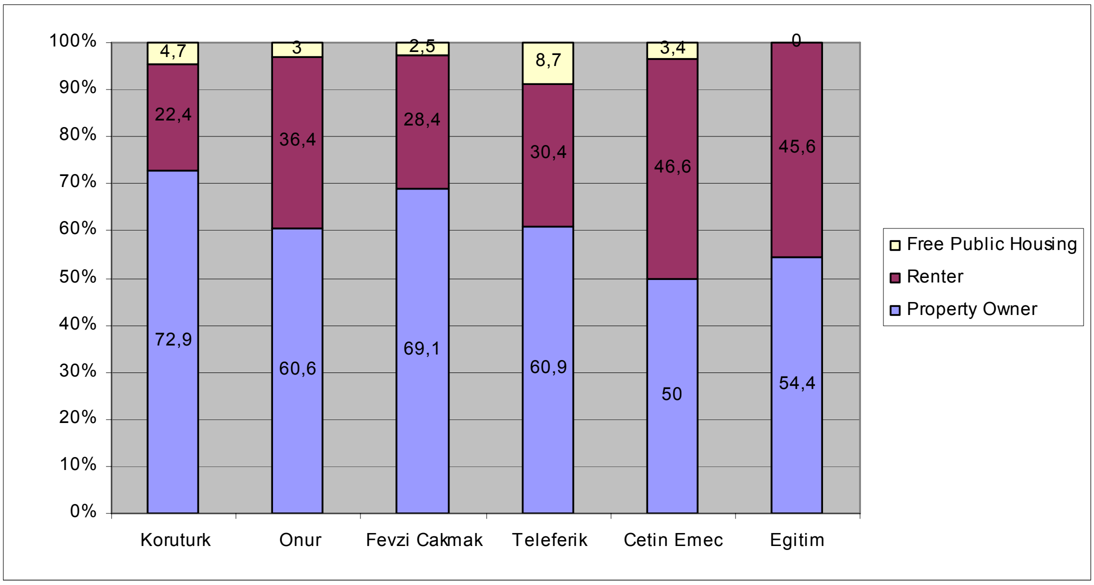


Figure 4. 15. The percentage of building ownership situation for case areas in Balçova district

Building Value

If it is to show the average building values respectively in the sample examination in the study area; average value of building was 18600YTL. in Korutürk neighborhood, 176000YTL. in Teleferik neighborhood, 149000YTL in Fevzi Çakmak neighborhood, 138000YTL. in Çetin Emeç neighborhood, 134000YTL. in Onur neighborhood and 119000YTL. Eğitim neighborhood (see Figure 4.16).

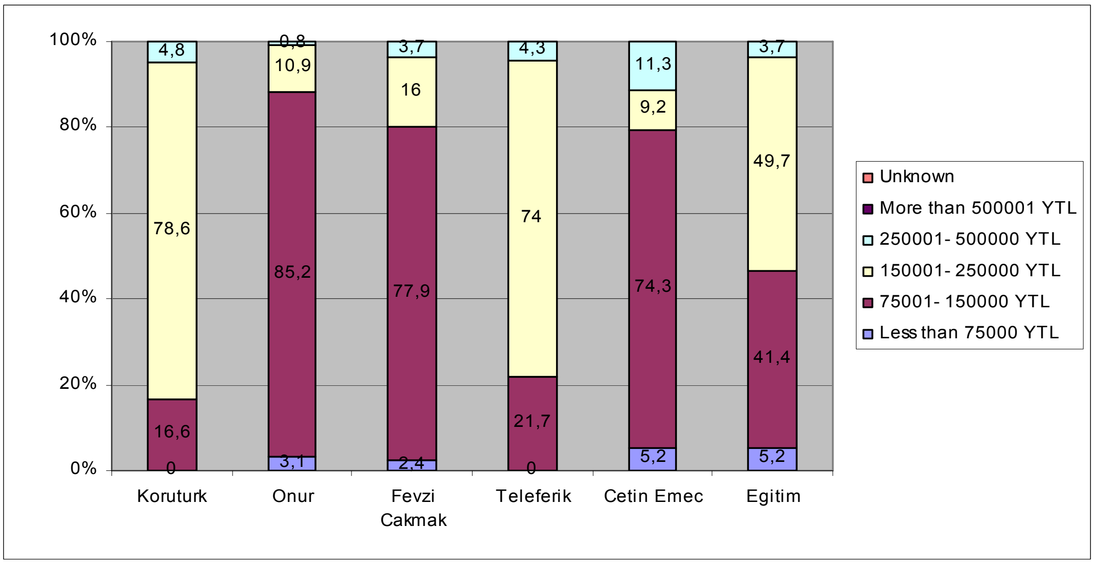


Figure 4. 16. The percentage of building value for case areas in Balçova district

Geothermal Energy Use

In two of the neighborhoods involved in the study area (Korutürk and Teleferik neighborhoods), the structure of GEDHS was already established. It was determined that infrastructure in two more parcels were completed during the course of this study. Although a large portion of the system has been completed, it does not mean that all people living in this district have been connected to the system (see Figure 4.17)

It was observed that 78.8 percent of the people have already been connected to the system. Although there are apartments in a percentage of 21.2 in the same area, there is also a group that does not use geothermal energy. There is a certain group in these two districts that live in an apartment system but not yet have geothermal energy connected to their apartments. The reasons for this will be examined under the next title. The geothermal heating system that can reach to certain areas in Onur and Fevzi Çakmak neighborhoods, we came across users to a percentage level of 34.8% and 32.1% respectively, and those who do not use the system range in 7.6% and 18.5% respectively. There are buildings in which the system has not been installed yet; these constitute the percentage levels of 57.6% and 49.4% respectively.

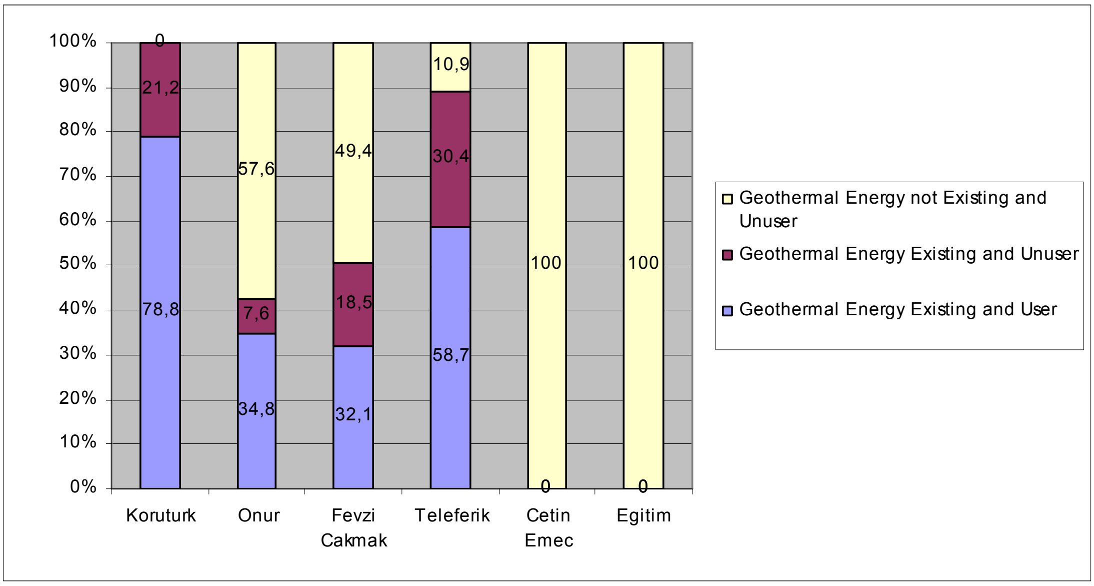


Figure 4. 17. The percentage of geothermal using situation for case areas in Balçova district

Energy Use Types and Costs

A study has been conducted in the study are to see what the average cost is in areas using geothermal energy, and what kind of energy is used and what its cost is in areas not using geothermal energy. As a result of this study, pollutant energy resources are also used in Balçova where clean energy is known to be used, and it has been investigated what sort of outcomes come true when compared with the use of geothermal energy.

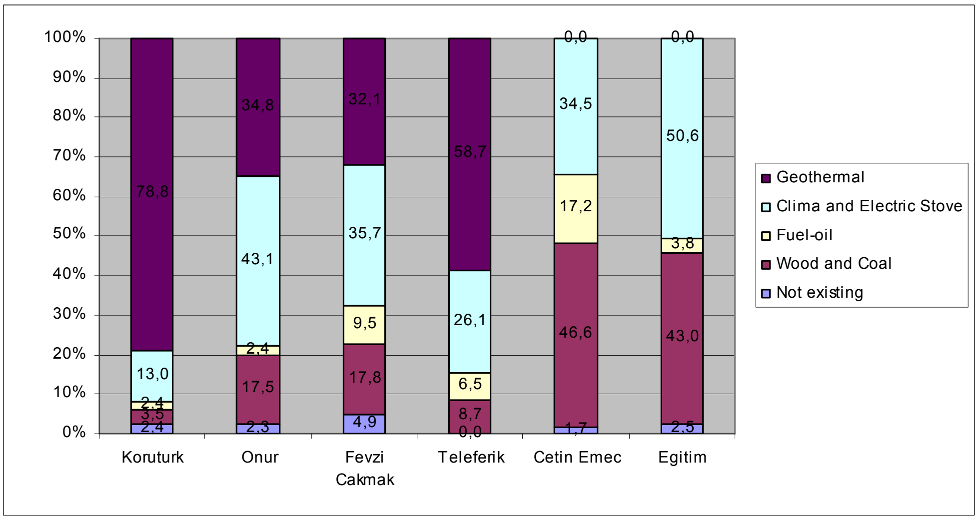


Figure 4. 18. The percentage of energy using types for case areas in Balçova district

Although the use of thermal energy in general is prevalent in the neighborhoods of Korutürk and Teleferik, the use of air conditioners and electric stoves is at a limited level (Korutürk 13%, Teleferik 26%). Air conditioner and electric stove use for the purpose of heating takes the first rank in Onur and Fevzi Çakmak neighborhoods (Onur 43%, and Fevzi Çakmak 35.7%). Geothermal takes the second rank (Onur 34.8%, Fevzi Çakmak 32.1%).

For Çetin Emeç neighborhood, wood and coal takes prominence for heating purpose (46.6%). In the second rank comes air conditioner and electric stove (34.5%) and in Eğitim neighborhood, it was observed electric stove and air conditioner for heating purpose is (50.6%) and in the second rank, coal is (43%), (see Figure 4.18).

A research conducted on heating costs in the study area in general, was determined that the cost of heating with coal or wood was approximately 75YTL/month, heating with fuel-oil is 107YTL/month, the cost of heating with electric stove or air conditioner was 74YTL/month, and finally the cost of heating with geothermal energy was 55YTL/month (see Figure 4.19).

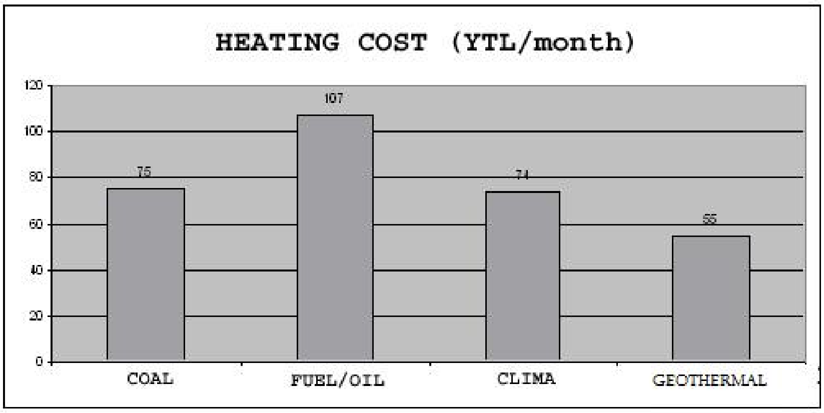


Figure 4. 19. The average heating costs for case areas in Balçova district

In Balçova, which was determined as clean energy district, it was observed that the use of wood and coal for heating purposes is common because the use of geothermal energy has not yet been made common. In the current study, in which advantage was observed for the geothermal energy, it is thought that GEDHS becoming widespread will be preferred in general.

4.2.2.3. Expectations about GEDHS

In the light of information obtained from the sample about residents' general socio-economic situation and the houses they live, emphasis was given to learn whether they have sufficient knowledge about heating, whether they benefit from geothermal energy, and what their expectations were about advantages and disadvantages of geothermal energy.

Corrections were made fewer than three main groups during the current study; in the first group, effort was given to learn the residents' accumulation of knowledge. In this context, the reason of people's moving into the neighborhoods in Balçova and the degree of effectiveness of geothermal energy in this matter, and on what purposes other than heating geothermal energy is used. In the second group formed in this analysis, the state of using thermal energy, and in case thermal energy does not exists, what its effects are in place and economic sense. The state of making use of the installation in the vicinity and using thermal energy for heating purposes in Balçova, effects of it on population, new job opportunities, real estate prices and real estate ownership took place in this group. Finally, positive and negative effects of geothermal energy on the district were examined.

<u>The Reason of Moving in Balçova</u>

Whether or not thermal energy exists among the reasons why the residents moved into this district is an important criterion at least in the sense whether or not people are aware of the existence of the thermal energy. In the framework of this analysis, two different opinions of the interviewers were called upon. In the first part, the cause of their moving into the district was asked without giving any choice, in the second part, they were asked whether the existence of geothermal energy had any effect in their moving into the district.

Taking part in the first section for the causes of moving into the district, nine different reasons were thought of. These choices were formed depending on their responses; real estate prices or rents being low, existence of geothermal energy, relatives or friends living in the vicinity, existence of natural beauty, and the purpose of investment.

In a speculation in which a person can give more than one answer, the choices that there are different natural aspects in six different neighborhoods, relatives and friends being in the vicinity and the district being close to business centers came to the fore. While geothermal energy existed at certain degrees in neighborhoods of Korutürk (21.2%) and Teleferik (19.6%), it came at the back plan in other neighborhoods; Onur neighborhood is being at the 5th rank, Fevzi Çakmak neighborhood being at the 8th rank (see Figure 4.20).

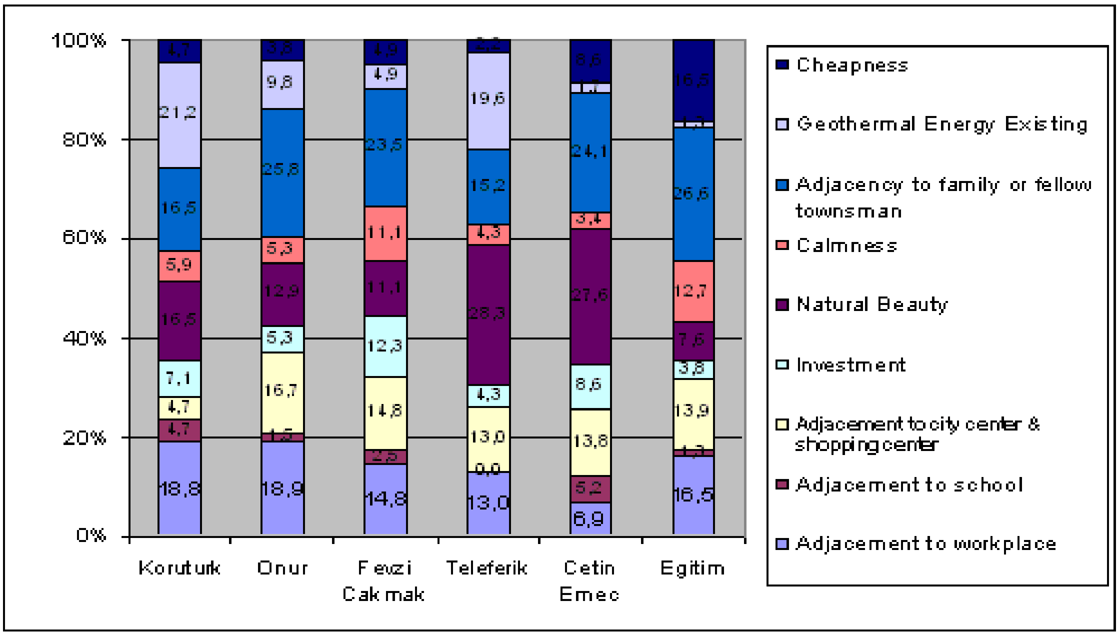


Figure 4. 20. The percentage the reason of moving in Balçova district

Evaluating the results of this study, it was found that the people living in this district moved here for other reasons rather than the existence of geothermal energy but they concluded that where he geothermal heating system was installed they considered it as the main reason for their existence. Step by step progression of this system, which has been in operation since 1997, the fact that the starting area is Korutürk neighborhood and that the residents of the district considered geothermal energy as the main cause of their existence can be considered a development in a short time interval.

Willingness to Moving out

Whether or not there is a relation with geothermal energy among the causes that the residents of this district wanting to move out of this district also formed the speculation of this study (see Figure 4.21).

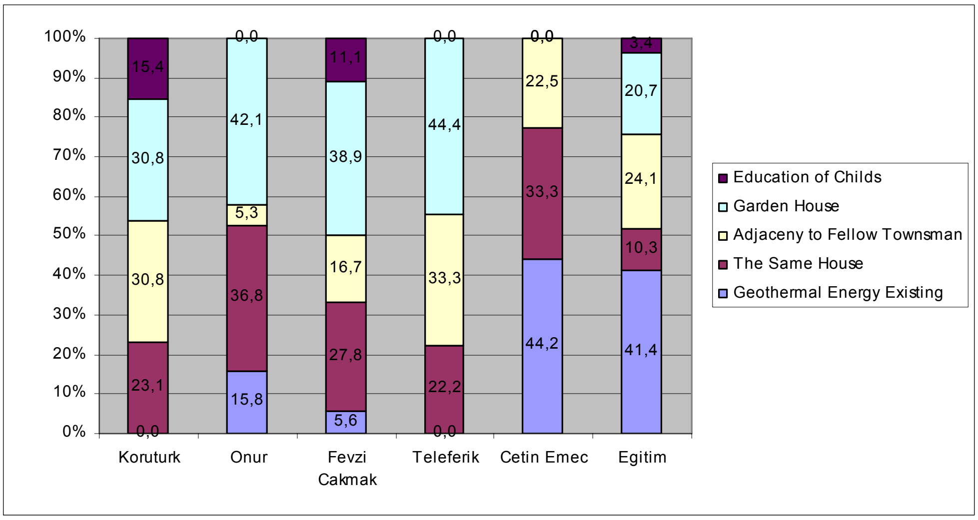


Figure 4. 21. The percentage of willingness to moving out from Balçova district

The Utilization Levels of Geothermal Energy

According to the sample, the subject of how much of the ways of making use of geothermal energy is known again can be accepted as the way of adopting and participation geothermal energy use can be used as a criterion. Knowledge and interest of the residents can be used as a base for studies to be conducted in this district.

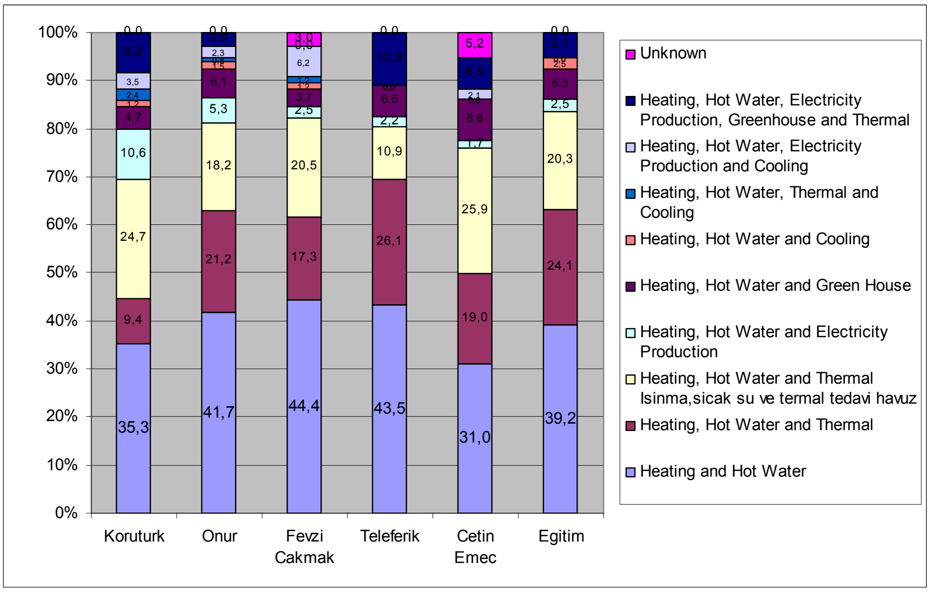


Figure 4. 22. The percentage of knowledge about utilization of geothermal energy in Balçova district

In this context, in the study conducted in six neighborhood, people' statements were evaluated without giving any clues and groping was made according to the replies obtained. In the light of results obtained, the people who do not have any information about geothermal studies were very limited in number (see Figure 4.22).

Utilization of Geothermal Energy Facilities

In the current study, to what extend the existing geothermal installation is utilized by the resident has been examined. Interest of the public in geothermal energy would be beneficial in that local and national agents will follow the studies and the people will get foreknowledge through these agents (see Figure 4.23).

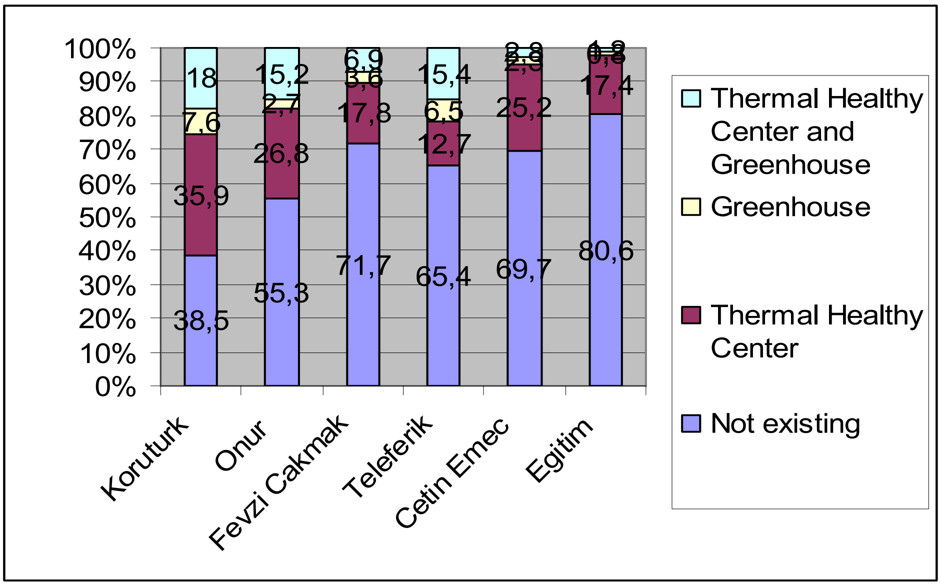


Figure 4. 23. The percentage of utilization of geothermal energy facilities in Balçova district

It was observed that residents made use of thermal installation in the vicinity at a limited level for building heating, hot water use in houses. The cause for this limited usage of the geothermal energy might be that local and national press did not show sufficient interest in the matter. The fact that informing people is not sufficient could be an important point in the present situation.

The Changing of Population Structure

People answered differently to the question whether or not there was any change in population, work, employment, real estate ownership and value after geothermal energy had begun to be used in the district. First, as a common opinion it was stated that there was an increase in population and real estate prices. In other choices, the differences in the area cause people to give different answers. In neighborhoods where thermal energy is used in buildings (Korutürk, Teleferik, Fevzi Çakmak and Onur neighborhoods) answers in relation with the increase were high. In Eğitim and Çetin

Emeç neighborhoods, it was observed that there occurred not much change (see Figure 4.24).

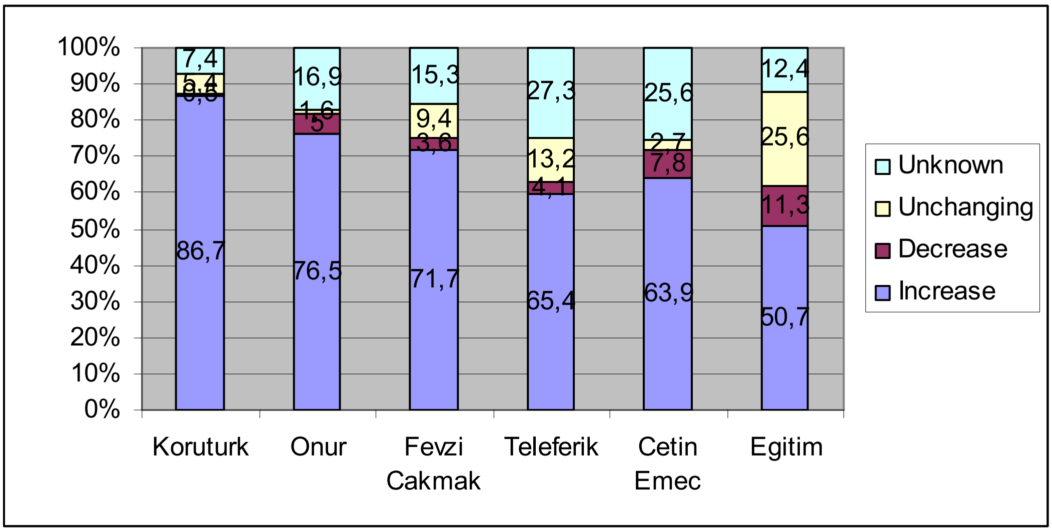


Figure 4. 24. The percentage of the changing of population in Balçova district

It was learned clearly that real estate prices increased after the use of geothermal energy in Balçova district (see Figure 4.25).

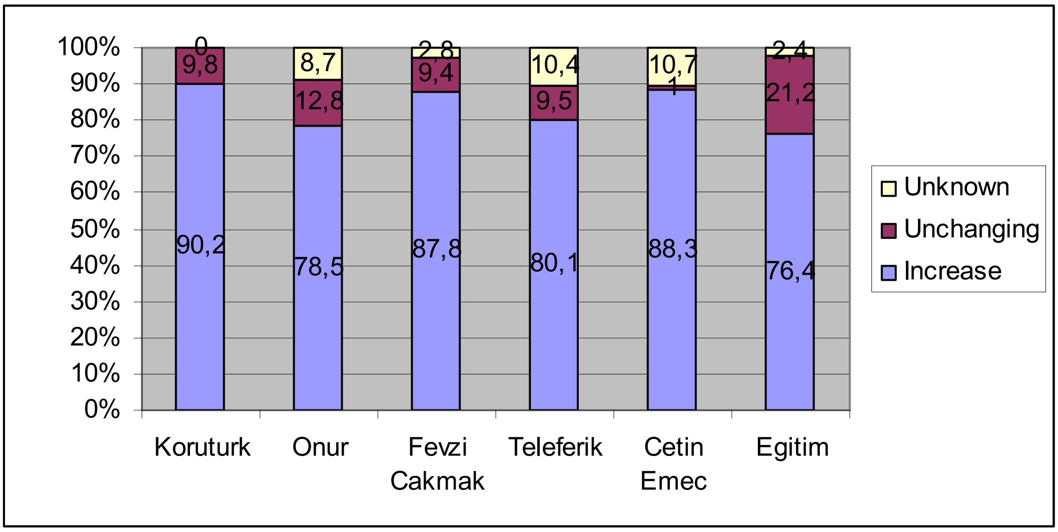


Figure 4.25. The percentage of the change in property values in Balçova district

With the use of geothermal energy in the district, very few positive answers were observed on the subject of employment increase and new job opportunities in Balçova district in general. New job opportunities did not occur at a ratio of 55% to 80% (see Figure 4.26). Of the very few positive answers, much reflected the situation was not due to the geothermal energy but the new shopping centers opened recently in the district.

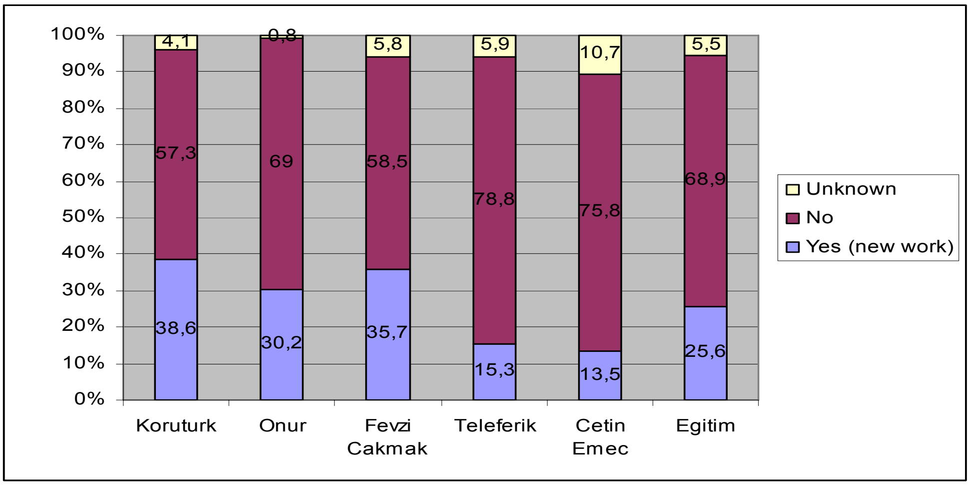


Figure 4. 26. The percentage of the change of new work and employment situation in Balçova district

It was observed that there was an increase in general in the title deed ownership after the geothermal energy use had begun to be used (see Figure 4.27).

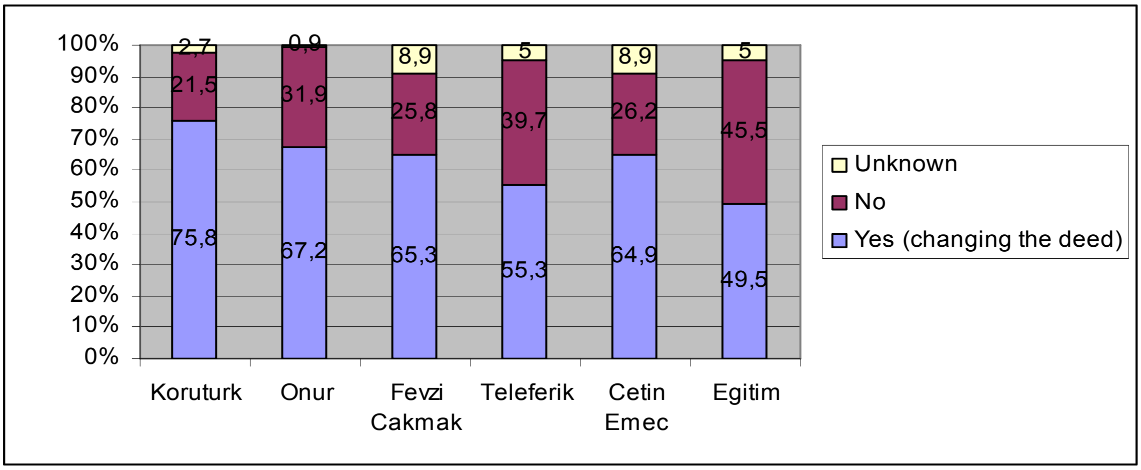


Figure 4. 27. The percentage of the change of deed ownership in Balçova district

The Positive Effects of Geothermal Energy

People living in the district touched on the issue that problems have decreased after the use of geothermal energy. Especially that air pollution disappeared, problems about business matters eased, houses begun to be heated more easily and the investment plans in the district were brought to the fore.

After geothermal energy came to the district, different results were reached on the subject of positive improvements among the neighborhoods: although positive results occurred in the decrease in air pollution in the neighborhoods of Korutürk (66.3%), Onur (56.4%), Fevzi Çakmak (48.9%) and Teleferik (68.8%), no change was observed in the neighborhoods of Çetin Emeç (48.9%) and Eğitim (59%), (see Figure 4.28).

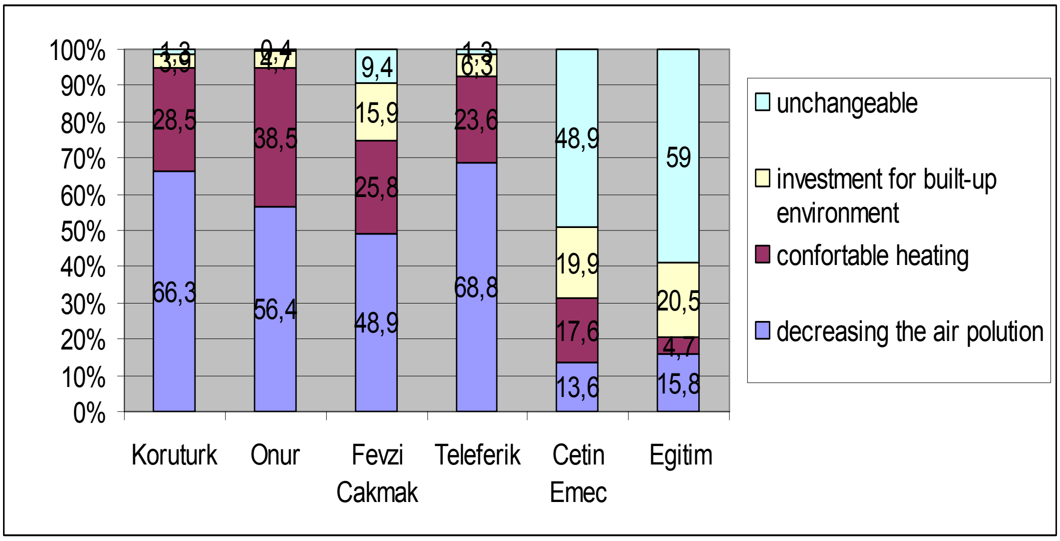


Figure 4. 28. The percentage of the positive effects of geothermal energy in Balçova district

The Negative Effects of Geothermal Energy

According to the result of the survey, seven different problem titles are seen in the study area in general. These are noise during well boring, complaint about bad smell around wells, health problems of the people, problems arising from heating, shaking during boring, urban infrastructure problems and complaints about the construction company.

In general of the study area, especially during infrastructure work, infrastructure problems on the existing roads stands as a big problem. There seems to be approximately 50% infrastructure problem in each neighborhoods (see Figure 4.29).

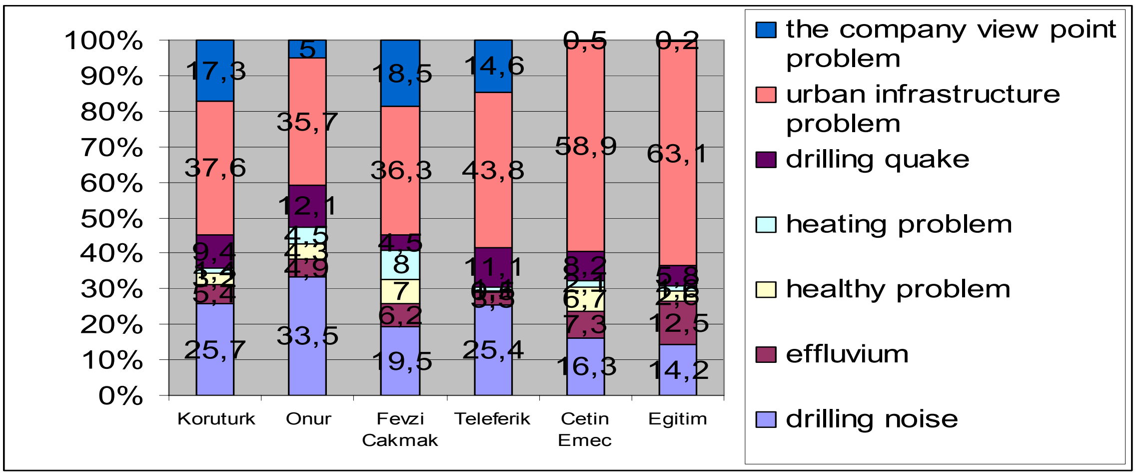


Figure 4. 29. The percentage of the negative effects of geothermal energy in Balçova district

4.3. The Land-Use Data Analysis of Balçova Case Area about Geothermal Energy Integrated Urban Land-use Planning

Land-use was the key influence in the practical developmental potential in those countries where environmental regulation was taken seriously and where public opinion held sway in policy formation (Pasqualetti 1986). In geothermal context, wrong land-use analysis and zoning, user energy density, building and parcel ration, inconsistent of residence equivalent and building ratio, parcel ownership and parcel size and vacancy variables (independent variables) are related with land-use data analysis part.

4.3.1. Land-use Analysis of Geothermal Energy and Previous Researches

Exploration, development and utilization of a geothermal field can have a significant consequence on the physical environment surrounding the resource. Opposition of communities often lies on the sitting of geothermal projects because of conflict in their desired resource/ land- use for the area and their adjacency to a potentially harmful project. The acceptable sitting of the project in turn is dependent on the adoption of a zoning plan agreed by all sectors. The zoning plan which is used for buffer areas around the resources, prescribes the rational utilization of land and the rational exploitation of natural resources.

Phase two tests the hypothesis that land-use would be a more important factor in direct usage of geothermal energy than in electrical applications because the resource must be not only developed in place, but also used in place. Researcher at nine sites in four western states validates the hypothesis and led to the following conclusions:

- Land-use characteristics (juxtaposition of allowable population densities and the temperatures of geothermal water) often play the deciding role in the success or failure of a geothermal development project.
- Land-use evaluation can be used as a screening mechanism in the identification of those sites where institutional conditions of land-use (e.g. land ownership, zoning) are most compatible to geothermal development.
- Sites identified by land-use evaluation to be most suitable should be given highest priority for development.

- The land-use analysis should emphasize user energy density, zoning, parcel size, parcel vacancy, and parcel ownership.

4.3.2. Data Collecting Process

Of these six neighborhoods that are within the study area, Teleferik and Korutürk neighborhoods are the ones that have the infrastructure completed which could allow the residents to use geothermal energy for the purpose of building heating. Fevzi Çakmak and Onur neighborhoods have got the system partially, while in Eğitim and Çetin Emeç neighborhoods the system has not yet been installed (see Figure 4.48).

In the current study, each building that stays in the study area was examined through inventory records and was transferred into the digital medium using SPSS statistical program. With the help of AutoCAD mapping program, square meter calculations were made for the study area using “available maps” that were drawn for the same area by the Metropolitan Municipality of İzmir. With the help of energy calculation obtained from İzmir Geothermal Energy CO, the amount of energy reaching the buildings was determined. This data was compared within Geographical Data System (CDS) using ArcGIS software program and spatial results were obtained.

4.3.3. The Evaluation of the Results

Spatial analyses made in these neighborhoods in general were realized in ten different categories on two areas with and without geothermal system. These categories can be stated as follows:

- Number of Floors,
- Number of Units in Buildings,
- Population Ratio in Buildings,
- Land Value,
- Building Unit Value,
- Existing Building and Residence Equivalent Ratio,
- Land Ownership,
- Office and Residence ratio (Mixed land-use),
- Land Block Density (User Energy Density),
- Heat Load Density of Building.

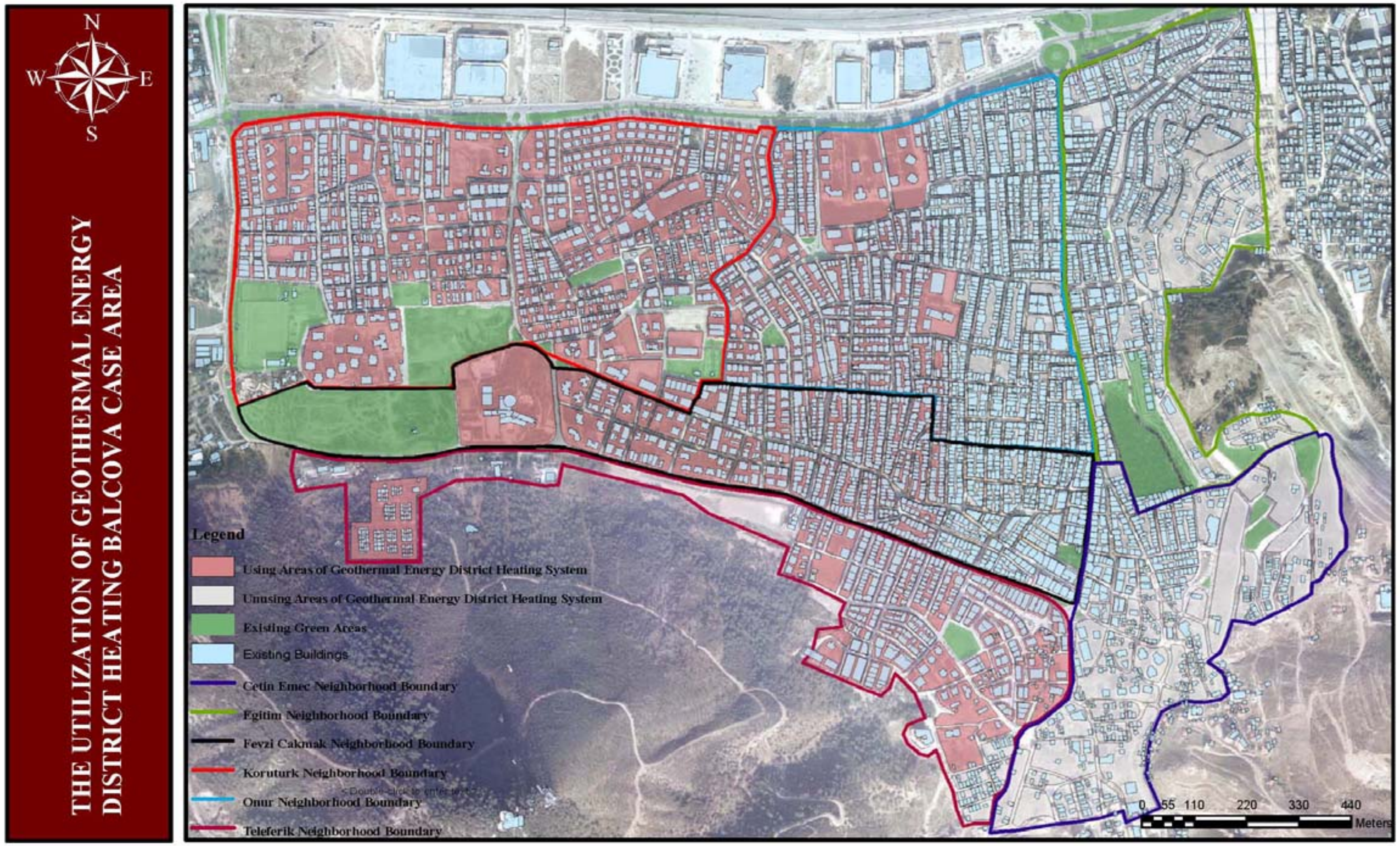


Figure 4. 30. The Geothermal Energy Utilization Areas in Balçova district

Number of Floors

General information about this analysis was obtained in the light of data taken from İzmir Geothermal Corporation. According to these data, it was reached to the information that there were approximately two flats on each floor of a building in the existing building texture during infrastructure studies. In order for these infrastructure studies to be conducted in the best way and with the minimum cost, there is an area of eight flats for each building block according to the information obtained from the authorities. For this reason, a building must have at least for floors within the least amount of space. Buildings having more than four floors seem suitable for geothermal infrastructure costs while these costs increase for buildings having less than four floors.

In the study conduct in six neighborhoods in the study area, the area was divided into two categories; the one using the geothermal energy for building heating and the one not using. At the end of this analysis, within the total study area consisting of 486 blocks of parcel, the number of construction blocks of parcels that use geothermal energy and surpassing four floors is 172. The total of these areas was 528028m^2 (see Figure 4.31, see Figure 4.32).

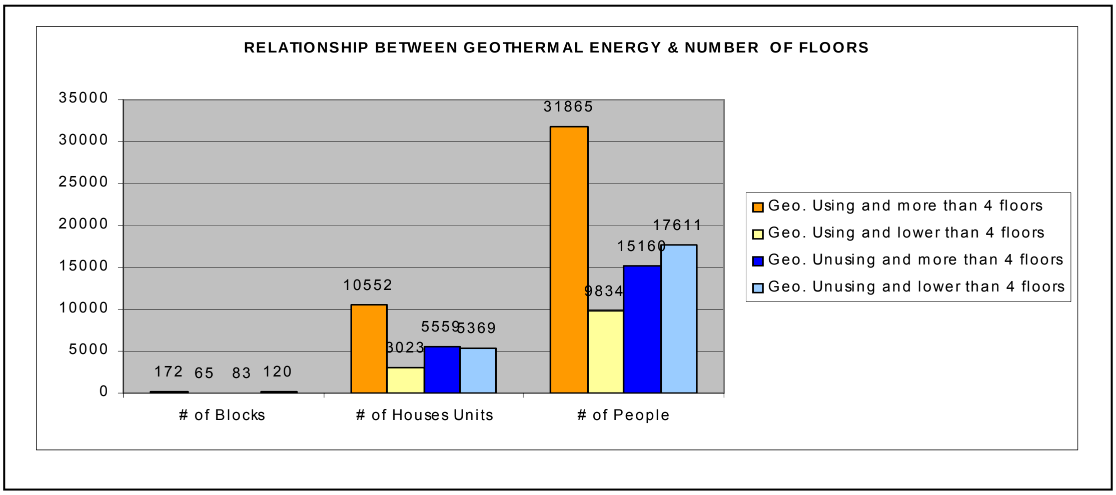


Figure 4.31. The relationship between the number of floors and geothermal energy utilization in Balçova district

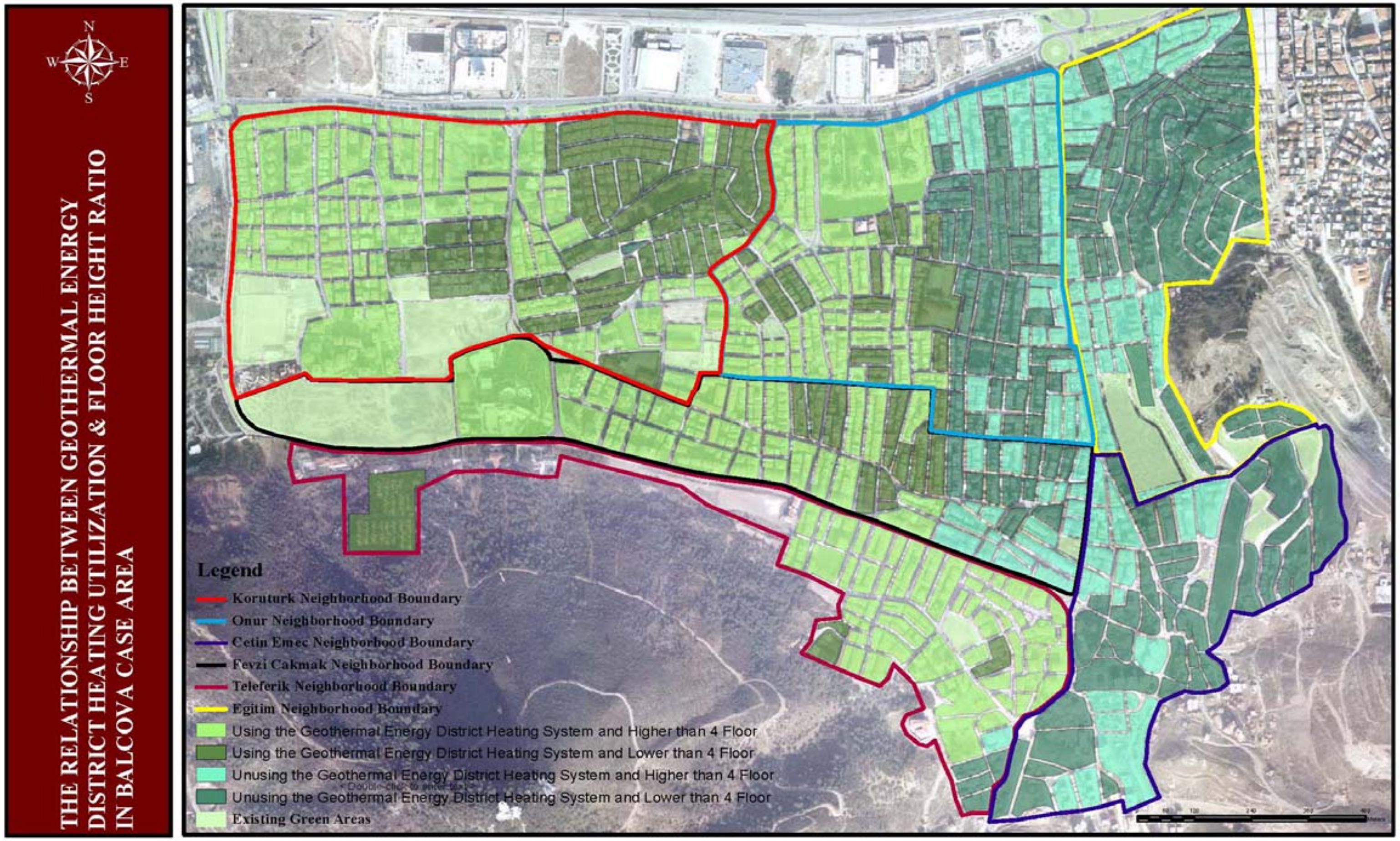


Figure 4. 32. The Relationship between the number of floors and geothermal energy utilization in Balçova district

Number of Units in Buildings

The analysis parallel to the story height analysis was made to show the relationship between the number of units in a building and the effectiveness of the use of thermal energy. During the preparation for geothermal infrastructure, that there is a usage of eight flats in a building is a sufficient datum obtained from authoritative units as a valid datum for the effective use of geothermal energy in that building.

In the land-use study, the total number of the units in building of parcel on which there were buildings with more than eight units is 64. In the same area, the number of units in buildings of parcel on which there were buildings with less than eight units is 173. In the whole of the area except for the buildings especially on Mithatpaşa Street and in Teleferik neighborhood eight-story threshold could not be achieved. As for the areas in which geothermal energy was not used, the number of units in buildings on which there were buildings with more than eight floors was 27 and that of those with less than eight floors was 176. Looking at the area in this point of view, depending on the number of units in the buildings, it is not possible to mention that geothermal energy can be used effectively even in areas where potential system will be set up (see Figure 4.33, Figure 4.34).

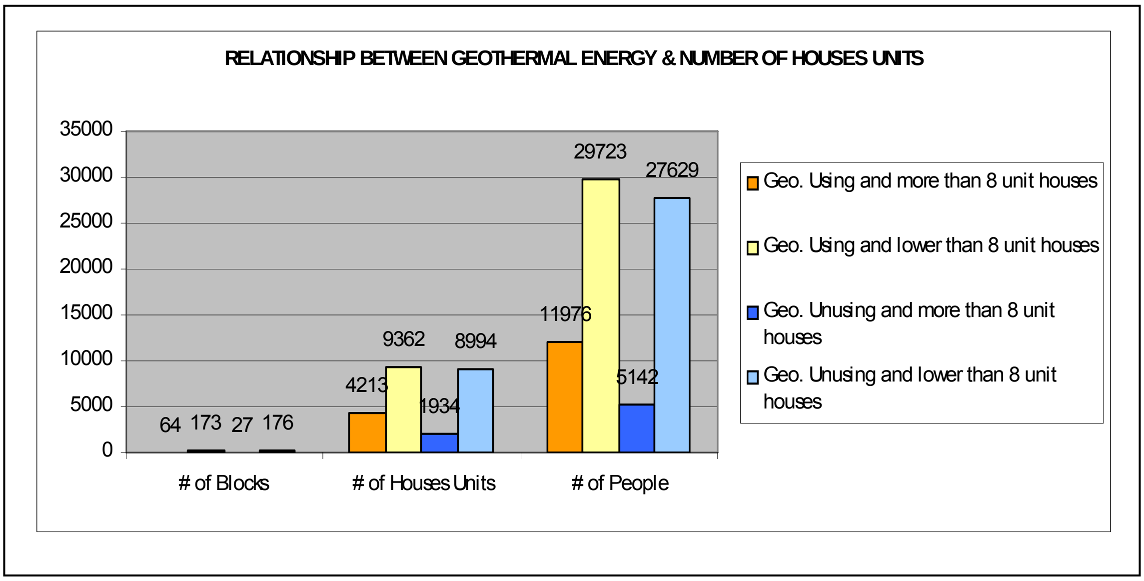


Figure 4. 33. The relationship between the number of units in buildings and geothermal energy utilization in Balçova district

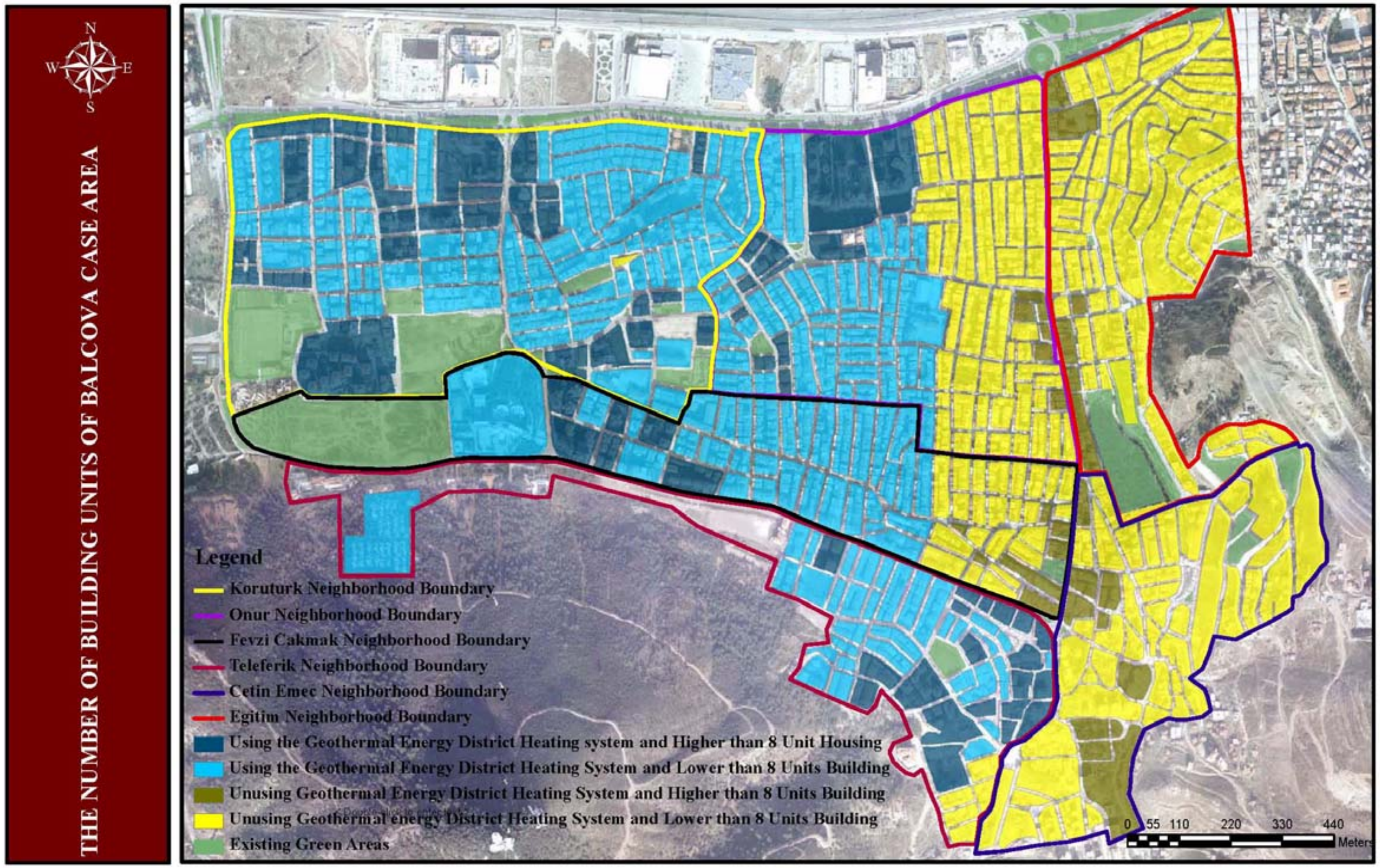


Figure 4. 34. The Relationship between the number of units in blocks and geothermal energy utilization in Balçova district

Population Ratio in Buildings

In neighborhoods within the study area, population ratio at the basis of building block of parcel was obtained during one-to-one area study, from “family health record forms” of Health Group Presidency in Balçova and the number of household living in each building was obtained.

In previous studies conducted on socio-economic effects of geothermal energy, especially in non-developed countries and in African countries, and in countries in South America, the section of population was calculated because the family sizes in these countries are over the usual number (Mariita 2002). In Balçova study area, on the other hand, as it was observed from the previous socio-economic data analyses, family sizes are under even Turkish standards. So in terms of population density, Balçova does not seem as an appropriate district for geothermal energy use (see Figure 4.35, see Figure 4.36).

In the study of population ratios, number was determined as standard families with four-members and on the basis of building, attention was given on how many people live on a unit of block of parcels.

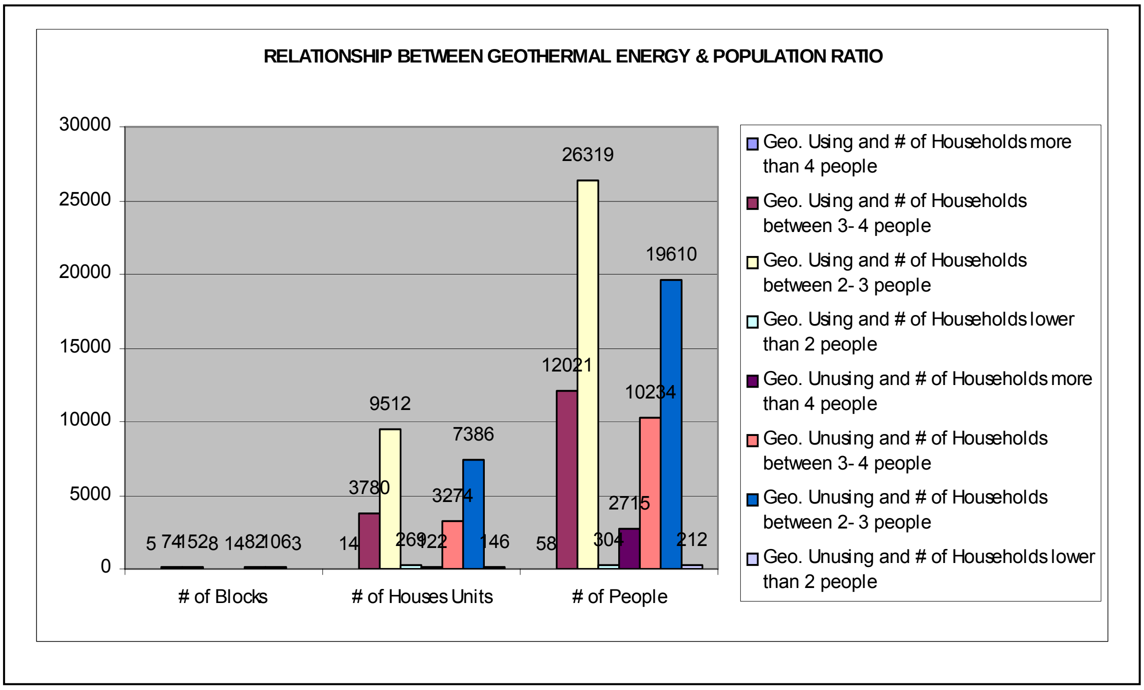


Figure 4. 35. The relationship between population ratio and geothermal energy utilization in Balçova district

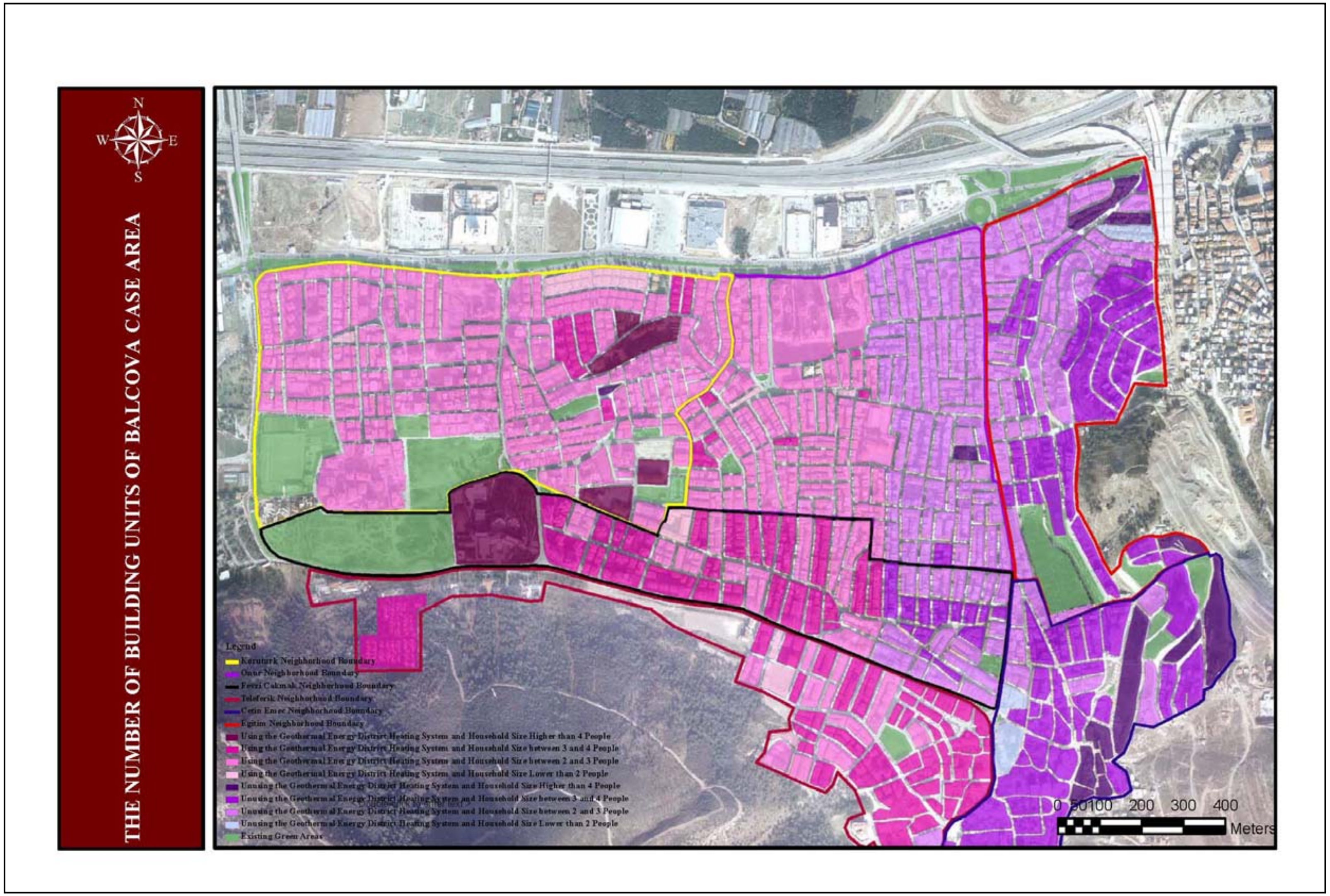


Figure 4. 36. The Relationship population ratio and geothermal energy utilization in Balçova district

Land Value

Analysis for land value was realized depending of data obtained from Balçova Municipality Real Estate Department. Here we accepted “plot market value” while it was accepted as plot value elsewhere, and the values were gathered together as of the date geothermal energy infrastructure works started and the energy itself was started to be used for house heating. In the light of this data gathered, the results obtained were categorized in five criteria. These values obtained on the basis of square meter were categorized as – 100 YTL/m^2, 101- 200 YTL/m^2, 201- 300 YTL/m^2, 301- 400 YTL/m^2 , 401- 500 YTL/m^2 and 501 +.

According to this data, market values of plots in areas using geothermal energy were included in four groups. 74 blocks of parcel took place in 201- 300 YTL/m^2 group, 74 blocks of parcel in 301- 400 YTL/m^2 group, 115 blocks of parcel in 401- 500 YTL/m^2 group and 31 blocks of parcel in 501 + YTL/m^2 group. When status of these in the area is examined, it was observed that the prices of those situated on the main streets increased and as proceeded inner parts they decreased. As of the date geothermal energy system was set up, no relationship was determined between the changes in real estate prices (see Figure 4.37, Figure 4.38).

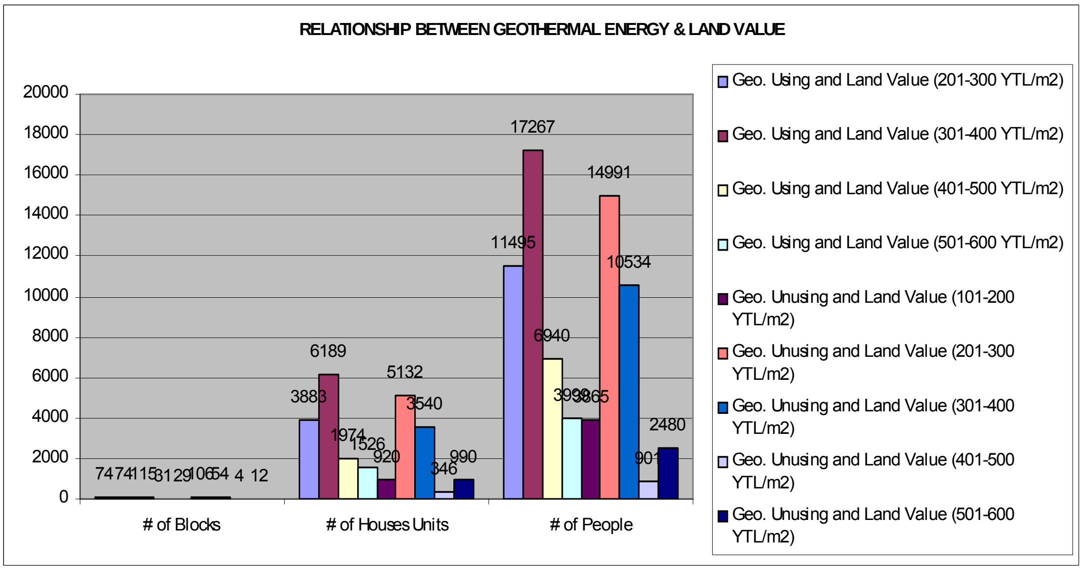


Figure 4. 37. The relationship between land value and geothermal energy utilization in Balçova district

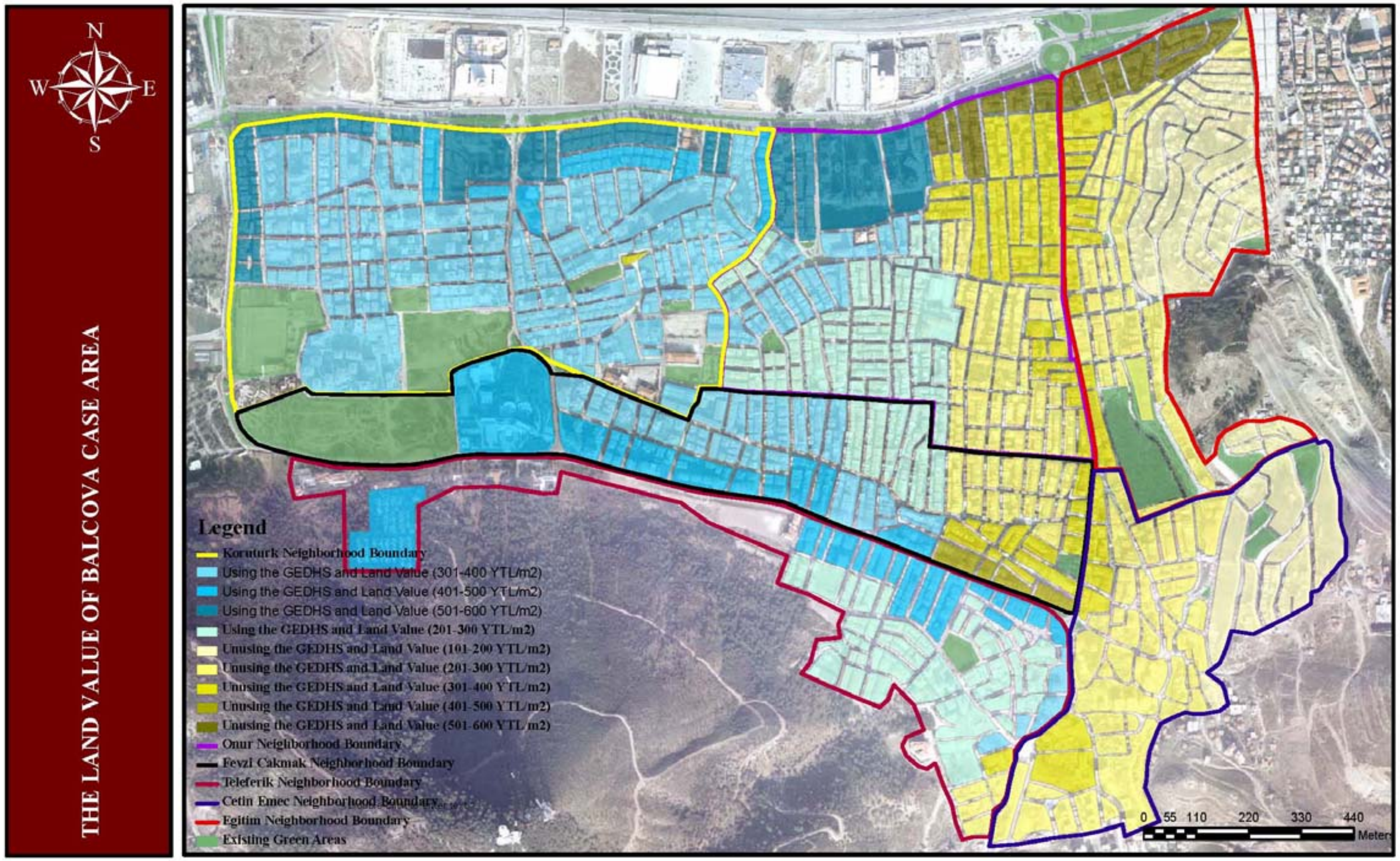


Figure 4. 38. The Relationship between land value and geothermal energy utilization in Balçova district

Building Unit Value

In the light of analyses, through market value analysis work similar speculations were made. The only difference in these analyses was that value determinations related to building unit values were made through residents of the buildings and real estate agents in the vicinity.

When we examinee blocks of parcels on the basis of real estate prices in areas using geothermal energy, in 29 blocks of parcels the following range of prices were observed; in 29 blocks of parcel 75001- 150000 YTL price interval, in 144 blocks of parcel 150001- 250000 YTL interval, in 56 blocks of parcel 250001- 500000 YTL interval and in 7 blocks of parcel 500000 YTL + unit prices. And in seven blocks of parcels, 50000YTL+ unit price was observed. In the area where geothermal energy was not used, in 26 blocks of parcels, units with prices less than 75000YTL were present. Other price intervals observed were as follows; in 116 blocks of parcels 75001- 150000 YTL, in 60 blocks of parcels 150001- 250000 YTL and in 2 blocks of parcels 250001- 500000 YTL. In this study of analysis, it was observed that unit prices were higher in areas where geothermal energy was used (see Figure 4.39, see Figure 4.40).

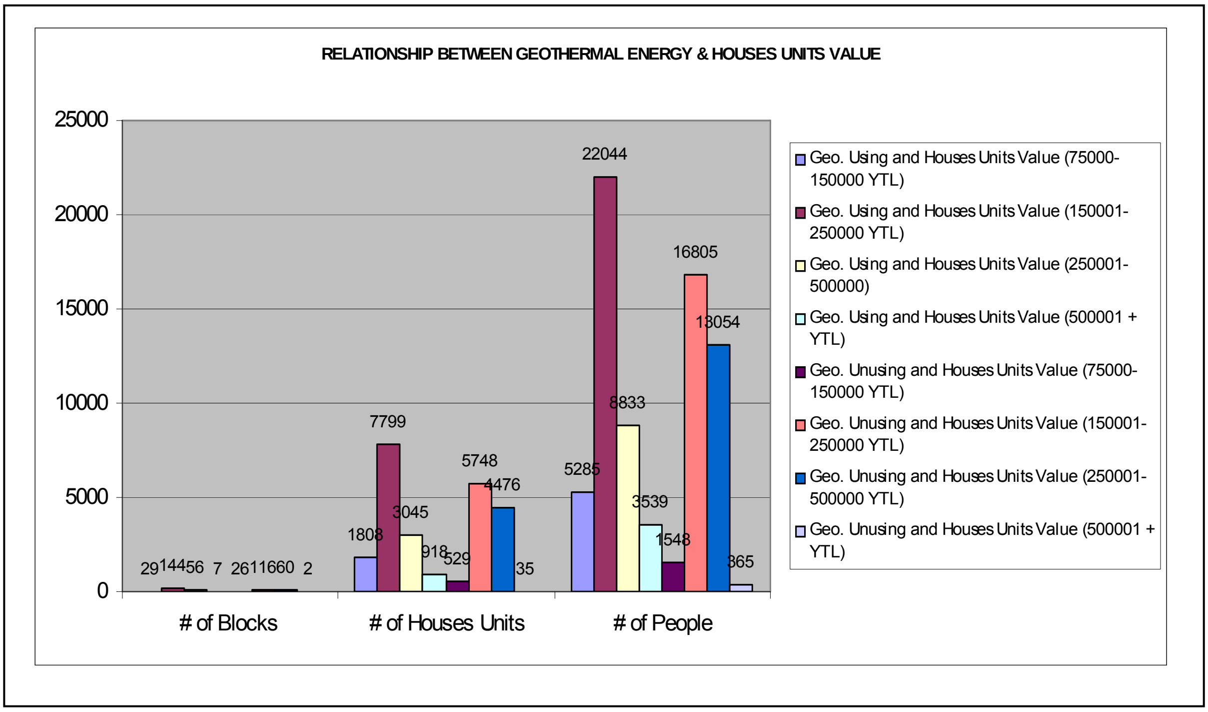


Figure 4. 39. The relationship between building unit value and geothermal energy utilization in Balçova district

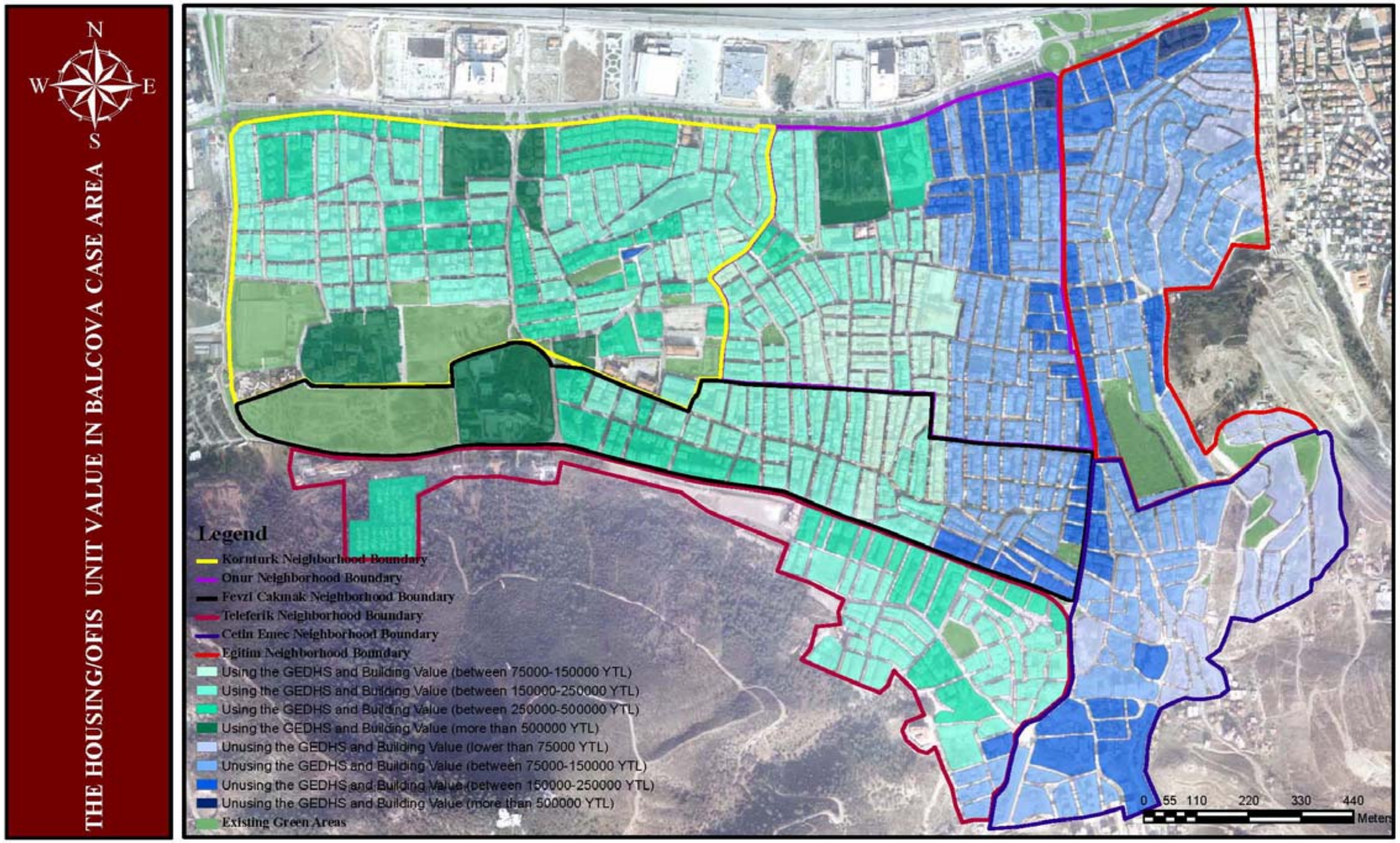


Figure 4. 40. The Relationship between building value and geothermal energy utilization in Balçova district

Existing Building and Residence Equivalent Ratio

The analysis was determined as the main category in field studies. During geothermal infrastructure works within the study area, residence equivalent m^2 was determined by the related authority as 100YTL. GEDHS connected to the buildings on this value. The amount of energy used in $100m^2$ was found to be 5240kcal/year. According to the data of İzmir Energy Corporation, a difference was found between the equivalent and the number of existing building, and it was concluded that there could be certain problems arising from the size of building.

In studies of analysis witting the borders of the area, 24 blocks of parcels were determined on which the number of existing buildings was over the residence equivalent number in areas using and not using geothermal energy. It was observed that these buildings were situated in the center part of the area. It was observed that on 181 blocks of parcel residence equivalent was over the existing number of building units and on 34 blocks of parcels residence equivalent number was over twice of the number of existing building. In areas where geothermal energy was not used, on 58 blocks of parcels, the number of existing building unit was over the number of residence equivalent, on 142 blocks of parcels the number of residence equivalent was over the existing number of buildings and on 5 blocks of parcels, the number of residence equivalent was over twice of the number of existing building (see Figure 4.41, see Figure 4.42).

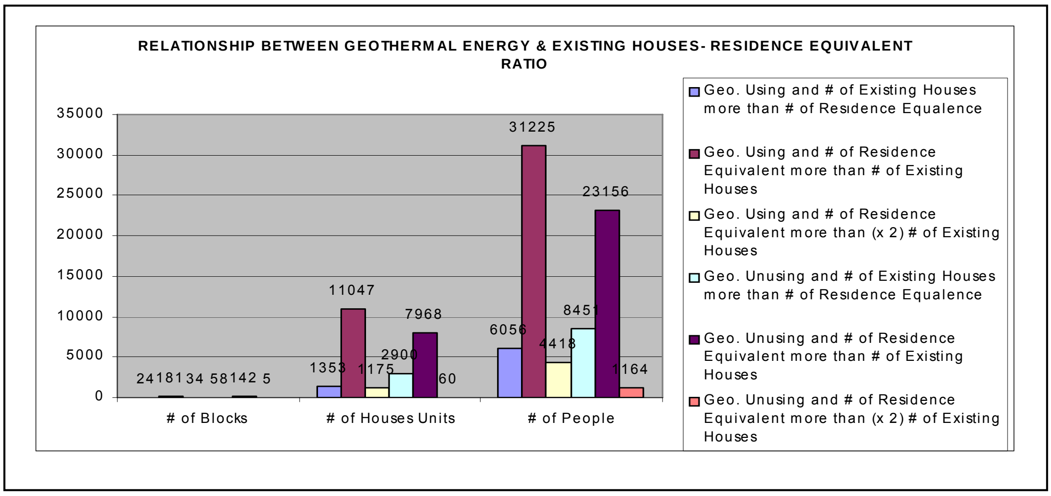


Figure 4. 41. The relationship between existing building.-residence equivalent and geothermal energy utilization

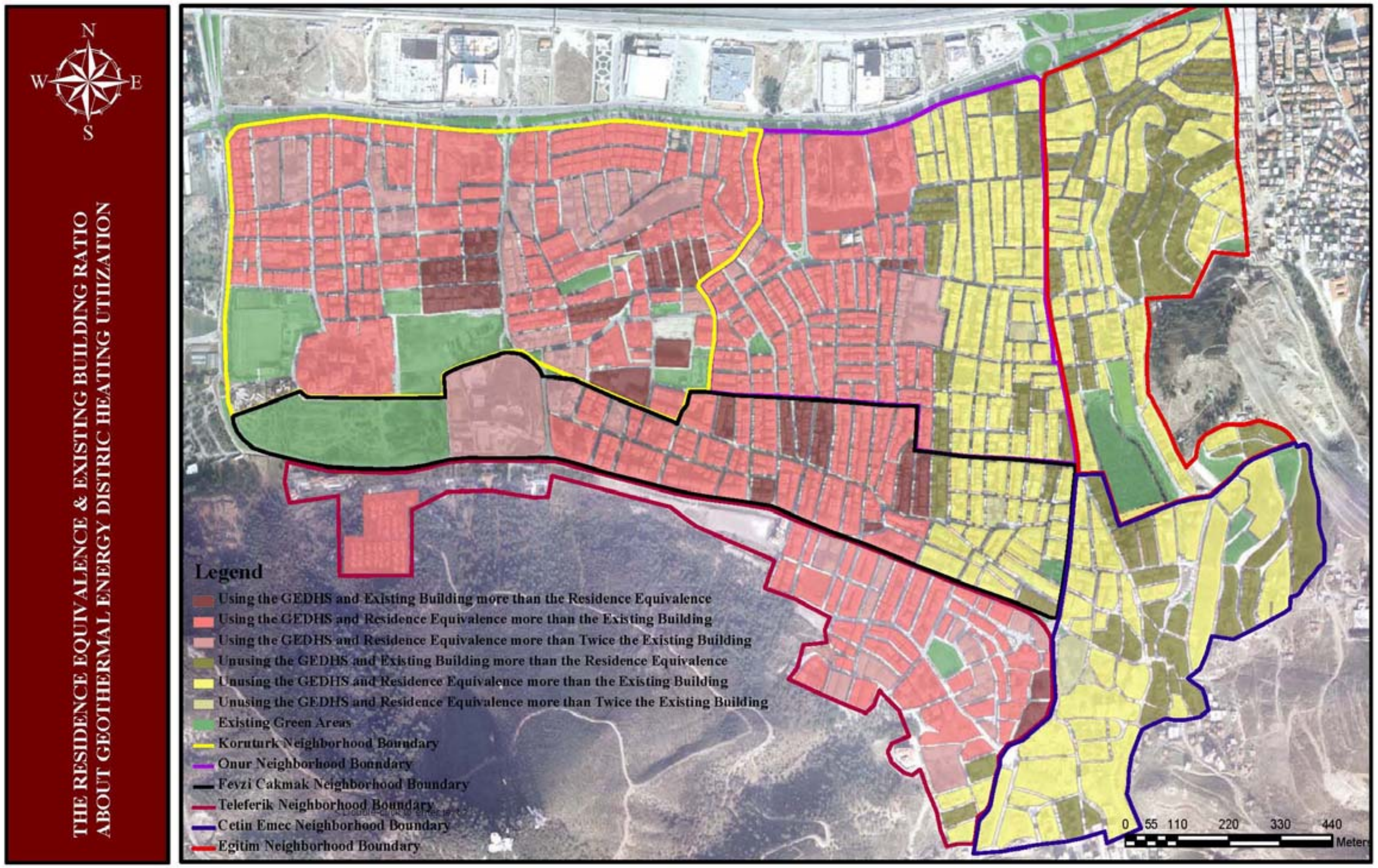


Figure 4. 42. The Relationship between Existing Buildings and Residence Equivalent Ratio in Balçova district

Land Ownership

On the subject of land ownership analysis Pasqualetti stated the relationship between land ownership and geothermal energy, and included land ownership in geothermal energy studies as a variable (Pasqualetti, 1980). According to Pasqualetti, in areas where geothermal energy is potentially exists, there is the reality that the public land ownership is preferred to the private land ownership. The purpose here is the wish to realize expropriation of the property in private hands and so draw the costs down. That the land ownership belongs to public institutors and establishment is an important criterion in this context.

It was determined that almost in all the case land ownership was in private hands. Although in small amount public land ownership by the Ministry of Finance and Balçova Municipality was present. In areas using and not using geothermal energy, there were 429 building which were privately owned and their total area was 1293296m^2. Balçova municipality owners have 46 blocks of parcels in a total area 96324m^2. The Ministry of Finance owns 11 blocks of parcels in an area of 51819m^2 (see Figure 4.43 and see Figure 4.44).

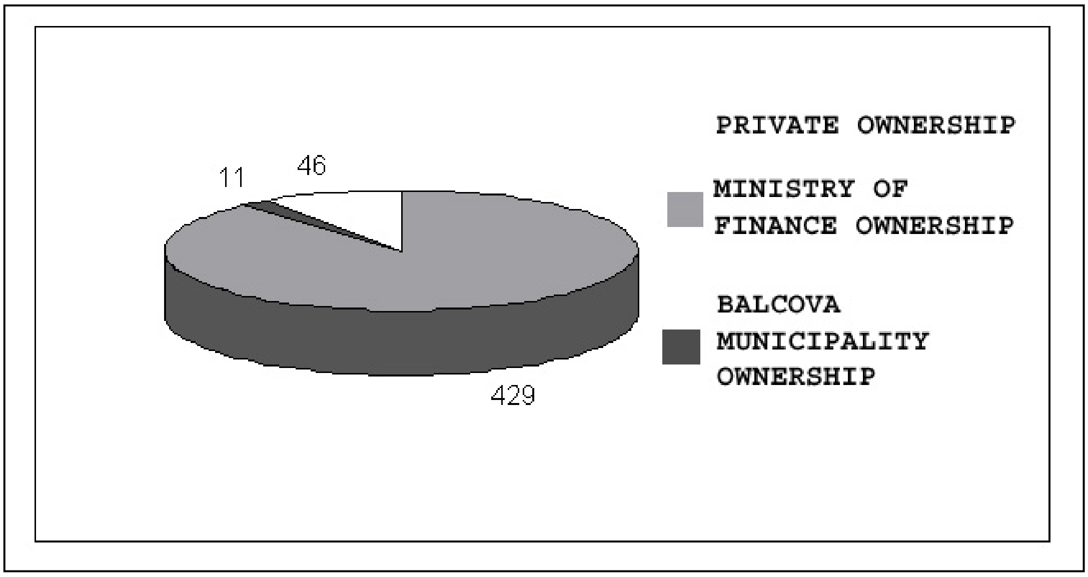


Figure 4. 43. The relationship between land ownership and geothermal energy utilization in Balçova district

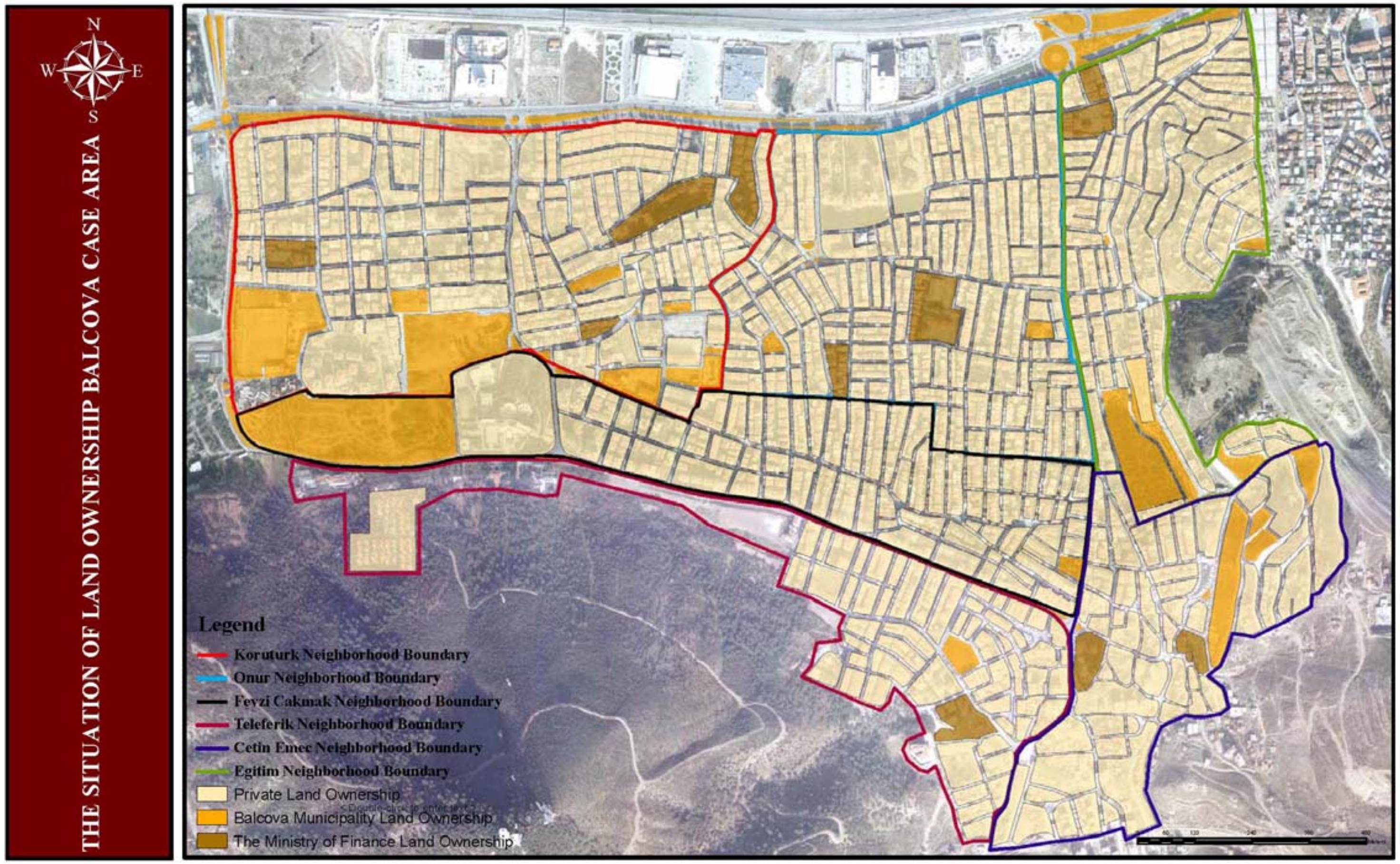


Figure 4. 44. The Relationship between land ownership and geothermal energy utilization in Balçova district

Office and Residence Ratio (Mixed land-use)

This analysis came into being during the study on general energy productivity in California (Yardstick 1996). In this approach, we encounter the use of energy at different effectiveness for different urban functions. The type of urban use of energy that is used at maximum level is the office and residence type of use which can be defined as mix use. The ratio of 4 residences and one office provides the most effective use of the energy. In the second order comes the mix use of energy where the energy is used in equal amounts in both residences and offices. In the third order, comes the mix type in which the amount of energy used in residence is four fold than that of used in offices.

In areas where geothermal energy was used a ratio of residence/office (4/1) was observed on 12 blocks of parcels. The number of blocks of parcel on which the energy was used equally was 1, the number of blocks of parcels where residence/office ratio was over 4 out of 111 and the number of blocks of parcels consisting of residences only was 113. As for the areas that do not use geothermal energy, on 16 blocks of parcels 1/4 residence/office ratio was provided, on 91 blocks of parcels, a ratio of over 4/1 residence/office was determined and on 98 blocks of parcels only building parcels were observed. In this context, it was observed that the energy was used ineffectively in the whole of the areas that use and not use geothermal energy (see Figure 4.45, see Figure 4.46).

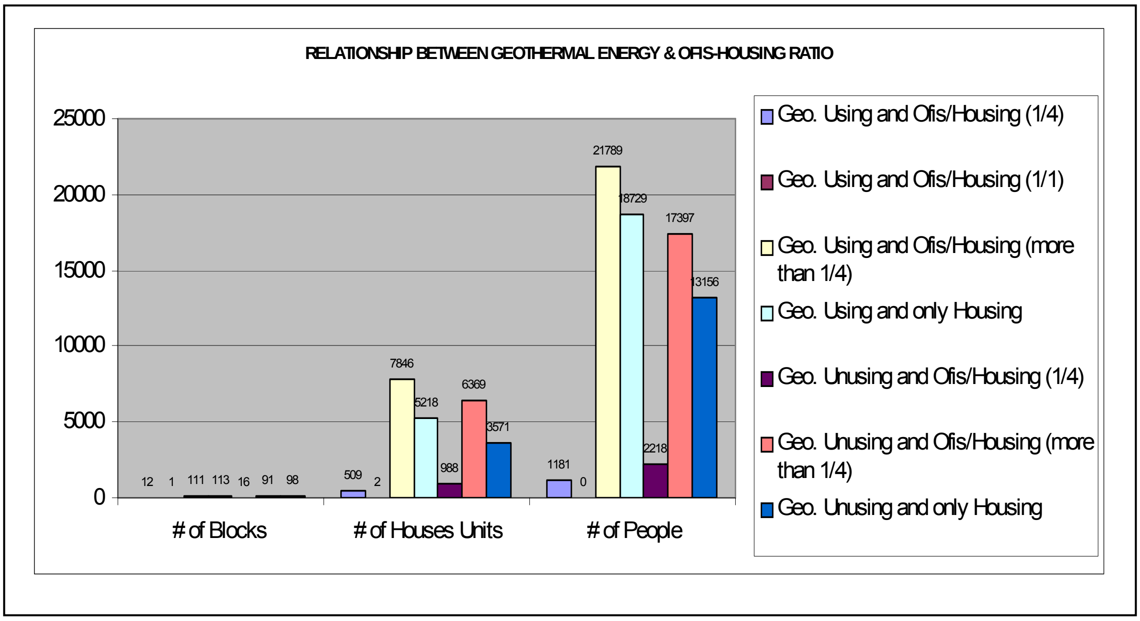


Figure 4. 45. The relationship between mixed land-use and geothermal energy utilization in Balçova district

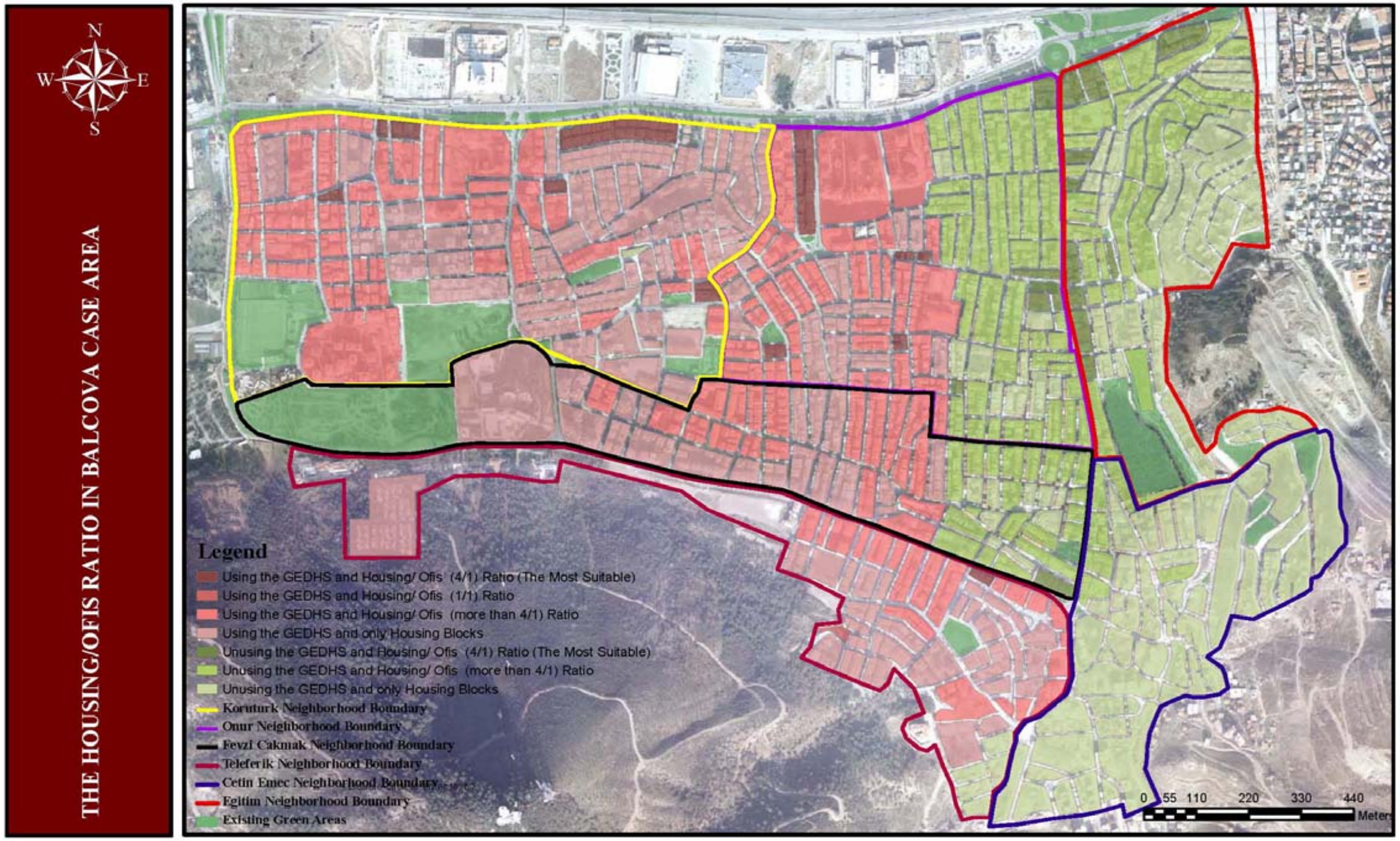


Figure 4. 46. The Relationship between office/house ratio and geothermal energy utilization in Balçova district

Land Block Density (User Energy Density)

The relationship of the typology of the building with geothermal energy was first mentioned by Pasqualetti in 1980. Using typology models in the main planning literature (American Planning Association 2007); Pasqualetti classified these typologies on the subject of land block density based on geothermal energy. These different types of land blocks are classified as Suburban, High Density Single Family, Town Houses, Garden Apartments and High Rise Apartments. These types of land blocks have the ratio of 6.63 residence/square (res/sq), 11.6res/sq, 45.5res/sq, 28.9res/sq and 107.6res/sq floor area ratio (FAR), respectively. And again according to the same data, a fall was observed in the amounts these types of buildings consumed ($/Thermal); 0.79- 0.78- 0.38, 0.43, 0.32 respectively.

In the light of this data, when area analysis was made, the most common type of building was townhouse type (78.6%). This type of land block comes afore especially in neighborhoods of Teleferik, Fevzi Çakmak and half in half in Korutürk neighborhoods. The number of people living in this district is around 50000. In the second order comes high density single family group (17.4%) especially in Onur and Korutürk neighborhoods (see Figure 4.47 and Figure 4.48).

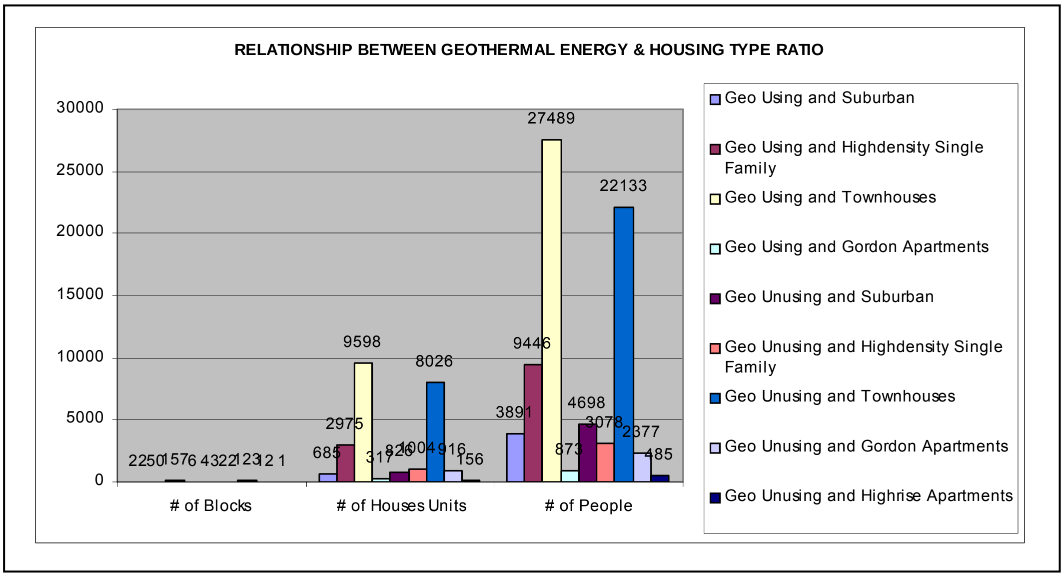


Figure 4. 47. The relationship between land block density and geothermal energy utilization

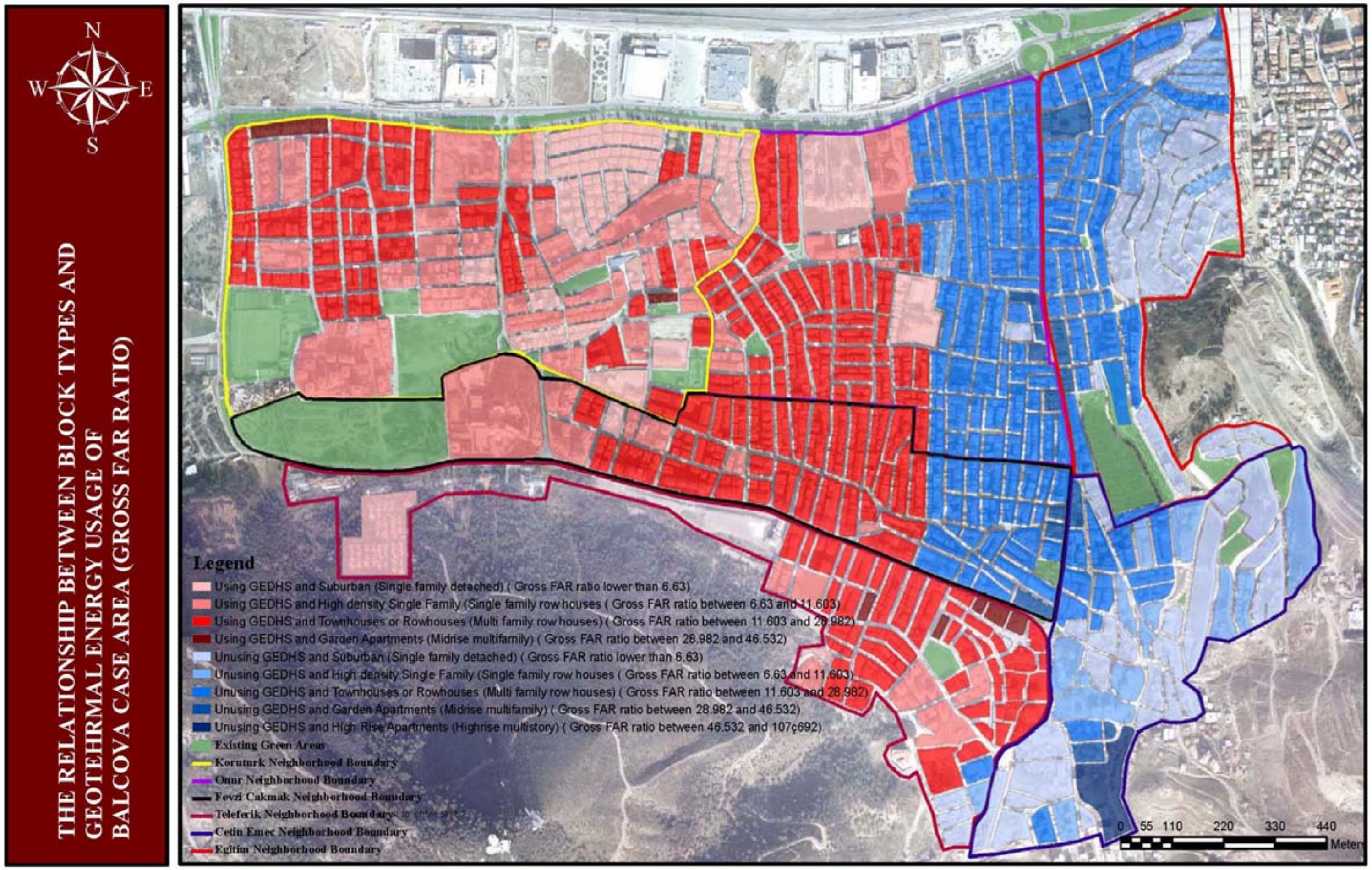


Figure 4. 48. The Relationship between building types and geothermal energy utilization in Balçova district

Heat load density of buildings

The study of “heat load density of buildings” was first conducted and finalized in 2003 by Toksoy for Teleferik neighborhood in Balçova (Toksoy 2003). In this study, a classification was made on the basis of the blocks on parcels on which there were buildings and five different density groups were determined. These values were derived from 54kcal/h which is necessary for building heating. 60kcal/h is used for the value for construction block of parcel. In this classification the first was found suitable for (more than 60kcal/h), the second (between 44-60kcal/h), the third could be suitable (between 18- 44kcal/h), the fourth should not used (10- 18kcal/h) and finally impossible for (less than 10kcal/h).

On total number of blocks of parcels in the study area, there are construction blocks of parcels that are most suitable for this purpose (88%). According to this data the district is highly appropriate for the purpose (see Figure 4.49 and Figure 4.50).

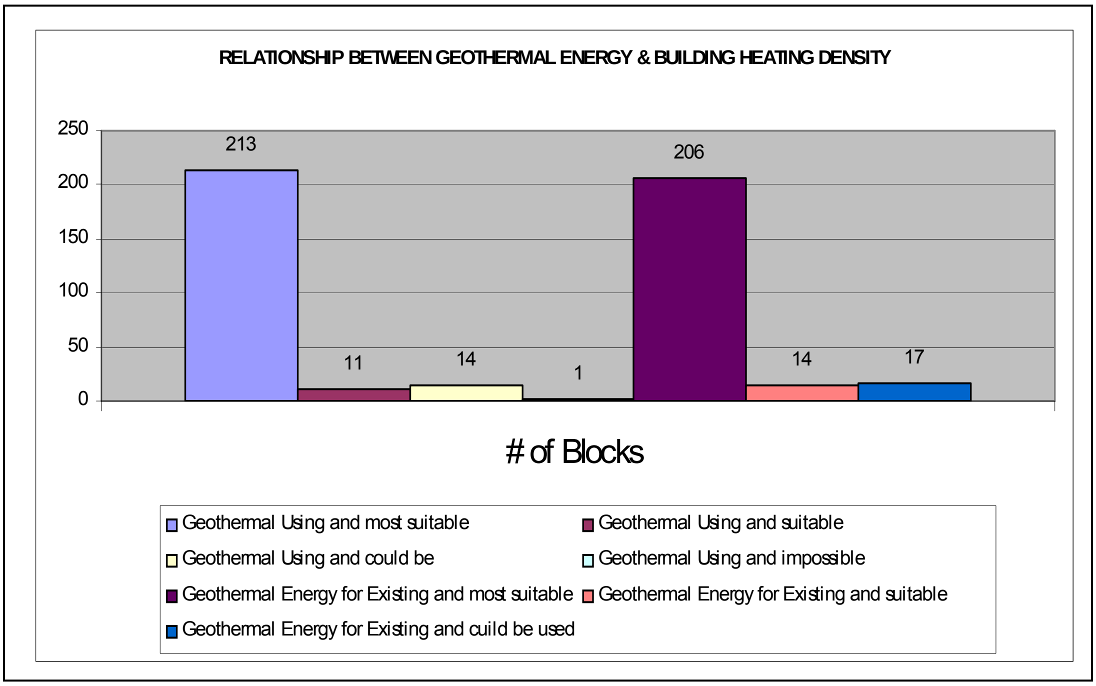


Figure 4. 49. The relationship between heat load density and geothermal energy utilization in Balçova district

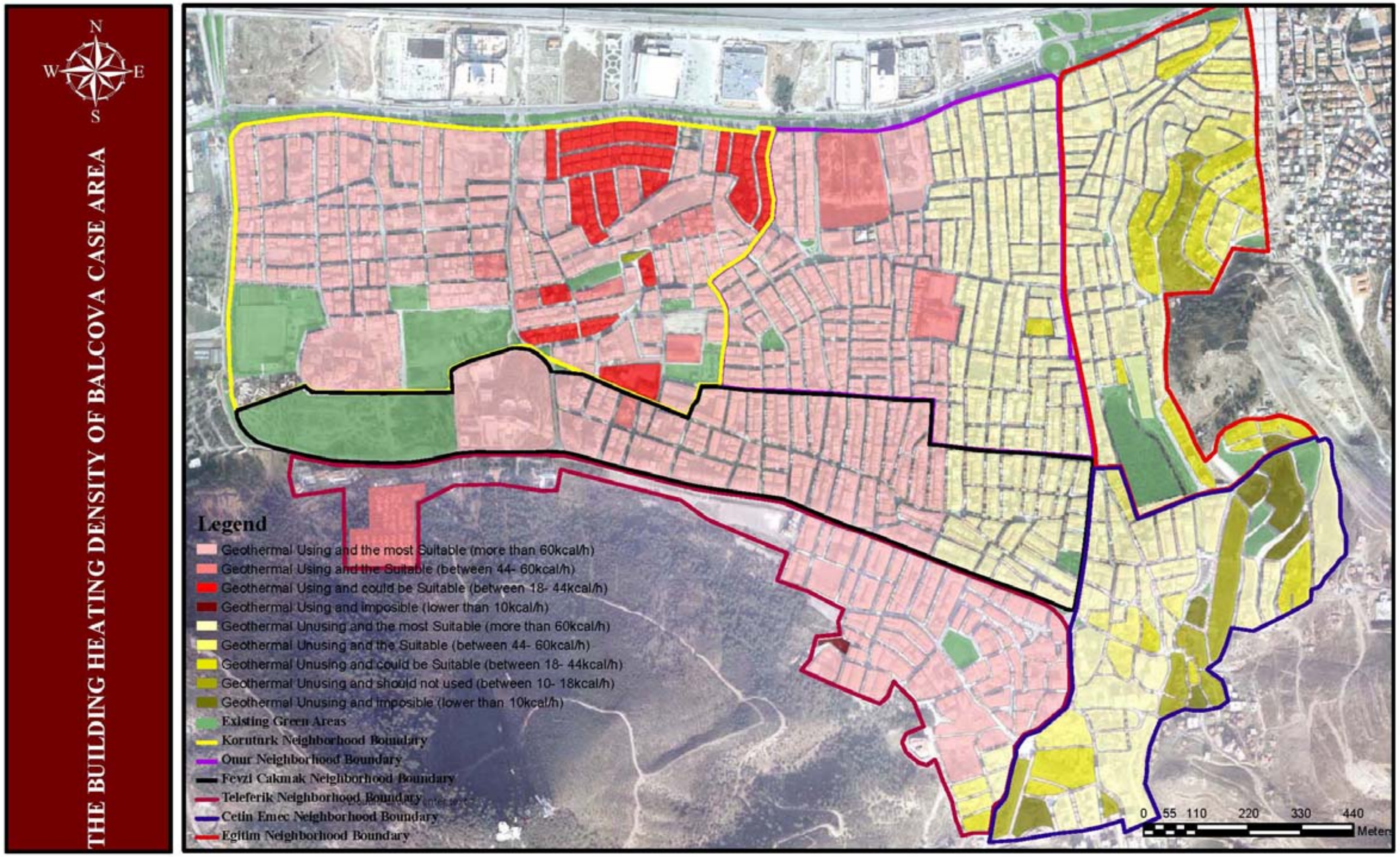


Figure 4. 50. The Relationship between heat load density of buildings and geothermal energy utilization in Balçova district

4.4. Overview of the Data Analysis on Geothermal Energy Integrated Urban Land-use Planning Approach

At the result of three studies of analysis conduct in this section, viewing the existing situations in the study area one can make the following conclusions;

- In Balçova district, which was examined under three titles; "adequate geothermal capacity", "incompletion geothermal conservation zone map" in the "Case Area Data Analysis" section, although data such as 20500 Residence Equivalent (RE) existing situation and 3100RE estimated capacity were given by the related authorities, in fact there is no clear information about the real capacity. Although, with the help of improved simulation systems, some estimations are made, the fact that insufficient number of geothermal drilling work has been done (well drilling constitutes the highest cost in geothermal studies), prevents us from reaching definite values about reservoir and capacity.
- "Advanced geothermal technology" can have important effects in the geothermal studies of Balçova Municipality. In the framework of the case area data analysis, the subtitle "Geothermal System Development Process", especially the developments seen in such areas as well drilling, integrated systems, geothermal piping nets, control and auditing increases the interest and investment in geothermal energy. Improvement of the systems that can go deeper in well drilling works and innovations in computer technology used for underground simulation techniques provides great contribution to bring forward new potential areas and include them in the system.
- "Established geothermal infrastructure system" was examined under the "Geothermal Reservoir and System Situations" titles within the group of case area analysis and as a result, it was found that the infrastructure was the one that spread the largest area among the existing geothermal infrastructure systems in Turkey. It is a positive point that this district was chosen as a study area. It is observed that infrastructure studies continue in many places at present. Although it is the area ahead of others in Turkey in general in terms of geothermal energy, the fact that the existing pipes are begun to be renewed in the GEDHS although not so long a time has passed since the year of installation, is an outstanding problem in infrastructure technologies. That this renewing arises from material out of routine one can be considered as a negative point.

- Incompletion geothermal conservation zone map; again as it is in geothermal capacity this variable was examined under the title of “Geothermal Reservoir Capacity and Geothermal Zoning Plan” within the group of “Case Study Data Analysis”. As a result of geological survey conducted in Balçova in 1998 by General Directorate of Mineral Research and Exploration (MRE), geothermal zoning plan was composed and this plan was included in master plan of the district and plan reports and 1st, 2nd, and 3rd degree protection belts were defined. These plans were implemented as it was until the year 2007, beginning from 2007 onward, with the new Geothermal Law (The Law of Geothermal Resources and Mineral Waters (5686 Law No) geothermal protection zones came into being and although they can be considered as an innovation, there occurred serious changes in the subject of these protection zones.
- “Inadequate laws and regulations”; this issue was examined *within the section of “*Case Area Data Analysis”. The fact that there was not any clear law or regulations about geothermal energy until the year 2007, arose great difficulties in studies that had been conducted until that time. Separately, in cases where geothermal reserves are being one within the other creates another problem in that residential plans are integrated with geothermal energy. So there is no clear integration in planning, laws and regulations on the subject of geothermal energy.
- “Congested parcel size and vacancy for drilling and fault line”, “heat load density of buildings”, user energy density (untidy land block density types)”, “residence equivalence- existing building ratio” and “mixed land-use (unused residence and office ratio)”; these variables were examined in detail in “Land-use Data Analysis” section. This will be evaluated in connection with master plan in the next chapter.
- “Community perception and interest on the project”; under the title of “The Evaluation of the Survey Data about Socio-Economic Survey” in the “Socio-economic Data Analysis” section, due to the public opinion surveys and driving from the sample several results were obtained. In six zones within the study area (Korutürk, Onur, Fevzi Çakmak, Teleferik, Çetin Emeç and Eğitim neighborhoods), it was observed that interest care in the geothermal energy district heating system was different. In zones where geothermal energy was

utilized for building heating, the number of those people with knowledge about geothermal projects in their zones seem high while knowledge accumulation about different sectors and their interest in building heating pretty low.

- The issue of “local agenda” which was examined in Agenda; “The Evaluation of the Survey Data about Socio-Economic Survey” in the sub-title of, “Socio-economic Data Analysis” section, took place in the sense how much this subject geothermal energy discussed in local agenda in İzmir. In the study conducted, the interest in the issue of geothermal energy can be considered high in İzmir in general. Giving news regularly on the issue of geothermal energy in local press allows the subject to stay active in people’s minds.
- “Participation (decision makers/ policy makers)”; this variable that was examined in the subject of “Case Area Data Analysis” and under the subtitle of “Geothermal Reservoir and System Situations” is one of the important titles. On the basis of local government, İzmir Metropolitan Municipality and Special Provincial Department showed interest in the matter because they were the stakeholders of the system. But this interest stays ways behind the national agenda. The issue of geothermal energy which takes play among alternative energy resources unfortunately falls to back plan like the other alternative energy resources. National agenda is constituted with natural gas, nuclear energy and other energy types. The issue of wind energy has begun to receive interest recently. The fact that private sector has gained the right of generating electric energy has a great role in this.
- “Misguided developers’ interest and imbalanced market”; as it took place under the previous title, the information obtained from studies stated under the title “Case Area Data Analysis”, and stakeholders of Balçova GEDHS were stated as two official organizations. First is İzmir Metropolitan Municipality and the second is Special Provincial Administration. İzmir Geothermal Energy Corporation was founded by these two institutions with a fifty/fifty capital and the corporation began operating in 2005. Operations on GEDHS have been continuing comprehensively. Increasing the number of heated apartment blocks in Balçova district, operations on drilling new wells, decreasing waste by improving the heating systems in the district, and new studies in Seferihisar district, a new geothermal zone constitute the operations of the project developers. Demands of the new zones to be heated with energy in the district

are at a high level. But natural gas studies in İzmir in general (in the direction of national strategies) might cause failure in geothermal studies in the future.

- More non-governmental organizations (NGOs) interest" and "inadequate communication"; in studies was conducted on the sample in "Socio-economic Data Analysis" group and it was observed that there is an association (in Turkey) operating in Balçova district. This association has 2500 members residing in Balçova district. On interviews held with the members of this association, problems arising from the company responsible for the GEDHS of the were touched on and desires were stated as follows;
    - different contracts must be brought together and reorganized,
    - elimination of injustices as a result the decision of the law court on behalf of the association,
    - not charging (on m^2) for the balconies that are not heated,
    - reviewing the energy policy and balanced application,
    - service workers must be trained,
    - streets must be repaired immediately by the municipality after repair work,
    - scientific determination of the geothermal reserves,
    - determination of new well zones and drilling new ones,
    - participation of people in the administrative studies.

CHAPTER 5

THE MODEL APPLICATION FOR GEOTHERMAL ENERGY DISTRICT HEATING SENSITIVE ALTERNATIVE PLAN: BALÇOVA CASE AREA

According to the conducted analyses, the answer to the question, “can there be a development (implementation) plan sensitive to energy input in the geothermal energy district heating system (GEDHS)?” will be examined in this section. Based on this plan, an alternative plan, which utilizes geothermal energy use, was conducted. As a result, both simulations were compared within the concept of energy efficiency.

Some restrictions and/or assumptions should be considered in the process of defining a development plan which is sensitive to energy input. These restrictions are;

As a start, five of the twelve variables, which were examined under the title of land-use analysis in the previous section, were selected. Through these five variables measurements can be applied easily. Hence, the main reason in choosing these variables is that they are classified with certain standards in international literature. These values, that indicate class difference on land can easily be traced on maps, and are listed respectively as follows;

- Parcel size and vacancy for drilling and fault line,
- Heat load density of buildings,
- User energy density (land block density types),
- Residence equivalence- development plan building ratio,
- Mix land-use of land block types (Residence-Office Ratio), respectively.

These variables will be explained in detail in the following sections.

Within four neighborhoods (Korutürk, Onur, Fevzi Çakmak and Teleferik neighborhoods) that constitute the study area, a fraction of 7% does not utilize GEDHS. There might be various reasons why this fraction does not use GEDHS, however most strong reason is that there is no choice depending on preference in the geothermal energy sensitive plan.

The most important assumption is that 1/1000 scale implementation plan of Balcova is ideal to refer to the actual development plan. In other words, criticism of the implementation plan (blue print) through general planning literature and acknowledgements were ignored. In the scope of energy efficiency, actual implementation plan and the alternative plan were compared according to the existing situation, in which geothermal energy is used as the main input. Thus, the concept of “fidelity to main plan” will only be important when questioned according to the degree that the alternative plan is in accordance with GEDHS principles.

For the spatial measurements of the implementation plan based on the GEDHS, Geographic Information System, (GIS) software, was used during simulation process. The most important to use this software is that it is swift getting the results. In the modeling process, AutoCAD Map 8.0 software was used to accumulate data and map plotting, SPSS software was used for the collection data for the variables, and ArcGIS 9.1 software was used as the main software.

In this chapter consisting of four sub-sections, includes a short theoretical section on the concept of simulation and why it is utilized. In the second section, configuration of the existing situation on the implementation plan for the sub-zones utilizing GEDHS in Balçova is presented. In the third section, five parameters which were selected among the land-use analysis variables are compared in the scope of their employment for the implementation plan and the alternative land-use plan with the aim to give the maximum efficiency. In the last section, a model for an implementation plan, which will be sensitive to geothermal energy district heating system that involves all of these five variables, will be introduced.

5.1. Simulation Approach

In this section, it is essential to define the necessity why simulation studies are conducted. In general literature, in regard to the chosen methodology, there are three main categories of modeling; econometric models, optimization models and simulation models. Econometric and optimization models require strictly formulated logical and mathematical presentation and they can deal with only objective variable, functions and parameters (Kleinpeter 1995). To extend the range of flexibility in dealing with social, environmental and political aspects, by inserting consumer behavior, different disaggregated methods have been elaborated.

Simulation is a method with which any phenomenon or system with similarities can be transposed and represented by a simpler or less complex model. Simulation models originate from rigid mathematical formulation without neglecting logical evaluation. Simulation is not only a method which tries to solve technical and economic problems, but also a way of thinking and acting (Kleinpeter 1995).

According to Kleinpeter (1995) implementation of simulation is important;

(1) to determine varying conceptual approaches, methodologies, and overall designs. Both aggregate and disaggregate models are presented, and there is a variety of perspectives presenting the need for and the role of empirical data.

(2) to demonstrate the possibility to construct a system that projects to the future across various scenarios at different geographic scales. Models deal with alternative land development patterns and work both at the broad metropolitan level and for small communities.

(3) to point out the possibility to integrate the outputs of these models with different types of visual presentations.

On the other hand Geographical Information System (GIS) are frequently used in simulations in urban planning studies. According to Energy Yardstick (1996), GIS combines a computer's capability to print maps with its capability to organize and retain large amounts of data and quickly perform complex calculations. By efficiency integrating mapping with location- specific data, GIS users are able to generate maps and reports that use a community's own data to answer specific questions. A GIS can be a large-scale or a small-scale and there can be a lot of energy integrated layer in GIS system (Energy Yardstick 1996); these layers can be listed: Climate: (Temperatures, wind, heating and cooling degree days), Land-use: (Housing locations, types and sizes, Typical energy equipment and fuels), Employment: (Business locations, types and size), Transportation: (Travel Demands, Vehicle Stocks, Transit Location), Renewable Energy Resources: (Solar Radiation, Ground Water, Wind Speed, Geothermal Characteristics, Biomass- solid waste), Infrastructure: (Street locations, types and conditions, Water and sewer locations and capacities, Street light and traffic signal locations), Conventional Energy Supplies: (Electricity grid locations, capacities, and rates, Natural gas grid locations and rates, Transportation fuel types and prices).

Within the framework of this study, GIS technologies, which are capable of making examinations and analyses in a very wide spectrum, were utilized.

5.2. Development Plan of Balçova Case Area

Balçova's Development (Actual Implementation) Plan (1/1000), which was endorsed and put into force in 1989, is not a plan that covers many inputs in the sense of geothermal district heating. In 1989, the Report of Balçova Thermal Springs Protection Area was released by General Directorate of Mineral Research and Exploration (MRE). In this report, it is emphasized in detail that this area is rich in terms of geothermal energy and it is necessary to establish geothermal conservation areas and to determine what the areas of 1-, 2- and 3-degree geothermal conservation areas encompass, plus what should be realized in these areas. The district was announced in 1995 as "Thermal Tourism Center and, the Construction Area for Tourism".

Since 2002, new areas of wells were determined to include to the regional heating system within Balçova district, with a change in plan of 1/1000 scale, five different wells were drilled during 2002- 2007. Within the case study area, since 2002, 5 development plan changes have been approved by the municipality for different neighborhoods and geothermal heating centers (GHC) are constructed after the plan changes.

When this implementation plan is viewed from the perspective of geothermal district heating it can be defined; especially when building densities, building types, resident/office mix used, unit sizes are taken into consideration:

In terms of land-use, there are apartment houses, areas of block residence (house) and terraced houses. There are different building types in different residential areas. By the phrase "residential area", it is pointed out that the areas in which the existing system is maintained by rehabilitation. Terrace houses cover the zone that is located to the southern slopes of Korutürk neighborhood and the houses with atriums. Block residence (house) appear in two different types. First type is blocks of multi-storey apartment houses with car parking, green areas and security (especially in Korutürk, Onur, and Fevzi Çakmak neighbourhoods, in areas around İzmir Economy University, in some areas such as Mithatpaşa Street). Second type is self-contained houses with atriums (such as İş Bank Houses and the ones on the slopes behind Korutürk neighborhood and in the sloped area in the middle of Korutürk neighborhood).

In the implementation plan, there is no decision on the increasing density through time. In residential areas of separated style, there are self-contained units or double units. In the areas dominated by block style, the height of blocks does not exceed 24m., and the space between two blocks is not less than 6m. (see Figure 5.1).

For commercial (business) areas, floor area ratio for shops or houses is determined as 0.80 and hmax. is 24.80m. administrative building types, FAR is 0.30 and hmax. is 12.80m. For public uses, FAR has been defined as 0.60. For educational, health and socio-cultural buildings FAR is 0.50. Thus, FAR and hmax values indicate that Balcova implementation plan lacks of decisive planning for the fault line passing through the case area.

5.3. Alternative Energy Sensitive Plan for Balçova Case Area

An important input for this research is to assess the amount of present energy use and to explore the energy use difference between the proposed and the existing situation. In the proposed of energy sensitive alternative implementation plan, five of the ten variables, which were introduced in previous chapter by land-use analysis are chosen. Main reasons in selecting these five variables are that they are well-defined and examined in literature, and facilitate data collection for Balçova case study analysis.

All these variables are used for comparing the "fidelity" of alternative implementation plan, which is based on the geothermal energy use, with the actual development plan. The basic formula is based on energy usage and land-use. In the formula 5.1., f(K) is parameters ratio (where K1: Residence equivalent determinant, K2: Heat load density for buildings determinant, K3: User energy density determinant and K4: Mixed land-use determinant), E_{base} is energy value used (EVU) (existing geothermal energy), U_{base} is the number of units (NU), E_{new} is the total proposed energy use.

$$E_{new}= U_{base} \times E_{base} \times f(K) \qquad (5.1)$$

According to this tentative and basic formula, each variable has a self-formula in integration with this general formula. The most important feature in this formulation is that it has got an indicator of energy efficiency based on land use. The f(K) value has been placed in the formula on the basis of standard values that exist in international literature.

Figure 5. 1. Development Plan for Balçova case are

5.3.1. The Criterion: “Parcel Size and Vacancy for Drilling and Fault Line”

The concept of parcel size and vacancy first appears in an article called “Planning for the Development of Site-Specific Resources: The Example of Geothermal Energy” by Pasqualetti in 1986. The research is structured especially on well conservation area and access space for constructions was determined as 40m (and 20m. radius).

A recent study on this subject was conducted in Turkey in 2006 by General Directorate of Mineral Research and Exploration. According to the values appearing in the document of “Preventive Measure about Geothermal Energy Conservation Area”, 15m. radius was determined for wells with strong constructions, and 25m. radius was determined for wells with weaker constructions in Well Conservation Areas. In the Balcova case area there are three active fault lines two of which are (Agamemnon I and Agamemnon II) in the east-west direction and the other fault line (Yeniköy Fault) is in southwest-north east direction (see Figure 4.1). The proximity distances of the settlements were calculated in Table 5.1.

Examination of the existing development plan indicates eight-storey building blocks exist in the range of risky fault zones according to the created conservation zones. In total 136 buildings stand in the protection zones on the faults. There are 742 units in these 136 buildings. Residence equivalent values of these 742 units were calculated as 920 units. The total amount of energy GEDHS used by the people living is 5036519kcal/h.

Second protection zoning in this scope is valid for the number of wells drilled. Through the examination of five wells in the study area, six building on 5 building blocks stand in well protection zones (see Table 5.1). There are 84 units in these buildings and the value of these units is 112 in the sense of residence equivalent. An amount of 617386kcal/h geothermal energy is used in these units with the purpose of space heating.

Table 5. 1. The influence of the fault lines and wells conservation zones

Influence Type	# of Blocks	# of Buildings	# of Units	# of Residence Equivalent (RE)	Total Energy (kcal/h)
Fault Lines	16	136	742	920	5036519
Wells	5	6	84	112	617386
TOTAL	21	142	826	1032	5653905

5.3.2. The Criterion: "Residence Equivalence and Development Plan Building Ratio"

The concept of residence equivalence and implementation plan building ratio is a variable, which was revealed during case area analysis in Balçova. The feature of this variable differs from region to region because the mean temperature of the region is an important factor for the value to occur.

This value for Balçova district was given by Toksoy (2001), according to the average residential floor area as $100m^2$. For a $100m^2$ unit in Balçova, there is a need of 5490kcal/h at an average temperature of 22^oC if the geothermal energy is utilized for heating purposes. The value of heat load density for one square meter is $54.90kcal/hm^2$.

In this context, as a result of analysis conducted on the development (implementation) plan, in 24 building blocks only 90 buildings exceed this average residential floor area, thus, these buildings offers an advantage in terms of evaluating their energy utilization. Total number of units in these buildings is 583, while the residence equivalence is determined as 20. On the other hand, the amount of energy consumed in the context of GEDHS has been determined as 1344679kcal/h.

A large part of the case area is constituted of buildings/blocks which expose a disadvantageous situation according to Table 5.3. In total, 13537 units in 3479 building on 267 building blocks are considered in this disadvantageous situation. Residence equivalence of 1537 units corresponds to 8220 units, and an amount of energy, 99914942kcal/h in total, is used for district heating.

According to Formula 5.2, unit value of residence equivalent is higher than the value in development plan and the two districts where residence (house) value is higher than unit value, the total of energy indicates the energy utilization in the scope of total GEDHS. The formula introduces: $U1_{eb>re}$ indicates the number of units (NU) of implementation plan buildings that exceed the residence equivalent, $U1_{re>be}$ indicates the NU of residence equivalent that exceeds the implementation plan buildings, $E1_{eb>re}$ is the energy value used (EVU) (kcal/h) for implementation plan buildings that exceed the residence equivalent, $E1_{re>be}$ defines the EVU (kcal/h) for residence equivalent that exceeds the implementation plan buildings, f(K1) is the ratio of parameters for implementation plan building and residence equivalent determinant, hence there is not any rational value for this variable, and E_{new} is the total proposed energy.

$$E_{total} = [U1_{eb>re} \times E1_{eb>re} \times f(K1_{eb>re})] + [U1_{re>be} \times E1_{re>eb} \times f(K1_{re>eb})] \qquad (5.2)$$

Commonly in this area, a restriction should be applied on the size of units, which can be reducing the size to 100m^2 and make it possible for extra 4683RE units to be utilized from the same amount of energy. Or in other words, such a change in the plan creates an advantage as a total of 25709670kcal/h in energy.

5.3.3. The Criterion: "Heat Load Density of Buildings"

Heat load density of buildings is a derived value from residence equivalence which was explained in the previous chapter. This ratio was first mentioned in Gülşen's thesis (2005), and derived by the multiplication of floor area ratio (FAR) in a block of parcel by 54.9 kcal, which is required for heating a unit of m^2. This determined value is the one centered by the density of block of parcels.

$$54.9\ kcal/hm^2\ x\ FAR = Heat\ Load\ Density\ of\ Building \tag{5.3}$$

According to these calculations structured in the framework of this research, heat load density was evaluated in five different categories (see Table 5.2).

In the first category for building blocks, the value is over 60kcal/hm^2 (see Formula 5.3) and is defined as district heating system is promptly available with a possibility to obtain rate efficiency over 0.70Mw. This value covers building blocks in city centers and high rise apartment blocks.

In the second category, a system with a value of 44-60kcal/hm^2 is defined as available district heating system and is defined as district heating system is promptly available with a possibility to obtain rate efficiency between 0.51- 0.70Mw. This value covers building blocks in city centers and buildings with many floors.

In the third category, buildings in the city center such as commercial buildings, and multi-unit houses, which are applicable for a district heating system with calculated value of 18 to 44kcal/hm^2 are classified. In these blocks, an efficiency rate of 0.20-0.51Mw per acre has been calculated.

In the fourth category, the value is 10-18kcal/hm^2. These areas where 0.20-0.51Mw efficiency is calculated per acre are the districts with are buildings with two units. For single houses area, district heating may be not feasible, where an efficiency of less than 0.12 Mw is obtained with an observed value of less than 10kcal/hm^2.

Consequently, in terms of heat load density cost of heating decreases proportionally as the levels increase. Cost reduces to 0.88 in single houses (compared to other energy types), decreases to 0.80 in house with two units. Cost is more advantageous with a value of 0.49 in the city center, commercial buildings. Multi-unit houses decrease down to 0.39 compared to multi-unit buildings in the same area. Finally, it reaches to 0.30 in multi-storey apartment houses (see Table 5.2).

As a result of analysis carried out on the development plan, 12 single house building blocks were determined as consuming energy less than $10kcal/hm^2$. Thus, 208 units (30RE) in 63 buildings can be defined as non-feasible for the utilization of District Heating System. Total amount of energy used in these areas is 146654kcal/h. In the problematic group, there are 118 buildings on 18 building blocks. 545 units on these building blocks have a RE value of 373, and consume a total energy of 2050733kcal/h. (see Table 5.3).

Total number of building blocks in the moderately feasible group is 50, number of buildings is 535, and the number of total units is 2661 (2657 RE) and the amount of heat consumed is 15652886. In a feasible group, there are 920 buildings on 85 building blocks. 5239 units (6239 RE) consume a total energy of 34193468kcal/h. Finally, the group which offers the extreme feasibility, in addition the group with the largest number of buildings consists of 5467 units (8971RE) in 933 buildings on 115 building blocks consuming 49215880kcal/h (see Table 5.3).

According to the equation 5.4., $U2_{sg}$ is the number of units (NU) of single houses, $U2_{2h}$ is the NU of buildings with two houses, $U2_{mh}$ is the NU of multi-unit houses, $U2_{mf}$ is the NU of multi-storey buildings, $U2_{hra}$ is the NU of high rise apartments, $E2_{sg}$ is the energy value used (EVU) (kcal/h) for single house, $E2_{2h}$ is the EVU (kcal/h) for buildings with two houses, $E2_{mh}$ is the EVU (kcal/h) for multi-unit houses, $E2_{mf}$ is the EVU (kcal/h) for multi-storey houses, $E2_{hra}$ is the EVU (kcal/h) for high rise apartments, fx(K2) is the ratio of parameters for head load density determinant, and the ratio of parameters are evaluated based on the Gülşen's study (2005), $fx(K2_{sg})$ is 3.33 single house ratio, $fx(K2_{2h})$ is 2.93 buildings with two houses ratio, $fx(K2_{mh})$ is 2.66 buildings with many houses ratio, $fx(K2_{mf})$ is 1.6 buildings with many floors ratio and $fx(K2_{hra})$ is 1 high rise apartments ratio and E_{total} is the total proposed using energy are determined.

Table 5. 2. The classifications and ratios of heat load density of buildings
(Source: Adopted from Gülşen 2005)

Heat Load Density of Buildings				
Construction Type	**An Advantage of Cost of Heat Ratio**	**Cost of Heat Ratio**	**kcal/hm^2**	**Availability for District Heating System**
Single Houses	0.88	Less than 0.12	Less than 10	Impossible
Buildings with 2 houses	0.88-0.80	0.12- 0.20	10- 18	Questionable
City center, commercial buildings, buildings with many houses	0.80-0.49	0.20- 0.51	18- 44	Applicable
City center, buildings with many floors	0.49-0.30	0.51- 0.70	44- 60	Available
City center, high rise apartments	Less than 0.30	Over 0.70	Over 60	Very available

$$E_{total} = [U2_{sg} \times E2_{sg} \times f(K2_{sg})] + [U2_{sfrh} \times E2_{sfrh} \times f(K2_{sfrh})] + [U2_{ga} \times E2_{ga} \times f(K2_{ga})] + [U2_{th} \times E2_{th} \times f(K2_{th})] + [U2_{hra} \times E2_{hra} \times f(K2_{hra})] \quad (5.4)$$

As a result of calculations, the value of f(K2) is determined as 0.67. If all the areas in the alternative plan are considered as extremely feasible (60kcal/hm^2), an amount of energy 67843946kcal/h will be sufficient. In summary, an energy amount of 33415674kcal/h could be saved. This corresponds to 6086 units on the calculation of residence equivalent (RE 100m^2=5490kcal/h).

Table 5. 3. The influence of the ratios of heat load density of buildings

Influence Type	# of Blocks	# of Buildings	# of Units	# of Residence Equivalent (RE)	Total Energy (kcal/h)
Single Houses	12	63	208	30	146654
Buildings with 2 houses	18	118	545	373	2050733
City center, commercial buildings, buildings with many houses	50	535	2661	2627	15652886
City center, buildings with many floors	85	920	5239	6239	34193468
City center, high rise apartments	115	933	5467	8971	49215880
TOTAL	**280**	**2569**	**14120**	**18240**	**101259621**

Of course, it cannot be demanded that there should be high rise buildings in all residential zones that are. In this context, the above mentioned values are to be normalized, at least from the perspective of availability for district heating system, as a result of turning all single family house or single family row house into garden apartment group, the value of fx(K2) corresponding to 0.69 can be determined as an energy of 31390482kcal/h and unit value of 5717RE.

5.3.4. The Criterion: "User Energy Density (Land Block Density)"

The parameter defined as user energy density or land block density was suggested by Pasqualetti (1986). This is a type of variable which depends completely on building density in general by including the building type, There is a strong relationship between building typology and the cost of energy, consequently between energy efficiency (see Table 5.4). The value used in determining these districts is the ratio of gross floor area ratio (FAR). This ratio is applied on the number of houses in an area of $1000m^2$ ($1\ km^2$).

Table 5. 4. The classifications and ratios of user energy density
(Source: Adopted by Pasqualetti 1986)

User Energy Density		
Building Type	**An Advantage of Cost of Heat Ratio**	**Residence (house)/sq km.**
Suburban (1- 2 storey)	0.799	6.630
High Density, Single Family (2- 4 storey)	0.787	11.630
Garden Apartments (5- 6 storey)	0.382	46.532
Town Houses or Row-houses (4- 5 storey)	0.432	28.982
High Rise Apartments	0.328	107.692

The data in Table 5.5., indicates 9311927kcal/h was consumed in total 1315 units (1708RE) in suburban area. The same values for areas where high density single family groups exist, 52780447kcal/h was consumed in 8006 units (9622RE). This value is 1268837kcal/h for 1870 units (2310RE) in garden apartments, 26483380kcal/h for 2929 units (4600RE) in high rise apartments.

Table 5. 5. The influence of the ratios of user energy density

Influence Type	# of Blocks	# of Buildings	# of Units	# of Residence Equivalent (RE)	Total Energy (kcal/h)
Suburban	69	535	1315	1708	9311927
High Density, Single Family	164	1550	8006	9622	52780477
Garden Apartments	25	287	1870	2310	12683837
High Rise Apartments	33	197	2929	4600	26483380
TOTAL	**280**	**2569**	**14120**	**18240**	**101259621**

According to the equation 5.5, $U3_s$ is the number of units (NU) of suburban, $U3_{hdsf}$; is the NU of high density, single family, $U3_{ga}$ is the NU of garden apartments, $U3_{hra}$ is the NU of high rise apartments, $E3_s$ is the energy value used (EVU) (kcal/h) for suburban, $E3_{hdsf}$ is the EVU (kcal/h) for high density, single family, $E3_{ga}$ is the EVU (kcal/h) for garden apartments, $E3_{hra}$ is the EVU (kcal/h) for high rise apartments, fx(K3) is the parameters for user energy density determinant ratio, and the ratio of parameters are evaluated as fx($K3_s$) is 2.43 suburban ratio, fx($K3_{hdsf}$) is 2.39 high density ratio, single family, fx($K3_{ga}$) is 1.24 garden apartments ratio and fx($K3_{hra}$) is 1 high rise apartments ratio and E_{total} is the total proposed using energy are determined.

$$E_{total} = [U3_s \times E3_s \times f(K3_s)] + [U3_{hdsf} \times E3_{hdsf} \times f(K3_{hdsf})] + [U3_{ga} \times E3_{ga} \times f(K3_{ga})] + [U3_{hra} \times E3_{hra} \times f(K3_{hra})] \quad (5.5)$$

Calculations out of the analysis results in according to user density variable brought demonstrates the value of fx(K3) as 0.53. If all areas are filled with high rise apartments and the advantage of cost of heat ratio being 0.328, 53667599kcal/h of energy would be very sufficient for the present need. In short 47592021kcal/h of energy could be saved and this corresponds to 8668RE units on the calculation of residence equivalent (RE=100m^2=5490kcal/h).

Similar to heat load density parameter, due to imbalances in applying the above mentioned extreme values, rehabilitation studies must be carried out and suburban and high density single family groups must be turned into garden apartment groups. Calculations based on this view brought forward 0.84 as fx(K3) value; 16201559kcal/h energy and 2951 (RE) unit value.

5.3.5. The Criterion: "Mixed Land-use (Residence- Office Ratio)"

Mixed land-use parameter was chosen as the last variable used in the study of master plan sensitive to geothermal energy. Valid values for this variable were taken from (Center of Excellence for Sustainable Development 1997).

The main input for this variable is the principle of taking into account the diversity of units types used in buildings. Here, the diversity between the function as houses and offices in a building has a direct relationship with the energy efficiency. The reason why these two different types of usage exists in one building is to establish a balance among the utilization times of the units because there is an active status between the offices that are active during the day time and the houses that are active at night.

According to the values given in Table 5.6, retail buildings are the most energy consuming, the most expensive type, and produce the greatest amount of carbon dioxide.

The ratio of ¼ (1 office /four houses) seems to be the best ratio of usage in a building. With such a ratio in one acre, the energy consumption per year is 4600 Million British Thermal Units/year (MMBtu/yr), energy cost per year is 48500 $/yr and the production of carbon dioxide is 530/tons per year. This ratio seems to be the most appropriate one (Center of Excellence for Sustainable Development 1997).

According to the analysis based on the implementation plan, office-residential using is accepted to be ideal. It should be certainly defined the proportion of office-residential use within the plan report or plan notes. Based on these, there are five different land use decisions for the case area. Within the 50 building blocks with office use, 467 buildings are located and totally 8174912kcal/h energy with 1247 unit (1501RE) is used. In the 41 building blocks with residential use, 350 buildings are located and totally 25229065kcal/h energy with 3465 unit (4370RE) is used generally GEDHS.

Table 5. 6. The classifications of building type situation

(Source: Adopted from Center of Excellence for Sustainable Development, Office of Energy Efficiency and Renewable Energy U.S. Department of Energy 1997)

Building Type	**An Advantage of Cost of Heat Ratio**	**Energy (MMBtu/yr) *(for 1 Acre)***	**Cost ($/yr) *(for 1 Acre)***	**CO2 (tons/yr) *(for 1 Acre)***
Retail	0.999	61100	566400	5020
Office	0.261	17000	168300	1660
Residence (House)	0.147	9392	99000	1080
Jobs (Office)/House Ratio: 4/1	0.129	8200	83800	860
Jobs (Office)/House Ratio: 1/4	0.072	4600	48500	530
Jobs (Office)/House Ratio: 1/1	0.089	5500	57700	620

In total, 13956880kcal/h energy is used by 1945 units (2543RE) in 298 buildings located in 25 building blocks. These buildings have mixed use of office and residential functions with the ratio of residential to office are 25%. Within the buildings that office and residential function ratio is equal, there are 17 buildings and totally 261732kcal/h is used with 60 units (47RE). Finally, for the buildings with office to residential function ratio is 25% energy efficiency becomes most advantageous. 46782499kcal/h energy is used with 7232 units (8531RE), in 1381 buildings, located in 146 building blocks.

According the equation 5.6, $U4_o$ is the number of units (NU) of office, $U4_h$ is the NU of house, $U4_{o/h,4/1}$ is the NU of office-house (4/1), $U4_{o/h,1/4}$ is the NU of office-house (1/4), $U4_{o/h,1/1}$ is the NU of office-house (1/1), $E4_o$ is the energy value used (EVU) (kcal/h) for office, $E4_h$ is the EVU (kcal/h) for house, $E4_{o/h,4/1}$ is the EVU (kcal/h) for office-house (4/1), $E4_{o/h,1/4}$ is the EVU (kcal/h) for office-house (1/4), $E4\ _{o/h,1/1}$ is the EVU (kcal/h) for high rise apartments fx(K4) is the parameters for mixed land-use determinant ratio, and the ratio of parameters are evaluated fx($K4_o$) ,is 3.69 for office ratio , fx($K4_h$) ,is 2.2 for house ratio, fx($K4_{o/h,4/1}$) is 1.78 for office-house ratio (4/1), fx($K4_{o/h,1/4}$) is 1 for office-house ratio (1/4), and fx($K4_{o/h,1/1}$) is 1.19for office-house ratio (1/1), and E_{total} is the total proposed using energy are determined.

$$E_{total}= [U4_s \times E4_s \times f(K4_s)] + [U4_{hdsf} \times E4_{hdsf} \times f(K4_{hdsf})] + [U4_{ga} \times E4_{ga} \times f(K4_{ga})] + [U4_{hra} \times E4_{hra} \times f(K4_{hra}) + [U4_{hdsf} \times E4_{hdsf} \times f(K4_{hdsf})] \quad (5.6)$$

Table 5. 7. The influence of the ratios of mixed land-use

Influence Type	# of Blocks	# of Buildings	# of Units	# of Residence Equivalent (RE)	Total Energy (kcal/h)
Office	50	467	1247	1501	8174912
Housing	41	350	3465	4370	25229065
Jobs (Office)/Housing Ratio: 4/1	25	298	1945	2543	13956880
Jobs (Office)/Housing Ratio: 1/4	146	1381	7232	8531	46782499
Jobs (Office)/Housing Ratio: 1/1	2	17	60	47	261732
TOTAL	280	2569	14120	18240	101259621

Depending on the user energy density variable, fx(K3) is estimated at 0.64. 65057634kcal/h will be enough in the regions that the ratio of office/house is (¼). Briefly 36201986kcal/h energy will be increased which is equal to 6594 RE over the calculation of residence equivalent (RE=100m^2=5490kcal/h).

Existing residential areas will be decreased depending on the land use changes from residential to office. According to the estimations based on implementation plan, 2578 (RE) unit of office should be transformed to residential use.

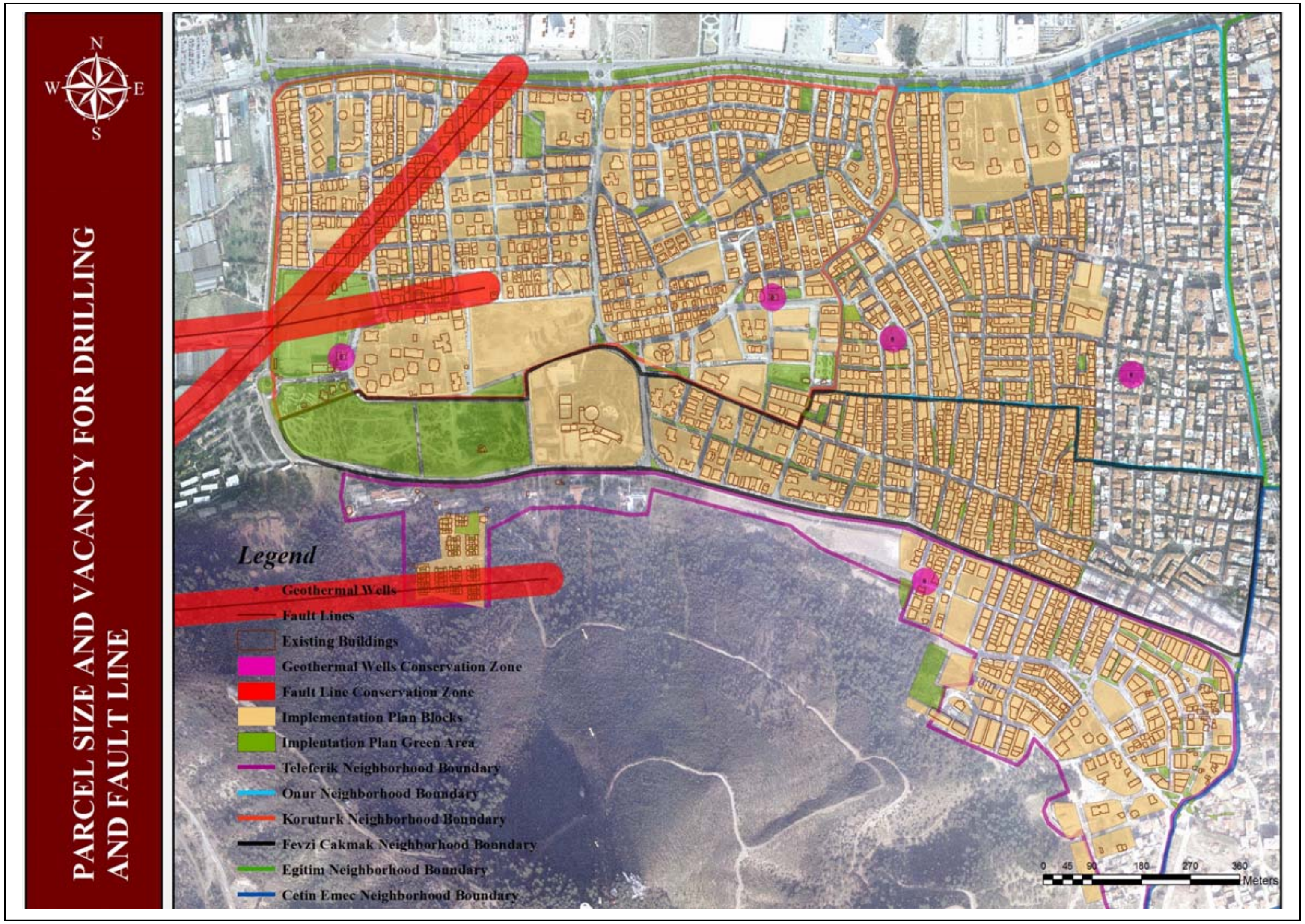


Figure 5. 2. “Parcel Size and Vacancy for Drilling and Fault Line” analysis of Balçova case area

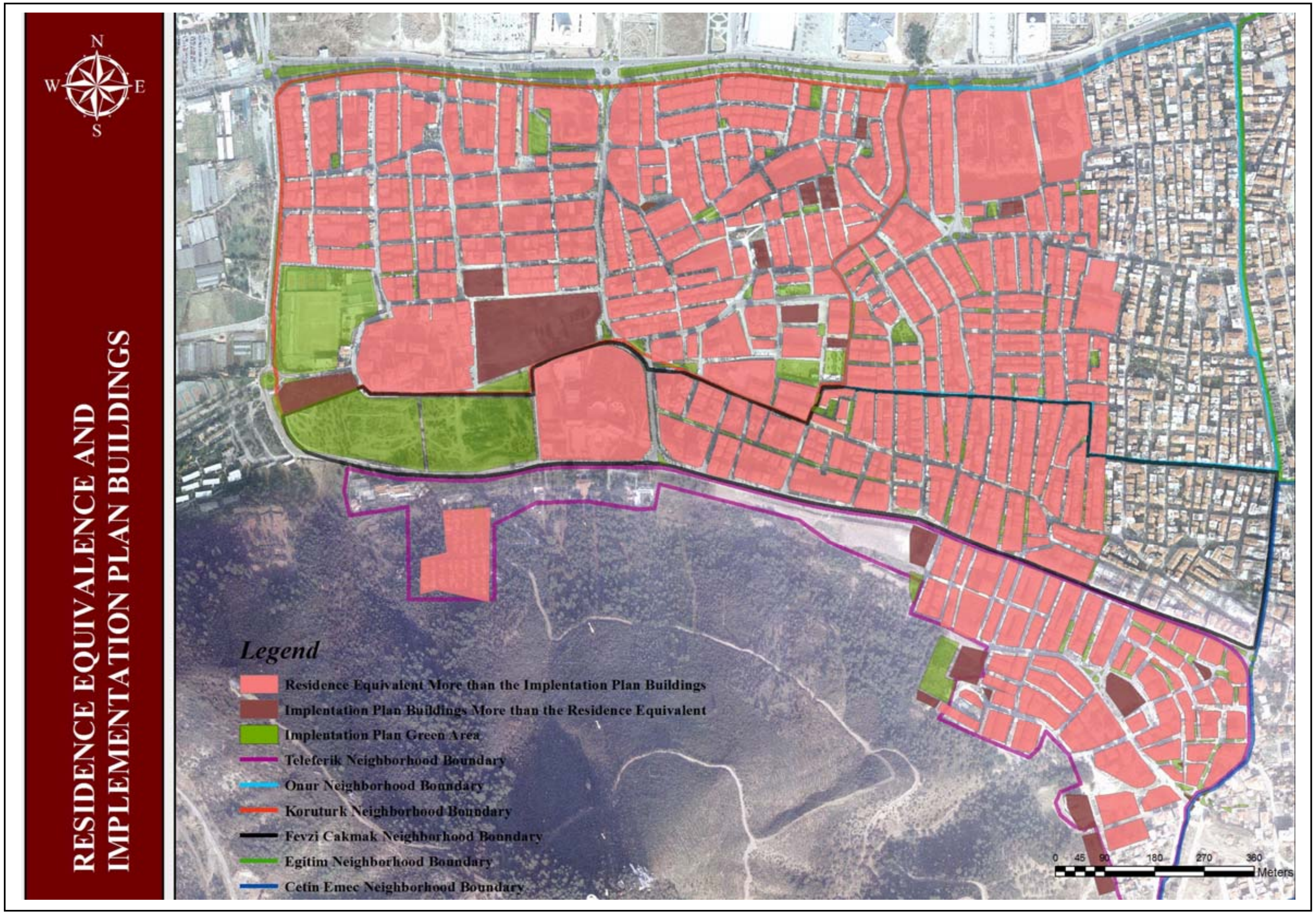


Figure 5. 3. “Residence Equivalence and Development plan Building Ratio” analysis of Balçova case area

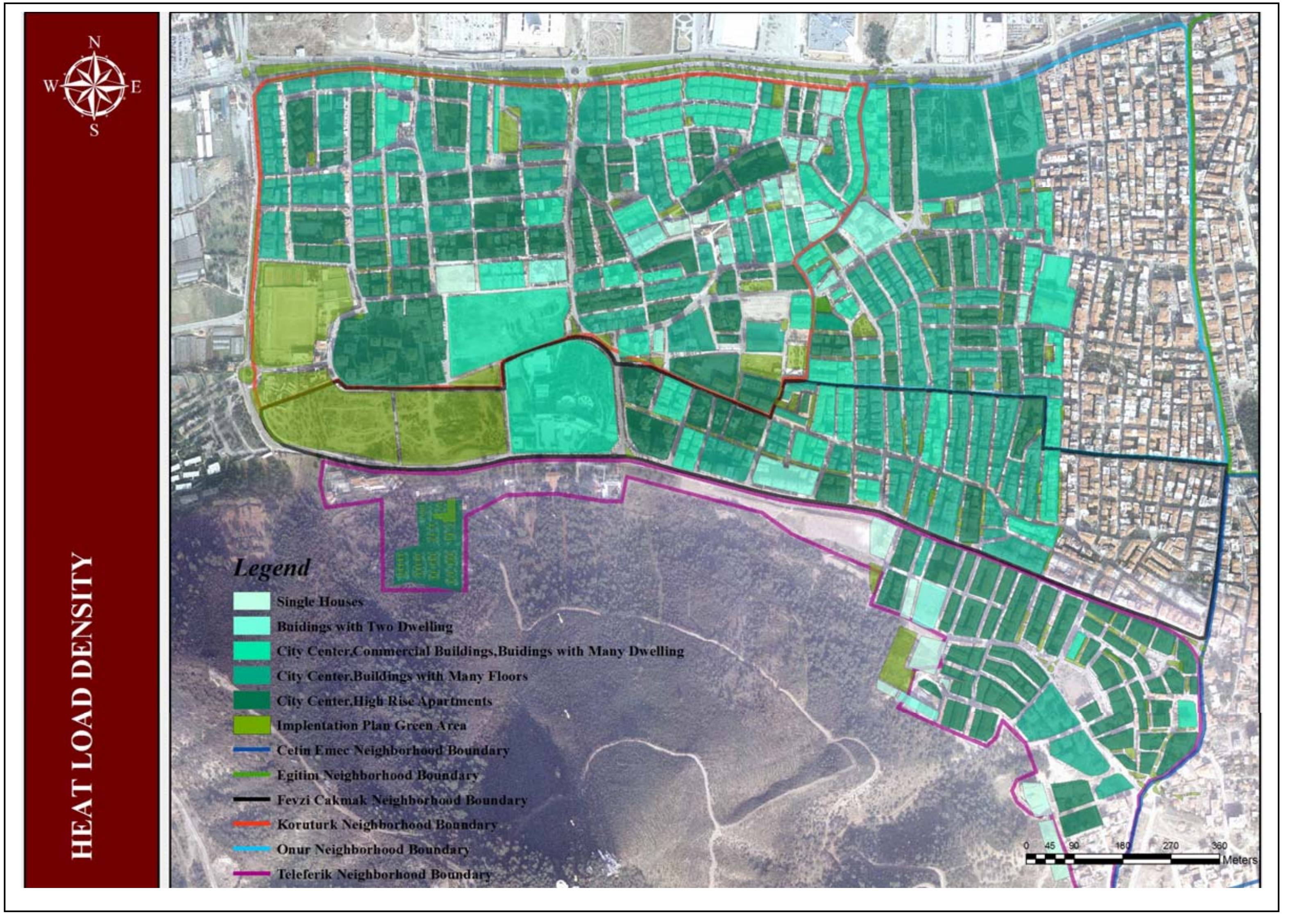


Figure 5. 4. “Heat Load Density of Buildings” analysis of Balçova case area

Figure 5. 5. “User Energy Density (Land Block Density)” analysis of Balçova case area

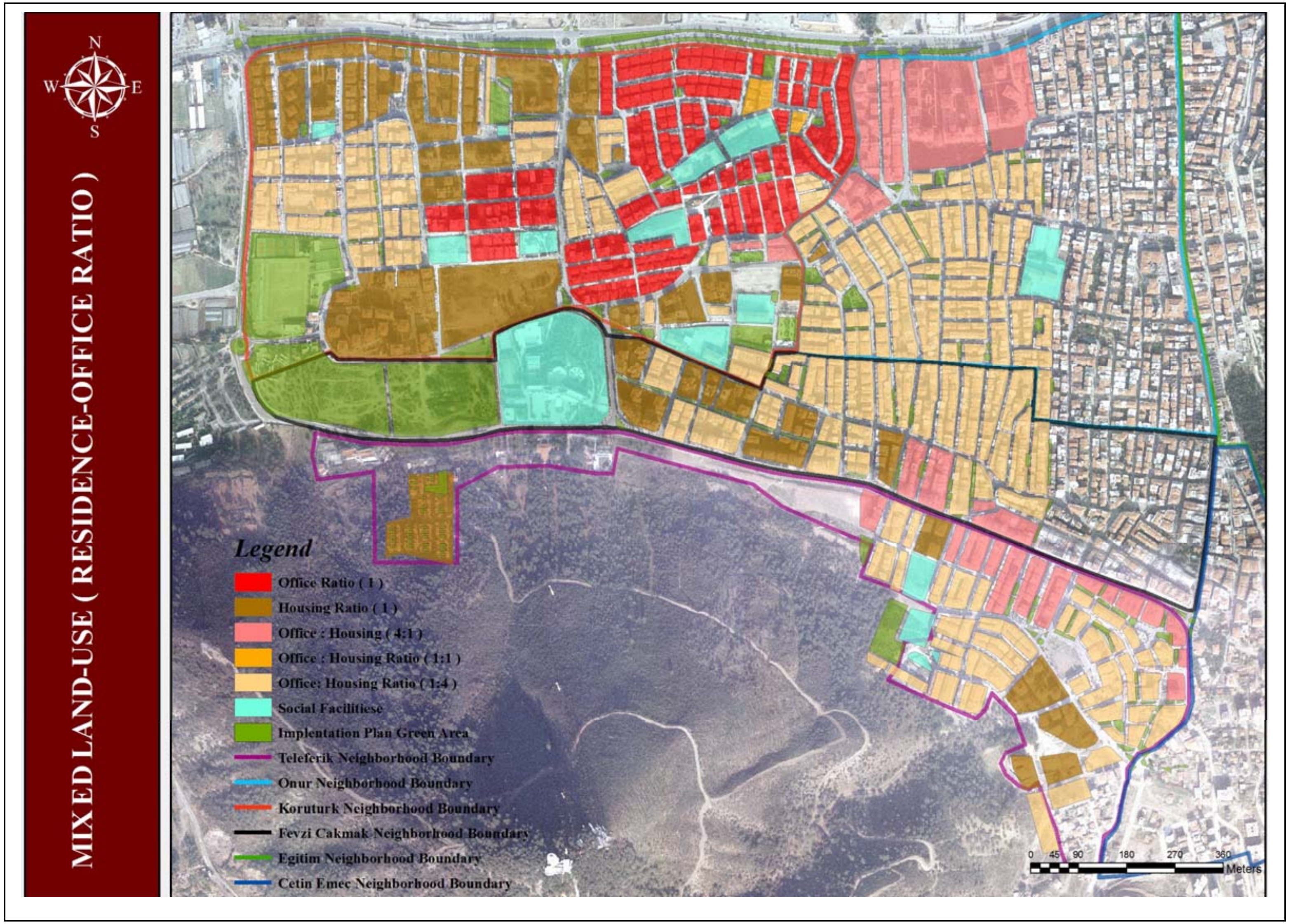


Figure 5. 6. “Mix Land-use (Residence- Office Ratio)” analysis of Balçova case area

5.4. The Evaluation of the Results about Geothermal Energy Sensitive Alternative Development Plan of Balçova Case Area

As mentioned above, implementation plan is evaluated, in terms of 5 different variables. According to *Parcel Size and Vacancy for Drilling and Fault Line Variable*, there is a 1032 residence equivalent (RE) decrease in the case area. Other result depending on *Residence Equivalence and Existing Building Ratio Variable*, it is proposed to demolish buildings in relation with the earthquake risk, in high risk areas which are equal to 4683RE unit energy.

The third and the forth variables, *Heat Load Density* and *User Energy Density (Land Block Density Variables),* are the components of main density calculation constructions. According to the alternative energy sensitive implementation plan, in both calculations, with these variables, more energy output is obtained in comparison to the existing implementation plan. Consecutively, 6086RE unit and 8668RE unit potentials are provided with the alternative plan if these variables are changed. This energy potential is supplied by these two variables both of which depend on density. In correlation with this, increase of one variable will also affect the other and it would be enough to change only one variable.

Finally, depending on the Residence-Office Ratio, besides 6594RE unit potential, 2578RE unit is gained as a result of the land use change from office to residential.

As a result, as potential of 19945RE unit is gained that is, an excess of energy of 106502751kcal/h is gained and since the 3610RE unit proportion and 19807124kcal/h of this new addition is met from the area that is converted, a new additional value of 16335 units and additional energy of 89695626kcal/h is saved. On the other hand, as a result of normalization value, 16994RE unit and 93297060kcal/hr values have been accomplished (see Table 5.8). The proportion of 3610RE unit and 19708125kcal/h is met from the section to be transferred in the area; last values of 13384RE units and 73489935kcal/hr energy have been gained. In comparison with the existing development plan, values obtained from this approach are used. These values correspond to an increase of 10360 units with respect to the existing unit sizes overall in Balçova.

Table 5. 8. The variables and land-use impact values

<table>
<tr><th>Variables</th><th>The Cause of Affects</th><th>The Affects to Units</th><th>Total Energy (kcal/h)</th></tr>
<tr><td>Parcel Size and Vacancy for Drilling and Fault Line</td><td>Risky Area</td><td>1032 RE (decrease)</td><td>-5653905</td></tr>
<tr><td>Residence Equivalence and Development plan Building Ratio</td><td>Unit Size (m²)</td><td>4683 RE (increase)</td><td>25709670</td></tr>
<tr><td rowspan="2">Heat Load Density of Buildings</td><td rowspan="2">Density</td><td>6086 RE (increase) (for extreme value)</td><td>33415674</td></tr>
<tr><td>5717 RE (increase) (for normalization value)</td><td>31390482</td></tr>
<tr><td rowspan="2">User Energy Density (Land Block Density)</td><td rowspan="2">Density</td><td>8668 RE (increase) (for extreme value)</td><td>47592021</td></tr>
<tr><td>2951 RE (increase) (for normalization value)</td><td>16201559</td></tr>
<tr><td rowspan="2">Mixed Land-Use (Residence- Office Ratio)</td><td>Land-use</td><td>6594 RE (increase)</td><td>36201060</td></tr>
<tr><td>Land-use</td><td>2578 RE (decrease)</td><td>-14153220</td></tr>
</table>

In order to offer the development plan which is sensitive to the energy used, demonstrating the relationship between geothermal energy district heating system (GEDHS) and planning discipline, an analysis was completed using the above mentioned variables based on the development plan (see Table 5.9).

An overall increase of building density seems to be an obligation. In this scope, in areas where low density single house exists, the floor area ratio (FAR) of 0.88 increases to 2.66 FAR for the very same areas subjected to density increase in the alternative plan. Also high density single family areas with a FAR of 2.19 increase up to 3.01 in the alternative plan. No difference takes place in garden apartments areas (2.63 FAR ratios) and in areas where high rise apartments (2.52 FAR) exist. This increase in general brought a change in the (29%) portion between the existing development plan and proposed plan.

Considering land-use balance of office/residence (house) ratio, office ratio of 526400m^2 in the existing development plan decreases down to 359700m^2 in the proposed alternative plan, and housing areas of 1172500m^2 increases up to 339200m^2, a 14% change was observed as against a 35% change in office areas.

By eliminating developments in risky areas and establishing green areas such as play grounds for children, recreation areas and so forth, existing green areas in the study area were raised to 336836 m^2 in the alternative plan. That is to say, a green area of 36724 m^2 was added. Thus, a change of 11% was realized.

Table 5. 9. The comparing the development plan and energy sensitive alternative plan (Fidelity Rate)

<table>
<tr><th>Plan Parameters</th><th>Development Plan</th><th>Alternative Plan</th><th>Changing Ratio</th></tr>
<tr><td rowspan="4">Building Density</td><td>0.88 FAR
(Single Family)</td><td>2,66 FAR
(Single Family)</td><td rowspan="4">29%</td></tr>
<tr><td>2.19 FAR
(High density single family)</td><td>2,81 FAR
(High density single family)</td></tr>
<tr><td>2,63 FAR
(Garden apartments)</td><td>2,63 FAR
(Garden apartments)</td></tr>
<tr><td>2,52 FAR
(High rise apartments)</td><td>2,52 FAR
(High rise apartments)</td></tr>
<tr><td rowspan="2">Land-use Balance (Office-Residence)</td><td>526.400 m^2
(Office)</td><td>339.700 m^2
(Office)</td><td>14%</td></tr>
<tr><td>1.172500m^2
(Residence)</td><td>1.359.200m^2
(Residence)</td><td>35%</td></tr>
<tr><td>Green Area</td><td>300.112m^2</td><td>336.836m^2</td><td>11%</td></tr>
<tr><td>Land Ownership</td><td>212.060 m^2</td><td>248.784 m^2</td><td>15%</td></tr>
<tr><td>Population</td><td>72700 (# of people)</td><td>103900 (# of people)</td><td>30%</td></tr>
</table>

Under the existing development plan, in the total area of 1300000m^2, which is under private ownership, there is public ownership holding of 2122060 m^2. In the alternative plan, by causing the public gain risky areas in the conservation zones along faults and around wells, total area belonging to the public rose to 248784 m^2. That is to say, an increase of 15% is at stake compared with the existing development plan.

In the context of population density, influenced by general house hold size of 3.02, potential units of 14120 were determined on the existing 13575 units with 69886 household. As a result of calculations according to the indicators of the existing developing plan and local averages, a population of 72700 was determined. Within the same ratios, additional 10360 units bring to the district an addition population of 31200. An estimated total population of 103900 was calculated. Estimated population change was 30%.

Besides direct effects of the energy sensitive alternative plan that are mentioned above, the increase in population as well has indirect effects on social facilities and technical infrastructure. In the framework of this study, spatial uses of the urban use was suggested, hence two new development areas were proposed, one in the north and the other in the south east of the area for which spatial solutions were advised according to the holistic maximum energy efficiency approach.

Also derived originating from the assumption, it is clear that existing facilities are sufficient only for the existing situation. There is a need for kinder gardens with total area of 2184m^2, elementary schools with total area of 62400m^2, high schools with total area of 62400m^2, socio-cultural facilities with total area of 15000m^2, government offices with total area of 9000m^2 and health facilities with total area of 30000m^2 for the new inhabitants of the area.

5.5. Overview of the Geothermal Energy Sensitive Alternative Plan of Balçova Case Area

As a result, alternative 1/1000 development plan is occurred about decisions and figures of 5.9 the plan based on the use of geothermal energy district heating system. Benefit from geothermal energy for a larger percent of the population was aimed along with the efficient use of geothermal energy. Notes of proposed plan were determined as follows;

- Through the entire research, the focus was on the regulation related to "the Law of Geothermal Resources and Mineral Waters". *(The aim is to provide a relationship between the laws of geothermal energy utilization and planning discipline, thus the common laws are established.)*
- On the total of the case area, geothermal conservation zones must be marked clearly: *(The aim is to determine the geothermal zones, since it has strong influence in the context of planning. Although Balçova district is already a geothermal region which has been studied thoroughly and has detailed data, the data on zones are out dated, therefore new definition for borders of geothermal zones is necessary),*
- Both the location of existing wells and potential ones are determined on the whole case area and heating centers will be marked on the plan. *(the aim is to attract attention to spatial awareness of geothermal sources and let these be specified on the implementation plans of the region),*
- On the whole planned area, trading of parcels that are public land ownership (treasury, municipality, etc.) should not be permitted. *(The aim is to emphasize the necessity that these areas are public landownership for drilling geothermal wells*

and different infrastructure studies. To execute studies on private land ownership create problems),

- Density in the study area is; in areas with garden apartments range from 2.60 to 2.80 FAR, in areas with high rise apartments is around 2.50 FAR,
- Building heights in residential housing areas in the case area has been determined as 12.80 m (4 stories). *(The aim is to use geothermal energy more efficiently in areas where 2,3,4-story houses exist; the areas labeled as separated, adjacent and block structuring style in the existing implementation plan),*
- In settlements of site type in the case area, the height of house has been determined as 24.80 m, in the existing situation. *(The aim is to provide energy efficiency by conserving open spaces to be used for parking place, play ground for children etc., and providing open spaces for geothermal energy use in compulsory situations),*
- In the planned area, unit area of usage will not exceed 1200 m^2. *(The aim is to convert the disadvantage occurring due to the difference between the existing unit square meter and residence equivalent into advantage and provide more units with geothermal energy),*
- In every building in the planned area, residence-office (business etc.) usage ratio will be 4/1. *(The aim is to provide a balance the day /night energy use of the building in order to increase energy efficiency),*
- In site type settlements in the study area, the existing usage must be opened to ¼ ratios for offices. *(The aim is to utilize the energy efficiency from residence-office ratio).*
- Green areas in the study area will not be opened to a different usage or common usage with something else: *(The aim is to create appropriate conditions (such as distance etc.) to offer applicability of opening new wells in the already dense texture of the region)*

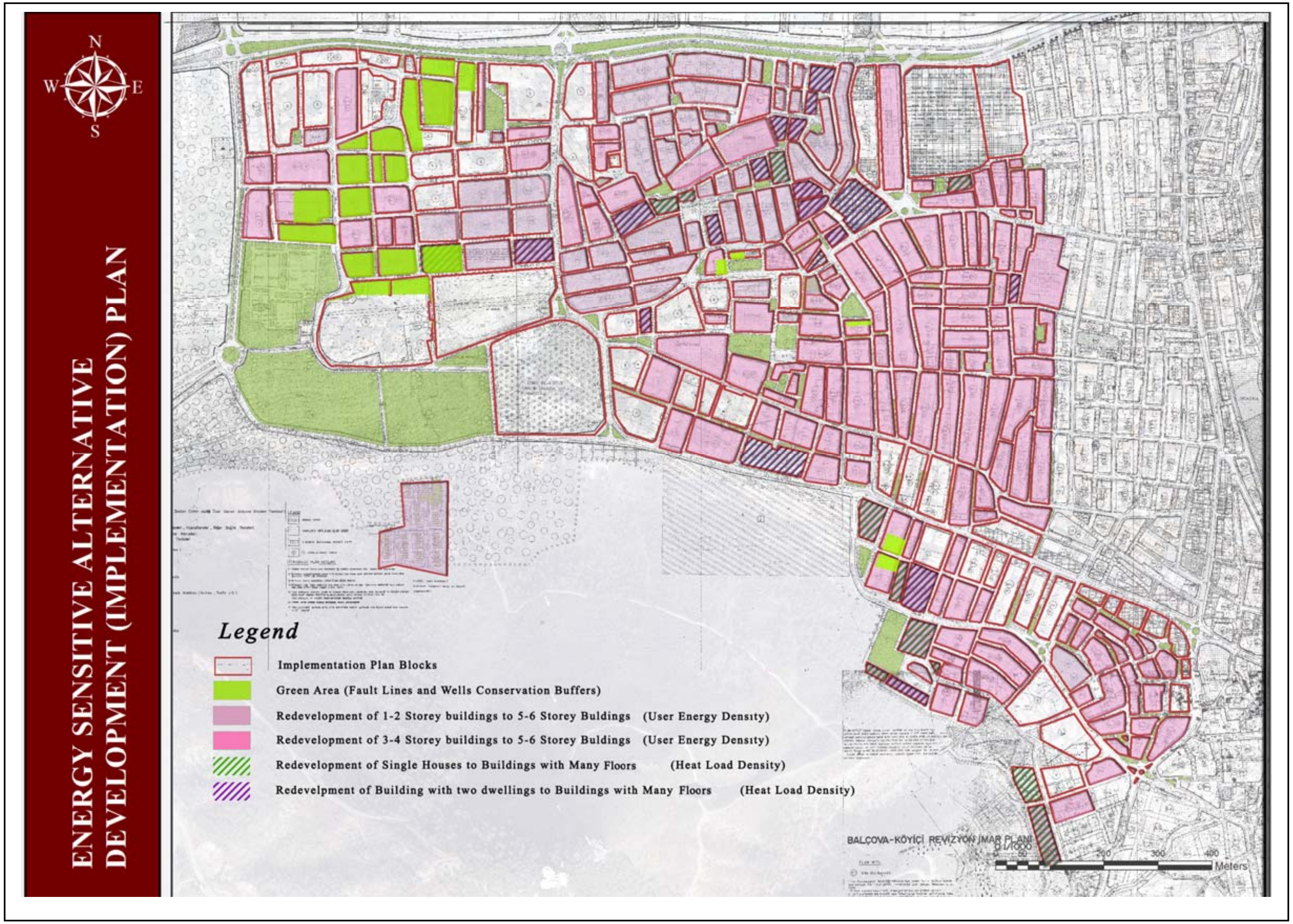


Figure 5. 7. Geothermal Energy Integrated Alternative Urban Land-use Plan

CHAPTER 6

CONCLUSION

The energy conservation problems observed on the land-use, socio-economic structure and policy specific to Balçova district, can in fact be generalized to all other areas in our country; (1) the lack of regional and national policies for effective use of geothermal resource, (2) mismanagement of geothermal resource and infrastructure system, (3) misguided local politics and worries and (4) inefficient land-use allocation and planning process.

Therefore, the current study has brought two significant new inputs to literature. The main focus subject is the simulation methodology development. In general recommendations perspective, this study practically intends to make contribution to energy sensitive alternative development plan, which is formed in the direction of land-use decisions perceptive to the use of geothermal energy for district heating. The holistic point of view that explains relationship between geothermal energy and planning process that are mounted on three pedestals: land-use, socio-economic structure and policy in policy-planning-project process.

According to energy sensitive development (implementation) plan approach, two major determinants have been emphasized in the relationship of geothermal energy district heating system to land-use. (1) Density decisions in relation to efficient use of energy where the increase of the residential density provides more advantage for efficient use of energy for special case of geothermal energy use, the fact that higher density can be accepted as an input for energy sensitive alternative plan view point. (2) Land-use type in relation to efficient use of energy is one of the inputs that come forward in regions where geothermal energy exists. In undeveloped but planned regions it necessary to plan in the direction of industrial- commercial and residential planning where the existing land conditions are appropriate such as;, heating and cooling functions in residential, industry etc. land-uses and greenhouses, and thermal use must be integrated into these functions. In regions where there are settlements, first mix-use must be preferred all other geothermal uses (well, heating center, infra structure etc.) must be included in plans, where spatial needs must be met.

In this thesis, the most important acknowledgement is given to (1/1000) scaled development plan for Balçova, which is already ideal. On the energy efficiency aspect, the existing development plan and the energy sensitive alternative plan have been compared on the basis of existing situation and the situation in which geothermal energy is used as the main input. Therefore, the concept of "fidelity" is important when to what degree the alternative plan is based on the geothermal energy district heating system (GEDHS). The district of Balçova in the province of İzmir determined as the "case area" in this thesis, because it is one of the best models in Turkey with regard to the ever existing relation between geothermal energy source and built environment.

According to specific results taken by the proposed simulation method in the application stage of the study, "energy sensitive alternative development plan" is found sensitive to geothermal district heating. The method had been developed using a novel comparison-based simulation method. In this application, simulated approach proposes *to maximize energy efficiency* and *to maximize fidelity to the development plan* constraints, thus optimization to be integrated into planning. Parcel size and vacancy for drilling and fault line, heat load density of buildings, user energy density (land block density types), residence equivalence- existing building ratio and mixed land-use (residence-office ratio) were determined as the factors affecting development plan in the simulation. These variables and the fidelity concept has been both determined in the development of the proposed simulation.

As a result of sample study on the development plan, 13384 residence equivalent (RE) units were added to the study area, the heating needs of these units have been provided from energy of 73489935kcal/h saved from the efficient use of the five variables mentioned previously. Corresponding residence equivalent value in appropriate conditions is a value of 10360 units.

Separately, the literature corresponding value of the above mentioned values in the context of energy is an increase of 29% in building density, a decrease of 14% in office areas in terms of land balance based on office-housing use, a 35% rise in housing areas, a rise 0f 11% in green areas, a 15% transfer from private to public in land ownership and finally a 30% increase in population.

According to explanatory variables, existing situations and to propose a suggestion about the relationship between geothermal energy and planning decisions is the other goal of the thesis. The analysis of the existing situation and suggestions of changes for all parameters is expressed in detail as per project-plan-policy process.

- Since the local press created *local agenda* which is the variable of the policy process, people have general information about Balçova district heating system. However, some exaggerated information that appearing in local press causes local politicians to pursue opportunities and create great differences than general expectations. This causes the expectations of the local people to decrease and become indifferent from the subject matter. Although thermal energy district heating systems come forward in the agenda in İzmir, people are not aware that the system constitutes an example for other future considerations in the country. Separately, there is an accumulation of knowledge through overhearing. Informing people about the activities and aims, and furnishing with true and real information can be a solution for the creation of false agenda.

  Despite the local agenda which is interested to a certain degree in geothermal energy, the problem of *community perception and interest on the projects* was determined. Attention and interest of the residents of Balçova in GEDHS is very limited. Thus, there is a problem in people's participation in the matter. Although their knowledge on the fields of usage is limited, people living just around the zones where the system is established have a great deal of information about the geothermal system and its operations. İzmir Geothermal CO. which is the operator of the heating system, and Balçova Municipality are great stakeholders in GEDHS in Balçova district. When the project is checked, it is obvious that paying more attention on the project constitute participation force in this kind of spatial projects. In such studies, local government, firms, are as important as local agenda for getting the support local people. For this reason, importance must be given to informing the local people and establishing platform needed to share their expectations.

  NGOs' interest in such projects is an example of significance. Generally, it is difficult to attract the attention of non-government organizations (NGOs) to such projects; however this had not been a problem in "Balçova GEDHS project". There is the Association of Users of Geothermal Energy with 3000 members in this district for many years. This formation which is a great chance in the sense of participation is unfortunately an element of tension due to inadequate communication. There are problem between İzmir Geothermal CO.

and the Association of Geothermal Energy Users has been carried to the court. Ineffectiveness of the project operators in drawing local people into the project underlines the importance of the NGO subject. Instead of creating mutual problems, NGOs should be integrated with the project and broaden participation as much as possible.

The variable of *inadequate communication* constitutes the basis of all problems mentioned above; problems confronted between the operator firm and local people, the operator firm and local civil organization, local government and press, local government and local people. Increasing the communication as much as possible, even establishing an organization in this mater can be a suggestion for solution.

The fact that people who are charged at high, effective national levels who are also -called the *policy or decision makers* do not have the necessary accumulation of knowledge about geothermal energy projects. This causes them to stay indifferent to energy saving which receive national and international interest. However, in countries like Turkey, which is poor in terms of primary energy sources (petroleum, natural gas, etc.), alternative e energy types such as geothermal, wind, solar, etc. can be seen as a solution that would reduce dependency on foreign energy resources. In regions where it is put into practice, it is observed that geothermal energy can enable the conventional energy to be used for more efficient ways.

According to *misguided developers' interest and imbalanced market* variable, energy market policies, and the formation of required legal regulations would open the way. For this reason, existing regulations must be initiated and private sector must be encouraged. What is important here is that interest of the private sector must be drawn to the subject of geothermal energy in the light of holistic strategies. In addition the state's protective, applicative, and supervisory role should be realized at the highest level through effective studies.

The last variable in relation with subject of policy at national level at this very important point is at the stage of *inadequate laws and regulations*. The fact that there had been no special laws or regulations for geothermal energy until 2007 had been a great deficiency. The geothermal energy is a conjunction of many disciplines, starting from the process of prospecting, locating through the process of taking it out, using and sending it back again. Many professions take part in this energy process. According to the newly enacted law related branches of professions are not defined in detail, which can be seen as a deficiency, as well.

- In case geothermal reservoirs are situated within the lower strata under residential regions, residential plan must be shaped according to geothermal resource and studies on physical plans must be stated clearly in the related law. In order for the geothermal systems to form unity with land-use decisions in planning process, development plans especially in existing geothermal regions, must be prepared in an integrated way and they must be put into the law as an important article.

In the planning process, the explanatory variables coming together have been determined as the group of *inefficient land-use allocation and planning process*. The land-use issue, which is mentioned in the literature before has gained importance in terms of land-use decisions in regions where geothermal energy is used in residential areas for district heating purposes. It manifests itself as an important parameter; inappropriate land-use allocation and zoning, untidy land block density (user energy density), unused residence and office ratio (mixed land-use), less residence equivalent and existing building ratio, private land ownership, congested parcel size and vacancy and sufficient heat load density of buildings.

Regions with geothermal districts are in fact special areas in terms of planning. Concepts of *land-use allocation and zoning* have been formed in these regions depending on certain variable. Although there are not many examples, planning approach in our country for the settlement areas in geothermal regions consists only of the determination of the conjectural zone. In settlements, where real geothermal fields exist, land-use decision should play an important especially when it is going to be utilized for certain purposes. On geothermal reservoir (especially the drilling phase), industrial zoning is normally more acceptable than commercial, and commercial more than residential. Noise, aesthetic intrusions and general disruption are almost entirely a function of the temporary drilling phases of the project.

"Height of buildings" and "number of units" can be used as variable on areas where geothermal energy district heating system is supplied. In the light of these parameters called *user energy density*, in high dense areas, geothermal energy can be used more efficiently for heating purpose compared to low dense ones. Consequently, low dense housing areas can be turned into more dense residential areas when the time comes to renew these regions.

The variable of *residence and office ratio (mixed land-use)* indicates land-use type which is applied in ordinary plans on parcels fronting main streets. But in regions where geothermal energy heating systems exist, this variable is a very important input in terms of energy efficiency. Especially, the units with ¼ ratios (four residences and one office) enable us to catch the maximum efficiency in energy use. These parameters have not been used adequately in Balçova district.

The variable called *residence equivalent and existing building ratio* is a variable which comes out during the analyses conducted in Balçova district. The concept of residence equivalent stems from the need to calculate necessary amount of energy to heat $100m^2$ units of residence (house). The size of a house determines the amount of energy to be used; therefore this criterion came out as an important outcome. Geothermal energy which is used in many places in the world has been utilized as a state policy to heat small houses with crowded household in poor sections. However in Turkey this serves rich regions and has become a symbol determining the status. Especially, in the Balçova example, the fact that there are houses much over $100m^2$ in the region seems to be a negative application in this respect. The provision that the size should not exceed certain amount of floor area must be included into plans in house settlements based on geothermal energy in the sense of sample study.

Another land-use input is the variable of *private land ownership*. Especially on settlements where geothermal energy is provided, it is advised that ownership should be in the hand of public rather than private. The reason why the land ownership should be in the hands of public is that people do not want to face a long lasting noise problem when it is necessary to drill a well and set up a geothermal system. When criticized from this perspective, it can be seen that there is a big problem in Balçova district. There are parcels of which % 99 is owned by private persons. For this reason, even a small place cannot be found when it is necessary to drill a well and land belonging to the public should better not be sold out for future project needs.

The variable of *parcel size and vacancy* is an important variable in geothermal regions where it is necessary to drill new wells and set up new heating centers. For this reason creation of vacancies and leaving space between them is extremely important.

The *sufficient heat load density of buildings* variable, like many other land-use variables, came with the concept of density. Here, the density stressed in terms of the ratio of number of residence (house) units and the square meter of parcels. According to this variable, an increase in density, that is to say, the fact that the number of residences on one parcel is excessive does not reflect adequate understanding in panning. For this reason a high value in heat load density of buildings is a positive thing in the effective use of geothermal energy district heating.

- In the project process, *mismanagement of geothermal resource and infrastructure system* has been was determined as the first problem. In this group which is based on the nature and technology of the geothermal energy itself, there are the following explanatory variables, adequate geothermal capacity, well-established geothermal technology, improved geothermal infrastructure system and incompletion of geothermal conservation zone map. Although there are variables brought together under a negative statement in this group, improvements in application and technology have positive effects on the solution of the problems.

The variable of *adequate geothermal capacity* that parallel to the improving technology, the techniques were has also improved and using these techniques would establish a rather wider area with a higher capacity for heating the Balçova district has spreads to a rather wide area and that its capacity is sufficient for heating the district. Although it is one of the regions in Turkey where a number of studies are conducted, these studies remain stay insufficient at the point of drilling wells in certain locations. The drilled wells are not in a sufficient number and no clear decisions are reached about the real borders of the reservoirs. First of all, definite information must be obtained about the reservoir by drilling wells. This study must be used as an input for the planning of the settlements over the reservoir. In such regions, where the reservoir has not been determined accurately, making ordinary plans may create problems both for the realization of the settlement and for the installation of district heating system.

Whereas underground geothermal zone boundaries cannot be determined clearly, the problem of *incompletion of the geothermal conservation zone map* comes out. Under this new regulation, three graded conservation zones were redefined and gave opportunity for certain types of development. Redefined definitions in the Regulation about the Geothermal Law must definitely be reconsidered.

Finally, this study is an experimental one, which many future studies should be built on to. The type of geothermal energy chosen for the study, the nature of Balçova settlement, the use of geothermal energy in district heating and the fact that geothermal field and urban settlement juxtapose another created restrictions problems for this research. In the aspect of the main speculation created in the scope of this thesis, there is still a need for new studies on different areas and different energy types. In example, solar and wind energy based studies are needed. Besides, variables stated in previous studies, Pasqualetti 1986 and 1989; Toksoy 2001; Gülşen 2003, on the relationship between GEDHS and land-use decisions, and the new parameters added will inevitably be developed in the future studies.

REFERENCES

Agyeman, Julian, Robert D. Bullard, and Bob Evans, eds. 2003. *Just sustainability's: development in an unequal world.* London: The MIT Press.

Aksoy, Niyazi. 2005. Balçova-Narlıdere jeotermal sahası rezervuar gözlemleri:2000-2005. *Proceedings of the Geothermal Energy Symposium*. İzmir: The Chamber of Mechanical Engineering Pub.

Anderson, W.P. 1996. Urban form, energy and the environment: A review of issues, evidence and policy. *Urban Studies* 33 (1): 7-35.

Arkoç, Veli. 2006. *Balçova*. İzmir: Türev Matbaacılık.

Babbie, Earl R. 1990. *Survey research methods.* Washington: Watsworth Publishing.

Balçova Local Government. 2007. İlçemiz hakkında genel bilgiler. http://balcova.gov.tr (accessed November 8, 2007).

Balçova Municipality. 2007. Balçovayı tanıyalım. http://www.balcova.bel.tr (accessed November 4, 2007).

Balocco, C. and G. Grazzini. 1997. A statistical method to evaluate urban energy needs. *International Journal of Energy Research* 21: 1321-1330.

Ball, David.J., Collien Fernandes, Hutchinson, Dorothy W. eds. 1981. *Energy use in London.* London: Transportation and Development Department and Scientific Branch, Greater London Council, County Hall.

Banister, D., S. Watson and C. Wood. 1997. Sustainable cities: Transport, energy and urban form. *Environment and Planning* 24: 125-143.

Barth, Hans G. and Günter Baumbach. 2001. *Air quality and urban development in İzmir-Turkey.* Hannover: Pro Universitate Verlag Sinzhein.

Beaumont, John R. and Paul Keys, eds. 1982. *Future cities: Spatial analysis of energy issues.* Chichester: John Wiley & Sons Ltd.

Beaumont, J.R., M. Clarke and A.G. Wilson. 1981. Changing energy parameters and the evolution of urban spatial structure. *Regional Science and Urban Economics* 11: 287-315.

Beck, Horace. 1973. *Folklore and the sea.* NY: Mystic Seaport Museum.

Beddoe, M. and A. Chamberlin. 2003. Avoiding confrontation: Securing planning permission for on-shore wing energy developments in England: Comments from a Wind Energy Developer. *Planning Practice & Research* 18 (1): 3-17.

Bergman, Lars. 1976. *An Energy Demand Model for the Swedish residential sector.* Stockholm: Swedish Council for Building Research.

Blechschmidt, Katrin. 2001. *Spatial planning in Poland and Estonia for promoting energy efficiency and renewable energy sources.* Holstein: Theoretical Back round Pub.

Boyden, Stephen, Sheelagh Millar, Ken Newcombe, and Beverley O'Neill, eds. 1981. *The ecology of a city and its people: The case of Hong Kong.* Canberra: Australian National University Press.

Butera, Federico, Francesco Mereu, Giorgio Schultze, and Gianni Silverstrini, eds. 1995. *Introduction of the energy parameter in the master plan of a large european town.* Palermo: Municipality Pub.

Burchell, Robert W. 2002. *Costs of sprawl- 2000.* NY: National Research Council Transportation Research Board.

Byme, Barbara M. 2001. *Structural equation modeling with AMOS: Basic concepts, applications, and programming.* NJ: Mahwah Erlbaum.

California Energy Commission, Washington Energy Office and Oregon Department of Energy, eds. 1996. *The energy yardstick: Using place's to crete ore sustainable communities.* WC: Energy Office Pub.

Capello, R. and P. Nijkamp. 1999. *Sustainable cities and energy policy.* Berlin: Springer-Verlag Pub.

Center of Urban Planning and Environmental Management, 2004. *Capacity building for renewable energy in Hong Kong: Opportunities and constraint.* HK: University of Hong Kong Press.

Coles, D., Y. Vichabian, R. Fleming, C. DesAutels, V. Briggs, P. Vermeesch, J.R.Arrell, L. Lisiecki, T. Kessler, H. Hooper, E. Jensen, J. Sogade and F.D. Morgan. 2004. Spatial decision analysis of Geothermal Resource Sites in the Qualibou Caldera, Saint Lucia, Lesser Antilles. *Geothermics* 33: 277-308.

Combine Heat Power (CHP) Group. 1979. *Combined heat and electrical power generation in the United Kingdom. Energy Paper 20,* edited by the District Heating Working Party of the Combined Heat and Power Group. London: HMSO.

Clandinin, D. Jean and F. Michael Connelly, eds. 2000. *Narrative inquiry: Experience and story in qualitative research.* San Francisco: Jossey-Bass Press.

Clark, James W. 1974. *Defining an urban growth strategy which will achieve maximum travel demand reduction and access opportunity enhancement.* Seattle: Washington University Press.

Creswell, John W. 1998. *Qualitative inquiry and research design: Choosing among five traditions.* Thousand Oaks CA: Sage Publications.

Creswell, John W. 2003. *Research design: Qualitative, quantitative, and mixed methods approaches.* London: Sage Publications.

Dantzig, George D. and Thomas L. Saaty. eds. 1973. *Compact city: A plan for a livable urban environment.* NY: WH Freeman.

Dendrinos, D.S. 1979. A basic model of urban dynamics expressed as a set of Volterra-LOtka equations. *Department of Transportation report of U.S.* 25: 121-155.

Dinçer, İ. 2000. Renewable energy and sustainable development: A crucial review. *Renewable and Sustainable Energy Reviews* 4 (2): 157-175.

Edwards, Jerry L. and Joseph L. Schofer. eds. 1975. *Relationships between transportation energy consumption and urban structure: Results of simulation studies*. Minneapolis: University of Minneapolis, Department of Civil and Mineral Engineering Press.

Erbaş, E. 2002. Enerji kullanımı ve yerleşme alanları planlaması. *Planlama.* 2002 (2-3): 56-64.

European Commission. 2003. Business opportunities in the geothermal energy sector in Turkey. *The report of Energy Programme Action* 5: 2000.

Fanchiotti, Attendee. 1993. *Day lighting in architecture, a European reference book.* Brussels: Commission of the European Communities Pub.

Gadsden, S., M. Rylatt, K. Lomas and D. Robinson 2002. Predicting the urban solar fraction: A methodology for energy advisers and planners based on GIS. *Energy and Buildings 1458:* 1-12.

Galtung, Johan. 1967. *Theory and methods of social research.* Berlin: Universitettsfolaget Pub.

Geothermal Education Office. 2007. Direct (non-electrical) uses of geothermal water. http://www.geothermal.marin.org (accessed July 5, 2007).

Geothermal Energy Association (GEA). 1993. *U.S. geothermal power plant data sheet.* California: GEA Press.

Geothermal Resources Council. 2008. Geothermal Resources Council goals. http://geothermal.org (accessed February 17, 2008).

General Directorate of Mineral Research and Exploitation (MRE). 2008. *The report of geothermal conservation zone.* Ankara: MRE Publications.

Gordon, P., A. Kumar and H. Richardson. 1989. Congestion, changing metropolitan structure and city size in the United States. *International Regional Science Review.* 12: 45-46.

Goumas, MG., V.A. Lygerou and L.E. Papayannakis. 1998. Computational methods for planning and evaluating geothermal energy projects. *Energy Policy* 27: 147-154.

Gülşen, Engin. 2005. *Planning and design of a new geothermal neighborhood heating system of 2*5000 dwellings in Balçova.* İzmir: IZTECH Press.

Hemmens, G. 1967. Experiments in urban form and structure. *Highway Research Record* 207: 32-41.

Hepbaşlı, A. and C. Çanakçı. 2003. Geothermal neighborhood heating applications in Turkey: A case study of İzmir- Balçova. *Energy Conservation and Management.* 44: 1285- 1301.

Hietter, Laurie M. 1995. *Introduction to geothermal development and regulatory requirements* in *Environmental aspects of geothermal development.* Edited by K.L. Brown. Pisa: International Institute for Geothermal research Pub.

Hui, S.C.M. 2000. Low energy building design in high density urban cities *Proceedings of the Sixth World Renewable Energy Congress*, Brighton, UK.

Hull, A. 1995. Local strategies for renewable energy. *Land-use Policy* 12: 7-16.

Iglesias, Eduardo. 2000. *Proceedings of the World Geothermal Congress 2000*, Kyushu- Tohoku: International Geothermal Association Pub.

Iniyan, S. and T.R. Jagadeesan. 1998. A comparative study of critical factors influencing the renewable energy systems use in the Indian context. *Renewable Energy* 11 (3): 299-317.

Institute for Energy Engineering. 2002. *Proceedings of the 15th International Conference on Efficiency, Costs, Optimization, Simulation and Environmental Impact of Energy Systems*. Berlin: Technische Universitat Berlin Press.

International Geothermal Association. (2006). Bylaws. http://iga.iggicnr.it (accessed May 19, 2008.

Ivancic, Alexander. 2004. *Local energy plans- A way to improve the energy ealance and the environmental impact of the cities: Case study of Barcelona.* Barcelona: ASHRAE Pub.

İzmir Geothermal Incorporate Company (IGIC), 2007. *The report of geothermal energy usage in Balçova.* İzmir: IGIC Pub.

Jansson, A.M. and J. Zuchetto. 1978. Man, nature and energy flow on the Island of Gotland. *Ambio* 7: 140-149.

Jebson, D.A. 1981. The effect of variations in the distribution of heat demand on the cost of district heating networks. *Proceeding of the Forth District Heating Association's National Conference* Torquay: Garston, Watford, Herts.

Jessop, Bob. 1978. *Capitalism and democracy: The best possible political shell?* in *Power and the State.* Edited by G. Littlejohn. London: Croom Helm Pub.

Jesus, Agnes C. 1995. *Socio-economic impacts of geothermal development* in *Environmental aspects of geothermal development.* Edited by K.L. Brown. Pisa: CNR pub.

Jick, T.D. 1979. Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly* 24: 602-611.

Kaygusuz, K. 2002a. Environmental impacts of energy utilization and renewable energy policies in Turkey. *Energy Policy* 30: 689-698.

Kaygusuz, K. and M.F. Türker. 2002b. Review of biomass energy in Turkey. *Energy Sources* 24: 383-401.

Keçecioğlu, Tamer. 1990. *Türkiye'de stratejik enerji planlamasında güneş enerjisinin yeri.* İzmir: Ege University Press.

Kenworthy, J. and F. Laube. 1999. A global review of energy use in urban transport systems and its implications for urban transport and land-use policy. *Transportation Quarterly* 53 (4): 23.

Kenya Electricity Generating Company (KenGen), 2000. *Annual report and accounts.* Nairobi: KenGen.

Keppel, Geoffrey. 1991. *Design and analysis: A Researcher's Handbook.* NJ: Prentice Hall Pub.

Khan, J. 2003. Wind power planning in three Swedish Municipalities. *Journal of Environmental Planning and Management* 46 (4): 563-581.

Kleinpeter, Maxime. 1995. *Energy planning and policy.* West Sussex: John Wiley & Sons Ltd. Pub.

Klosterman, Richard. 2001. *Planning support systems: A new perspective on computer-aided planning* in *Planning support systems.* California: ESRI Press.

Krause, D.W. 2001. Fossil molar from a Madagascar Marsupial. *Nature* 412: 497-498.

Kutluca, Ahmet K. and Gülden Gökcen, eds. 2007. *Jeotermal elektrik üretiminin sosyo-ekonomik etkileri: Kızıldere jeotermal sahası* in *Jeotermal enerjiden elektrik üretimi.* Edited by N. Aksoy. İzmir: MMO Pub.

Kwartler, Michael and Robert N. Bernard, eds. 2001. *Community-viz: An integrated planning support system* in *Planning support system.* Edited by R.K. Brail, R.E. Klosterman. California: ESRI Press.

Lagarde, Olivier. 2005. Association. http://www.energie-cites.org (accessed September 11, 2007).

Lantsberg, Alex. 2005. *Sustainable urban energy planning a roadmap for research and funding.* CA: California Energy Commission.

Lariviere, I. and G. Lafrance. 1999. Modeling the electricity consumption of cities: Effect of urban density. *Energy Economics* 21: 53-66.

Lash, J. 1999. Sustainable communities. *The bridge* 29 (4): 15-18.

LeCompte, Margaret and Jean J. Schensul, eds. 1999. *Designing & conducting ethnographic research.* Walnut Creek, CA: Altamira Press.

Local Governments for Sustainability. 2008. Developing institutional and social capacities for urban sustainability (DISCAS). http://web.iclei-europe.org (accessed January 12, 2008).

Longmore, J. and J. Musgrove. 1983. City development and planning as aids to transport system design and energy conservation. *Habitat International* 7 (3-4): 89-98.

Lundqvist, Lars, Goran Mattsson and Erik A. Eriksson, eds. 1985. *Spatial energy analysis.* Vermont NY: Gower Publishing Company.

Lyle, John T. 1994. *Regenerative design for sustainable development.* NY: John Wiley & Sons Published.

Lynch, Loretta and Michael Kahn, eds. 2000. *Summer 2000 report to governor Davis Regarding California's electric system.* California: California Public Utilities Commission Pub.

Manologlou, E., P. Tsartas, and A. Markou. 2004. Geothermal energy sources for water production, socio-economic effects and people's wishes on Milos Island: A case study. *Energy Policy* 32: 623-633.

Mariita, N.O. 2002. The impact of large- scale renewable energy development on the poor: environmental and socio- economic impact of a geothermal power plant on a poor rural community in Kenya. *Energy Policy* 30: 1119-1128.

Martinez-Alier, J. 2003. Scale, environmental justice, and unsustainable cities. *Capitalism, Nature, Socialism* 14 (4): 43.

Marvin, S., S. Graham and S. Guy. 1999. Privatized networks, cities and regions in the UK. *Progress in Planning* 51 (2): 89-165.

Mathieu, Helie. 1978. The role of urban planning in relation to overall adaptation to the new energy context: Some broad lines of a possible strategic orientation. *Proceeding of the First International Conference on Energy and Community Development*. Athens.

Means, Edward I. 2004. *Water and wastewater industry energy efficiency: A Research Roadmap.* CA: Awwa Research Foundation and California Energy Commission Pub.

McGeough, Una, Doug Newman and Jay Wrobel, eds. 2004. *A blueprint for urban sustainability: Integrating sustainable energy practices into metropolitan planning.* California: Gas Technology Institute.

McGranahan, U. and David Satterwhaite, eds. 2003. Urban centers: An assessment of sustainability. *Practices into Metropolitan Planning.* (Gas Technology Institute, CA).

Mertens, Donna M. 2003. *Mixed methods and the politics of human research: The transformative-emancipator perspective* in *handbook on mixed methods in the behavioral and social Sciences.* Edited by A. Tashakkori & C. Teddlie. Thousand Oaks, CA: Sage Publications.

Mertoğlu, Ö. 2002. Turkey'de jeotermal enerji. *Enerji Dünyası, DEK, Türk Milli. Komitesi Bülteni* 45: 26-38.

Miles, Matthew and Michael Huberman, eds. 1994. *Qualitative data analysis.* Thousand Oaks, London: Sage Publications.

Moustakas, Clark. 1994. *Phenomenological research methods.* Thousand Oaks, London: Sage Publications.

Murphy, Allan H. 1990. The benefits of meteorological information: Decision-making models and the value of forecasts. *Proceedings of Technical Conference, Economic and Social Benefits of Meteorological and Hydrological Services, World Meteorological Organization*. Geneva, No. 733.

Naess, P. and S.L. Sandberg. 1996. Workplace location, modal split and energy use for commuting trips. *Urban Studies* 33 (3): 557-580.

Nakata, T., K. Kubo and A. Lamont. 2005. Design for renewable energy systems with application to rural areas in Japan. *Energy Policies* 33: 209-219.

New Mexico Energy Institute. 1980. *Geothermal energy: National estimate for direct use.* Las Cruces, NM: New Mexico Energy Institute.

Nijkamp, Peter. 1994. *Sustainable city initiatives in Europe.* London: Earthscan Publications.

Odell, Daniel K. 1975. *Studies on the biology of the California Sea Lion and the Northern Elephant Seal on San Nicolas Island, California*. Los Angeles: University of California.

Organization for Economic Co-operation and Development (OECD). 1995. *Urban energy handbook.* Paris: OECD Publication Service.

OSTİA. 1998. *Membro effettivo di matematica e fisica nella LXIII Commissione di maturità scientifica presso il liceo scientifico labriola.* Roma: Via Capo Sperone.

Oulton, A. J enny. 1982. *British library and information research report no. 1.* London: British Library.

Owens, Susan E. 1986. *Energy, planning and urban form*. London: Pion Pub.

Owens, Susan E. 1989. *Models and urban energy policy: A review and critique in spatial energy analysis.* Edited by L. Lundqvist, L.G. Mattsson and E.A. Eriksson Avebury: Aldershot.

Parriaux, A., L. Tacher and P. Joliquin. 2004. The hidden side of cities- towards three-dimensional land planning. *Energy and Buildings* 36: 335-341.

Pasqualetti, M.J. 1980. Geothermal energy and the environment: The global experience. *Energy: The International Journal* 5: 111-165.

Pasqualetti, M.J. 1986. Planning for the development of site-specific resources: The example of geothermal energy. *Applied Geography* 38 (1): 82-87.

Patton, Carl V. and David S. Sawicki eds. 1993. *Basic methods if policy analysis and planning.* Englewood Cliffs NJ: Prentice-Hall.

Peker, Zeynep. 2004. *Integrating renewable energy technologies into cities through urban planning: In the case of geothermal and wind energy potentials of İzmir.* İzmir: İzmir Institute of Technology Pub.

Pira, E., M. Turbiglio and M. Maroni. 1999. Mortality among workers in the geothermal power plants at Larderello. *American Journal of Industrial Medicine* 35: 536-539.

Poston, T. and A.G. Wilson. 1977. Facility size versus distance traveled: Urban services and the fold catastrophe. *Environment and Planning A.* 9: 681-686.

Ravetz, Joe. 2000. *City-region 2020: Integrated planning for a sustainable environment.* London: Earthscan Pres.

Raja, R. 1997. Energy planning and optimization model for rural development- A case of sustainable agriculture. *International Journal of Energy Research* 21: 527-547.

Reddy, B.S. and P. Balachandra. 2003. Integrated energy- environment- policy analysis: A case study of India. *Utilities Policy* 11: 59-73.

Romanos, M.C. 1978. Energy-price effects on metropolitan spatial structure and form. *Environment and Planning A.* 10: 93-104.

Rotmans, J., M. Asselt and P. Vellinga. 2000. An integrated planning tool for sustainable cities. *Environmental Impact Assessment Review* 20 (3): 265–276.

Royal Town Planning Institute (RTPI). 1996. *Dealing with Racist representations.* London: The Royal Town Planning Institute.

Sadownik, B. and M. Jaccard. 2001. Sustainable energy and urban form in China: The relevance of community energy management. *Energy Policy* 29: 55-65.

Santamouris, Mat. 2001. *Energy and climate in the urban built environment.* London: James & James Ltd.

Sassin, W. 1981. Urbanization and the energy problem. *International Institute of Applied Systems Analysis* 3: 1-4.

Serpen, U. 2003. Jeotermal enerji yasa taslağı ile ilgili öneriler. *Proceedings of IX. Energy Congress:* 201-210.

Seymen, Ülker B. 1988. *Mekan organizasyonu bilimlerinde bilgi kuramsal açınımlar.* İzmir: Dokuz Eylül University Press.

Sieber, R. 1973. Ede: Crafts and surveys. *African Arts* 6 (4): 44-49.

Smart Communities Network Creating Energy Smart Communities. 2008. Land-use Planning Introduction. http://www.smartcommunities.ncat.org (accessed June 5, 2008).

Sommer, C.R. M.J.Kuby and G. Bloomquist. 2003. The spatial economics of geothermal neighborhood energy in a small, low- density town: A case study of Mammoth Lakes, California. *Geothermics* 32: 3-19.

Stake, Robert. 1995. *The art of case research.* Thousand Oaks, CA: Sage Publications.

Standards Association of New Zealand (SANZ). 1991. *Code of practice for deep geothermal wells.* New Zealand: Wellington Pub.

Steemers, K. 2003. Energy and the city: Density, buildings and transport. *Energy and Buildings* 35: 3-14.

Steiner, F. 1994. Sprawl can be good. *Planning* 60 (7): 14.

Stone, B.J. and M.O. Rodgers. 2001. Urban form and thermal efficiency: How the design of cities influences the urban Heat Island effect. *Journal of the American Planning Association* 67 (2): 186-199.

Strauss, Anselm L. and Juliet Corbin, eds. 1998. *Gronded Theory methodology: An overview* in *handbook of qualitative research.* Edited by N. Denzin and Y. Lincoln. Thousand Oaks, CA: Sage Publications.

Sturm, R. and D.A. Cohen. 2004. Suburban sprawl and physical and mental health. *Public Health* 118 (7): 488-496.

Sustainable Energy Europe. 2007. European Commission recognizes energy-saving efforts in the private sector. http://www.sustenergy.org (accessed June 11, 2007).

Tashakkori, Abbas and C.harles Teddlie, eds. 1998. *Mixed methodology: Combining qualitative and quantitative approaches.* Thousand Oaks, CA: Sage Publications.

Throgmorton, J.A. 1987. Community energy planning: Winds of change from the San Gorgonio Pass. *Journal of the American Planning Association* 53 (3): 358-367.

Toksoy, M., F. Kutluay and C. Çanakçı. 2001. Jeotermal enerji bölge ısıtma sistemlerinde işletme: Balçova örneği *Jeotermal Enerji: Doğrudan Isıtma Sistemleri; Temelleri ve Tasarımı Seminer Kitabı:* 287-305.

Toksoy, M. and A.C. Şener. 2003. Jeotermal bölge ısıtma sistemlerinde kavramsal planlama. *Jeotermal Enerji Seminer Kitabı:* 247-275.

Tucker, Hughr A. 1996. *The open information interchange technology handbook.* Great Britain: Technology Appraisals Ltd.

Turrent, David, John Doggart, and Richard Ferraro, eds. 1981. *Passive solar housing in the UK.* London: Energy Conscious Design.

Ukeles, J.B. 1977.Policy analysis: Myth or reality. *Public Administration Review* 37 (3): 223-228.

United Nations Environment Programme (UNEP). 2002. *Environmental due diligence (EDD) of renewable energy projects: Guidelines for geothermal energy systems.* Nairobi: UNEP.

United Nations Conference on Environment and Development (UNCED). 1992a. *The global partnership for environment and development.* Rio de Janeiro: United Nations Pub.

United Nations Conference on Environment and Development (UNCED). 1992b. *Adoption of agreements on environment and development: Agenda 21. Report of the UNCED Preparatory Committee.* Geneva: United Nations Pub.

United States Department of Energy (USDOE). 1993. *Commercial building survey.* Washington DC: Department of Energy.

United States Department of Energy (USDOE). 1994. *Energy, emissions, and social consequences of telecommuting.* Washington DC: Department of Energy.

United States Geological Survey (USGS). 1980. *Geothermal resources operational orders*. California: US Department of Interior Geological Survey Office of Deputy Conservation Manager.

Waddell, P. 2002. Urbanism: Modeling urban development for land-use, transportation and environmental planning. *Journal of the American Planning Association* 68 (3): 297-314.

Waddell, P., A. Borning, M. Noth, N. Freier, M. Becke and G. Ulfarsson. 2003. UrbanSim: A simulation system for land-use and transportation. *Networks and Spatial Economics* 2 (1): 43-67.

Waddell, Paul. 2004. *Introduction to urban simulation: Design and development of operational models.* Washington: University of Washington Publications.

Walker, G. 1995. Energy, land-use and renewable. *Land-use Policy* 12 (1): 3-6.

Weiler, Kathleen and Candace Mitchell, eds. 1992. *What schools can do.* Albany: SUNY Press.

Wievel, W. and K. Schaffer. 2001. Learning to think as a region. *European Planning Studies* 9 (5): 595-611.

World Council of Renewable Energy (WCRE). 2005. *Solar Habitat in Cities and Villages.* Germany: The World Council of Renewable Energy Pub.

World Bank. 2006. Renewable energy and energy efficiency. http://web.worldbank.org (accessed February 2, 2007).

Yılmazer, S. 1984a. İzmir-Balçova Jeotermal Sahasında ısı üretimine yönelik değerlendirme raporu. *MTA Dergisi* 7504: 18.

Yılmazer, Servet. 1984b. *Ege bölgesindeki bazı sıcaksu kaynaklarının hidrojeolojisi ve jeokimyasali incelemeleri*. İzmir: DEÜ Institute of Science Press.

Yin, Robert K. 2003. *Case study research design and methods.* London: Sage Publications.

Zuchetto, J. and A.M. Jansson. 1979. Integration Regional Energy Analysis for the Island of Gotland, Sweden. *Environment and Planning A* 11: 919-942.

APPENDIX A

NATIONAL STANDARDS, REGULATIONS, CODES AND LAWS RELATED TO GEOTHERMAL ENERGY SUBJECT OF TURKEY

Regulation for Mineral Waters (01.09.1988)

The Regulation for Mineral Waters was constructed for the purpose of describing all kinds of underground waters in a form that contain general sentences aimed at the usage of these waters.

The factor that interests us closely and that is an important binder in this regulation is that some arrangements about "the thermal energy protection bands" which are known as "Thermal Zone" have been made.

Under this regulation, protection areas are classifies under three categories: first-, second-, and third-degree protection areas. According to this grading, first-degree protection areas are generally determined as to be 10-50 meters far away from the source, and the following should be given close attention in these areas;

- All this area should be grass covered.
- Except hot and cold water structures, any structuring should not be allowed (only getting and storing drinking water).
- No piping of sewerage or drainage should be allowed to pass through the area.
- Maneuvering of heavy-load transport vehicles should not be banned within the area.
- No excavation operations such as stone quarry etc. Should be allowed in this area.
- Since any kind of pollution especially around this kind of areas affect the quality of water and health, these areas should be kept very clean (as an example periphery of the water springs and caisson wells). Since even it is possible that the herbicides used against plant diseases can mix with underground water, they should not be used unless it is very necessary.

- In case a boring well is necessary to be drilled, a responsible engineer should be applied to.

Borders of the second degree protection areas were determined to be 50-100 meters,

- No permission is given for those pollutants as trash and rubble that will cause pollution within the area.
- No permission is given for a cemetery in the area.
- No permission should be given for the operation of any stone quarry and dynamite explosion.
- No permission can be given for new structuring in the area; present situation should be protected as it is.
- Technical standards of the buildings should be brought into a better condition.
- Solid and fluid wastes of the buildings within the area should be taken out of the area in isolated containers without causing any leakage.
- Public establishments such as hot spring, and mineral spring within the area on condition that no pollution is caused.
- On the coastline sections of these areas, no permission should be given for those establishments as harbor, pier, and marina and shelter for fishermen.
- Children playgrounds, open sport fields can be established within these areas.
- If any drilling is to be conducted within the area, an engineer should be present.

No limit is present for those protection areas described as a third degree protection area. Points that need attention in these areas can be stated as follows;

- For buildings to be built in this area, it is necessary that a quality sewerage system should be constructed and the wastes to be born should be discharged outside the area.
- Any sort of agriculture can be conducted within this area; farm fertilizers to be used in agricultural activity should be stored outside this area.
- No industrial activity that will pollute the area can be allowed.
- Stone quarries can be opened within the area but no activity for explosion can be allowed.
- In every activity to be done about water, a related engineer should be present.

The law about the amendment in the Energy Production Law (August, 14, 1997, Number of Law: 9670)

Under this Law, mass housing areas encompassing houses exceeding 5000 in number, huge industrial plants, hospital, etc., can be produce their electricity. It will be possible to use technically the energy source already present in the area. Among these energy resources, the types of energy depending on the primary sources of energy as well as the types of alternative energy could take place.

But within the framework of this Law no definition was given on what sort of criteria will be valid in choosing the sort of energy, and in what planning criteria the choice of place will be conducted. Any local or regional planning/projecting or organization to do these activities was not defined. For this reason, the most important thing that lacks here is that within which primes and measurements the relationship between the kind or energy production and planning for settlements would encounter (Erbaş 2002).

Regulation for the Preparation of Project for Geothermal Energy Plants by the Bank of Provinces (25.06.2001)

This regulation, which was put into effect in 2001, is the most important legal arrangement on geothermal energy and urban planning at present. *"Article 1 (Aim)*: *the aim of this regulation is to regulate the principles to be obeyed in preparing projects for geothermal energy plant to be constructed in cities, townships and counties"* (Official Gazette no: 24443). The aim of the Regulation is based on the principle of preparing projects for thermal plants in all settlements from the smallest settlement to cities. With this regulation, it is necessary that permission should be taken from *Special Provincial Department and* the related municipality or the Bank of Provinces should be vested authority for the construction of the plant.

Articles 4, 5 and 6 of the Regulation show the relationship of urban planning discipline within the projects of energy plants. In Article 4 of the Regulation, which is about "Preparing Projects for Geothermal Plants", shows the relationship of urban planning discipline within the projects for geothermal energy plants. In Article 4, which is about preparing projects for geothermal energy plants, what is meant is the process of assessment according to settlement maps and development plan (municipal plan controlling development and construction within an area) in arranging geothermal energy projects.

In “Investigation and planning”, one of the most important articles of the regulation, (Article 5), subject titles and their contents taking place in preliminary study and planning report are stated. This report includes such points as information about the county (its managerial, historical, and geographical state; its demographic, socio-economic, and cultural state; the state of present electric network; state of the present geothermal plant; state of the maps and development plan (municipal plan controlling development and construction within an area), definition of the geothermal resource (temperature, discharge (flow capacity), chemical composition of the water, distance to the place of usage), determining the need for geothermal energy (state of subscribers and buildings, estimated need, climate, population density and kinds of buildings), determining the geothermal source (state of expropriation, general state plan, heating center, state of the network, project preliminary reports).

The last article about planning in the Regulation is Article 6, which bears the title “Principles for project designing”. In this article, the following are stated: general state plan beginning with 1/100000-1/25000-1/10000 scaled thermal source showing location of the waters and the wells, name, temperature and discharge, heating center, depot etc., to 1/2000 and 1/1000 scaled storing place, plans for transferring, distributing and returning pipes, and 1/500, 1/200 and 1/100 cross-sectioned and detail plans.

Except these subjects on the basis of planning, problems about this regulation, which involves such subjects as detailed study on material, model, and cost, stem from the problems arising from the present applications rather than the Regulation itself.

Decision on the Principles and Application Methods for Prospecting for Geothermal Resources in İzmir, Drilling Wells, Operating and Licensing (28.06.2002)

Behind this decision taken by İzmir Governorship lies the fact that wells drilled without any control and supervision creates the threat of vanish for the reserves in İzmir, which has got a considerable geothermal potential. Protecting geothermal resources has got the purpose of allowing them to be bored and used under proper techniques and not creating environmental pollution.

With this decision, it is stated that all transactions such as prospecting for geothermal resources, boring wells, operation, etc. will be conducted by Special Provincial Department; and permission will be obtained from Special Provincial Department including for prospecting cold water. It is emphasized that no transaction of licensing will be applied for prospecting to be conducted but Mine Prospecting Institute (MPI). *Article 1*: *prospecting for geothermal resources present within the provincial borders of İzmir (located or not located yet), transactions for boring well, operating economically, licensing are conducted by İzmir Special Provincial Department under the provisions of the Law No: 927 about the violation of Cold and Hot Spring Resort Waters and Establishments of Hot Spring Resorts.*

Law about the Use of Renewable Energy Resources for the Purpose of Electric Generation (10. 05. 2005, Law No: 5346)

Another important study on law that establishes a relation between the use of thermal energy and the planning discipline is this Law of 5346. Development and construction plans that will affect the use and the efficiency of energy resources called renewable resources such as hydraulic, wind, solar, geothermal, biomass, biogas, wave, current energy and other non-fossil energy resources will not be designed. Again under the provisions of this law, determination or allocation of geothermal resources for the production of electricity and protection will be stated in the regulation. "Article 1 (Aim): *The aim of this Law is to make widespread the use of geothermal energy resources for the production of electricity, putting them safe, economic and qualified way into the economy, increasing resource diversity, decreasing the emissions of greenhouse gasses, making use of the waste, protecting the environment and developing the production sector needed in realizing these aims."* (Official Gazette No: 25819).

In Article 8 of the Law, involves a field which is directly related with the planning discipline. Under this article titled "Applications for the need of land", for the purpose of generating electricity, one of the renewable sources of energy, land taking place in forests or in Land of Treasury can be made use of by taking permission from the Ministry of Forestry or the Ministry of Finance.

Hiring all these lands only for the purpose of generating electricity confronts us as a matter which stands on highly sensitive balances. The fact that forest land and Land of Treasury constitutes potential only for generating electricity, without looking at any other features (natural, cultural, historical, etc.), should not be sufficient cause for hiring (assort of sale) them for a long period of time.

Separately, the Law also involves the subjects which the owners of the license "the Use of Renewable Energy" given by The Energy Market Regulatory Authority (EMRA) should know. Under the regulation about giving "The Certificate of

Renewable Energy Resource" (04.20.2005, principles and rules about giving a certificate were determined (Official Gazette No: 25956).

This decision that has been put into effect up to date was constituted as a draft as of 2005 outside regulations and laws and its outlines were published. There are two others: a law and regulation that are important for us. Of these, one is "The Law Draft of Geothermal Resources and Mineral Waters" and the other is "The Raw Draft of T. C: İzmir Governorship Geothermal Energy Regulation" which is explained the part of geothermal system in Balçova in chapter four.

The Law of Geothermal Resources and Mineral Waters (13.06.2007, Law No: 5686) and the Regulation of the Development of the Law of Geothermal Resources and Mineral Waters (12.12.2007)

In generally, there are some problems about geothermal area planning concept and geothermal zoning concept in both legal process and development process. However the "resources conservation zones" concept was detailed in The Law of Geothermal Resources and Natural Mineral Waters (Law No: 5686) and in The Regulation of the Development of The Law of Geothermal Resources and Mineral Waters, related disciplines were not defined absolutely.

According to relationship between the Law and land-use planning concept, the theme of resource reservoirs and tourism conservation- development areas come into prominence. Especially, the subject of Articles 4, 14 and 20 in resource reservoirs conservation subtitle. And the subject of Article 17 in culture and tourism conservation-development areas and tourism centers subtitle are pointed to in this context. The Article number of 4 says that, conservation area protects and takes measures the resources pollution and sustainability from external effects, and the geological, hydrological and topographic structure, climatic situation, soil type, drainage area boundaries, settlement areas, industrial facilities around the resources area are defined. The other important number is 14. Article which refer that the etude report of resource conservation area is an input for the development plans in this areas. But in these articles, the limitations and constraints are not detailed.

Conservation area zones are explained in the number of Article 20 which is referring to the Appendix 8 Article. According to the Appendix Article 8 conservation zones are defined; under this regulation, protection areas are classifies under three categories: first-, second-, and third-degree protection areas.

First zone; there can be constraints and prohibition related with the settlement and there can be base point for master and development plans. Thermal tourism and thermal healthy facilities can be built up on two floors, 50 diameter distances from natural spring points and 30 diameter distances from well points, if the all wastes can transport to the outside of the third conservation zone. Since any kind of pollution especially around this kind of areas affect the quality of water and health, these areas should be kept very clean (as an example periphery of the water springs and caisson wells). Since even it is possible that the herbicides used against plant diseases can mix with underground water, they should not be used unless it is very necessary. In case a boring well is necessary to be drilled, a responsible engineer should be applied to.

Second zone; solid and fluid wastes of the buildings within the area should be taken out of the area in isolated containers without causing any leakage. No permission is given for those pollutants as trash and rubble that will cause pollution within the area. If any drilling is to be conducted within the area, an engineer should be present.

Third zone; in every activity to be done about water related fist and second zones, a related engineer should be present.

APPENDIX B

QUESTIONNAIRE FORMS OF DATA COLLECTION FOR SOCIO-ECONOMIC AND LAND-USE ANALYSES

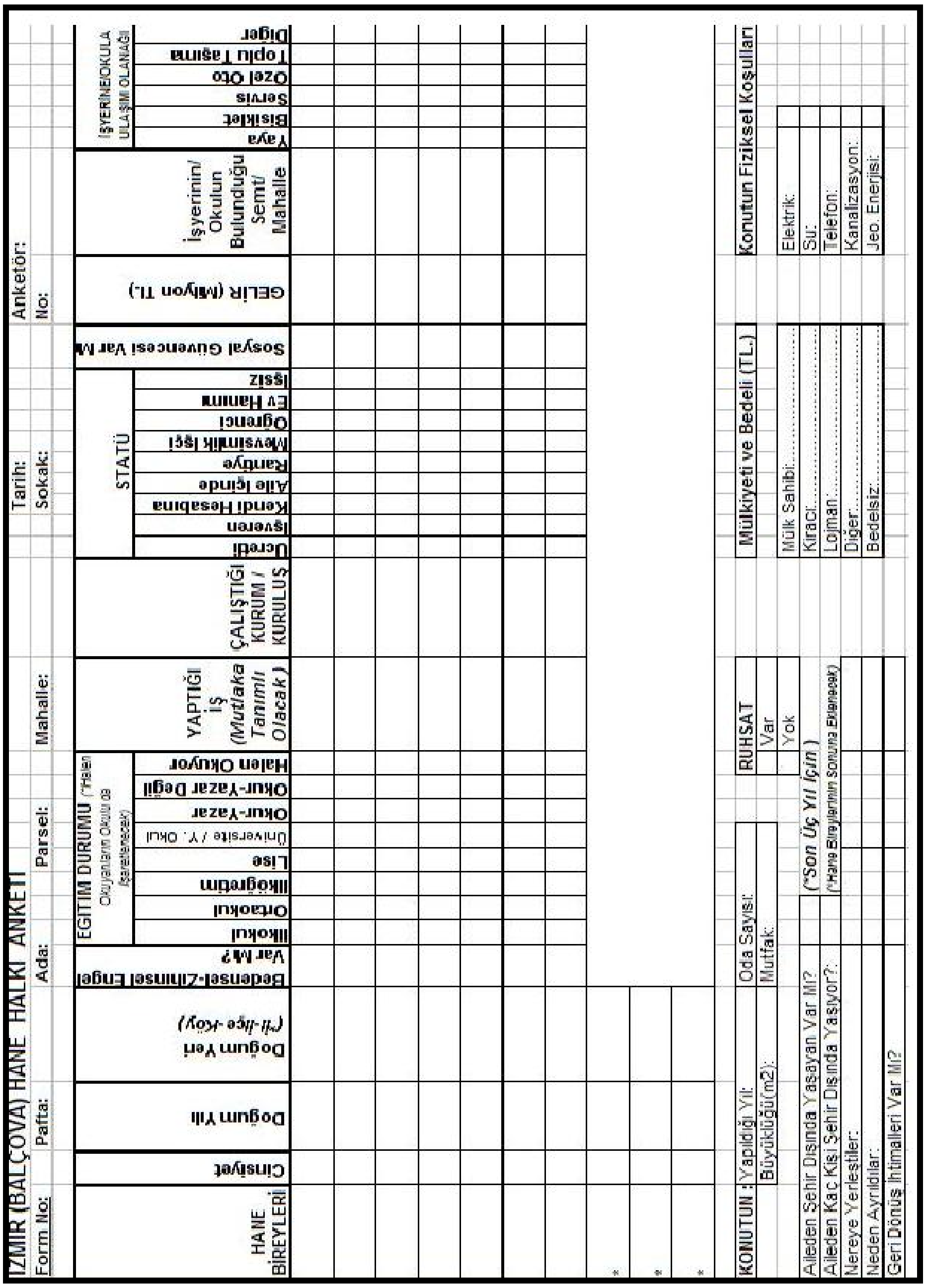


Figure B-1. Questionnaire form (A) of data collection for socio-economic and land-use analyses

İZMİR -BALÇOVA HANEHALKI ANKETİ 2 **ANKETÖR:**

1. Bu mahallede bulunma nedeniniz? İşyerine yakınlık ☐ Kent merkezine yakınlık ☐ Okula yakınlık ☐ Doğal güzellikler ☐ Yatırım amaçlı ☐ Sakinlik ☐ Ucuz olması ☐ Arkadaş ve aile yakınlığı ☐ Jeo. Enerji ☐ Diğer …………………………	9. Balçova'da Jeotermal ile ısıtma sistemi kurulumu sonrası semtte ev ve işyeri tapularında değişim gözlendi mi? Hayır ☐ Evet ☐ Ek: …………………………………………………………
2. Başka yere taşınmak istiyor musunuz? Hayır ☐ Evet ☐ Nereye? ……………… Neden? ………………	10. Balçova'da Jeotermal ile ısıtma sistemi kurulumu sonrası çevrenizde ve yaşantınızda ne tür olumlu etkiler gözlemleyebildiniz? Ek: …………………………………………………………
3. Konuttaki enerji kullanımını (ısınma) nasıl karşılıyorsunuz? Odun/Kömür ☐ Mazot ☐ Klima ☐ Jeotermal ☐ Maliyeti? ………………	11. Balçova'da Jeotermal ile ısıtma sistemi kurulumu sırasında veya halen herhangi bir olumsuz etkisi oldu mu ? Gürültü ☐ Koku ☐ Isı ☐ Sağlık ☐ Sallantı/sarsılma ☐ Ek: …………………………………………………………
4. Balçova'da Jeotermal ile ısıtma sistemi kurulumu sonrası semte gelen turist sayısında/turizm aktivitelerinde bir artış oldu mu? Hayır ☐ Evet ☐ Ek: …………………………………………………………	12. Jeotermal kaynağı veya enerjisini herhangi bir şekilde evde yada iş yerinde kullanıyor musunuz? Hayır ☐ Evet ☐ Ek: …………………………………………………………
5. Balçova'da Jeotermal ile ısıtma sistemi kurulumu sonrası semtte teknik altyapı (elek.,su,kanalizasyon) ve sosyal altyapı (hastane, okul, resmi tesis, turizm tesisi) çalışmalarında bir artış gözlendi mi? Hayır ☐ Evet ☐ Ek: …………………………………………………………	13. Jeotermal ile ilgili çevrede bulunan mevcut tesisleri yada ürünleri kullanıyor musunuz? Hayır ☐ Evet ☐ (Termal, Sera, Isıtma, Diğer) Ek: …………………………………………………………
6. Balçova'da Jeotermal ile ısıtma sistemi kurulumu sonrası semt nüfusunda değişiklik (artış) oldu mu? Hayır ☐ Evet ☐ Ek: …………………………………………………………	14. İlgili ve yetkili merciler ile düzenli olarak bilgilendirme ve sorunların tespitine yönelik toplantı yapılıyor mu? Hayır ☐ Evet ☐ Ek: …………………………………………………………
7. Balçova'da Jeotermal ile ısıtma sistemi kurulumu sonrası semtte istihdam oluştu mu? İstihdam Hayır ☐ Evet ☐ Yeni iş imkanı Hayır ☐ Evet ☐	15. Jeotermal enerjiden hangi alanlarda faydalanıldığını biliyor musunuz? Ek: …………………………………………………………
8. Balçova'da Jeotermal ile ısıtma sistemi kurulumu sonrası semtte emlak piyasasını hareketlendirdi mi (emlak fiyat artışı)? Hayır ☐ Evet ☐ Ek: …………………………………………………………	16. Balçova'da gerçekleştirilen jeotermal çalışmalardan (termal turizm, sera-konut ısıtma, sıcak su kullanımı vb.) beklentileriniz nelerdir? Ne tür eksiklikler gözlemliyorsunuz? …………………………………………

Figure B-2. Questionnaire form (B) of data collection for socio-economic and land-use analyses

İZMİR - BALÇOVA BİNA ENVANTERİ Tarih:

Form No: Ada : Mahalle: Sokaklar:

AdaNo / Proje AdaNo	SokakNo	Parsel No	BinaNo	Binanın kullanım türü								Binakat yüksekliği	Parsel büyüklüğü (m²)	Bina büyüklüğü (m²)	Bina toplam nüfus	Arsanın değeri	Binanın değeri	Binada jeo. Kullanılıyor		Binanın harcadığı enerji de	Binanın ısınma maliyeti	Parsel mülkiyeti					
				Konut	Ticaret/Ofis	Eğitim	Sağlık	Resmi Tesis	Turizm	Sanayi	Konut+Ticaret							Evet	Hayır			Özel Mülkiyet	Belediye Mülkiyeti	Maliye Mülkiyetinde	Hazine Mülkiyetinde	Diğer	

Figure B-3. Questionnaire form (C) of data collection for socio-economic and land-use analyses

APPENDIX C

THE VALUES OF REAL ESTATE AND LAND CONTEXT RESEARCHES OF BALÇOVA DISTRICT

Location

Housing location group comprising 4 main criteria is the most effective one within the all ranking groups. These criteria's are determined as the view of housing, the quality of the environment of the housing -considering all social and cultural characteristics of the inhabitants, the distance with the social facilities such as shopping centers, touristic, educational and cultural facilities, and lastly the slope of the site. Main reason defining these criteria's is the elderly and retired people living in the site. The economic power of these people and the physical difficulties that they are in, caused them to choose Balçova as a living place (see Figure C-1).

Figure C-1. The land-use situation in Balçova district

The map shows the advantageous of the houses according to their location. According to this map, the northern parts have good sea view where as the southern parts has a good mountain and forest view. Eastern and western parts have advantages having both good sea and mountain-forest view (see Figure C-2).

Another factor depending on location and affecting the real-estate prices comes to be the distance of the houses to the shopping centers, and health, educational and cultural facilities around. Especially, the shopping centers locating on the north of the site, is an important factor of this preference. University, hospital, thermal hotel and recreational areas increase the potential of the area and people choose this are to live.

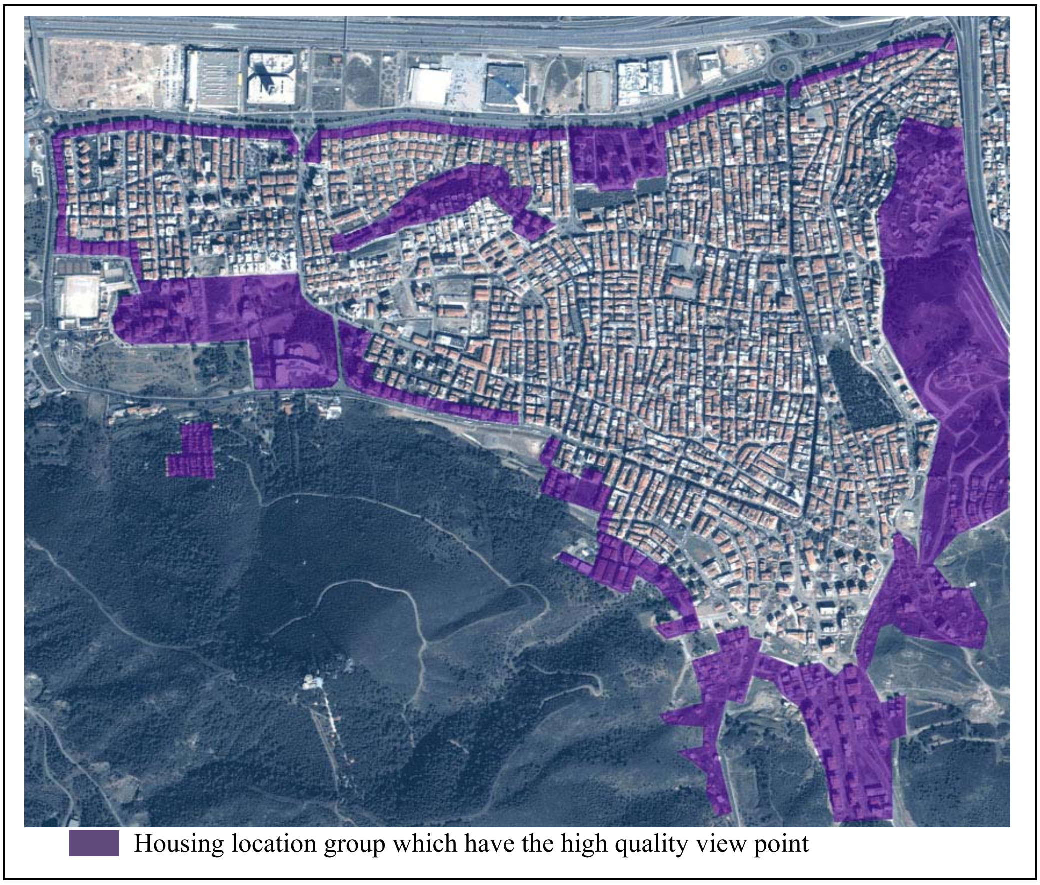
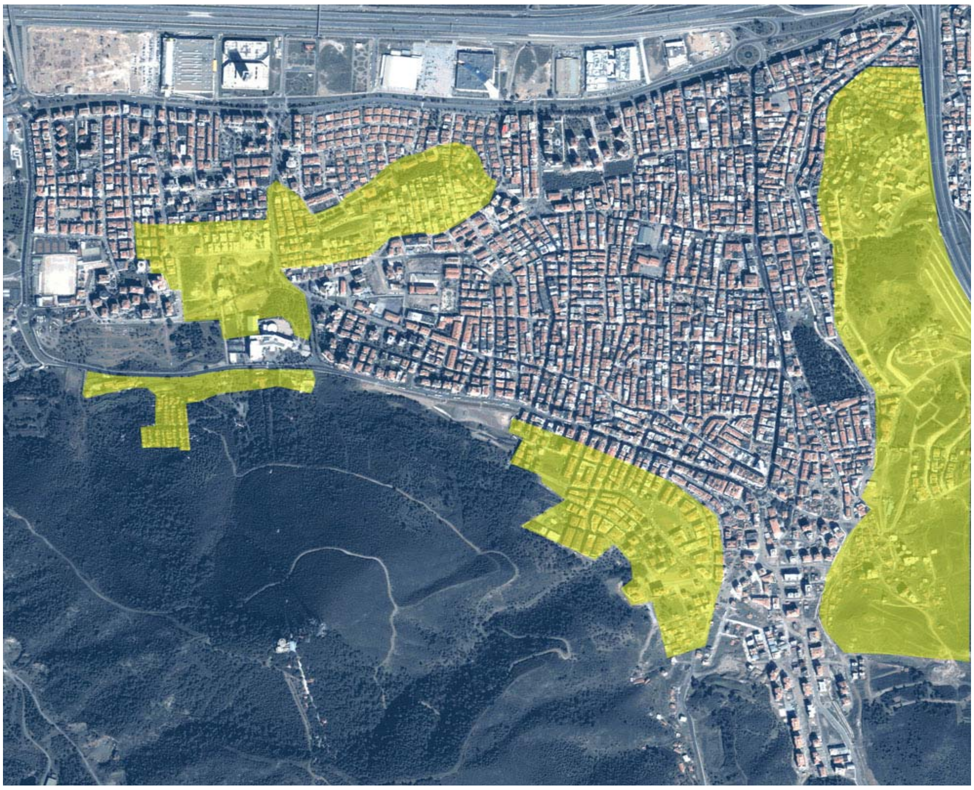


Figure C-2. The good quality view point in Balçova district

Sloppy areas have both advantages and disadvantages. These areas are very suitable to have the good view however it has some difficulties for elderly and retired people. Though, usually the young population prefers these sloppy areas to live (see Figure C-3).

Within the second group named as regional infrastructure, it is explained whether geothermal energy is used or not, and the condition of the major and minor roads, location of the public transportation stations and general car park conditions is discussed. It is observed that geothermal energy being the sub-title of the regional infrastructure is more important than the other headings.



Housing location group which have the suitable sloppy

Figure C-3. The good quality sloppy area in Balçova district

Regional Infrastructure

Geothermal energy district neighborhood heating system has been working since 1997 periodically. Between 1997-2003 first phases, named as Tulsuz Region, all of Korutürk neighborhood, between 2005-2006, 3900 residence equivalent (RE) are completed in Teleferik neighborhood and part of Fevzi Çakmak and Onur neighborhoods are completed and reached 8680RE between 2006-2007 at the second phase, 4500RE heating system is completed at the part of Onur neighborhood and Fevzi Çakmak neighborhood (see Figure C-4).

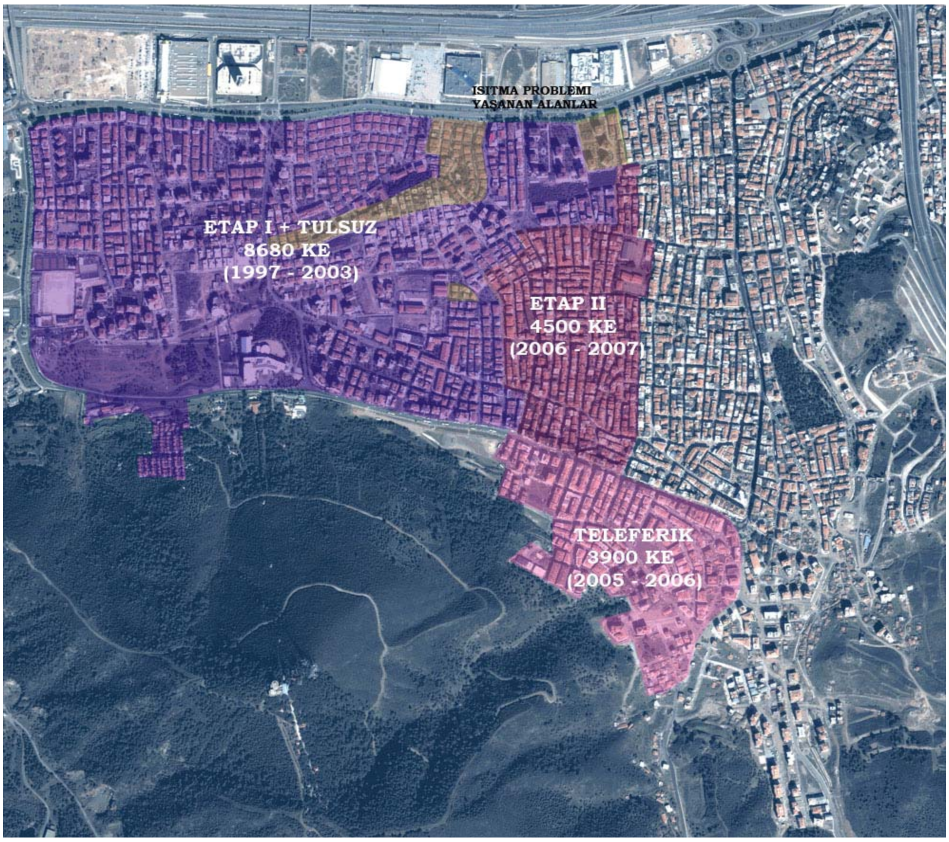


Figure C-4. Regional geothermal infrastructure in Balçova district

Again according to the executed research, locations of the major arterial highways and bus-stops were observed as the causes of preference and as the factors determining house prices in the region. Mithat Paşa Avenue surrounding research area from the north, Vali Hüseyin Öğüt Avenue at the west border, and Ata and Sakarya Avenues passing through the region especially appear as neighborhoods having real-estates with high-value (see Figure C-5).

Building Construction Cost

The third group comprises the construction cost of the house, which can be examined under three sub-headings. They are ranged as qualities and costs of materials used interior spaces of house, size of the house in square-meter, and finally qualities and costs of materials used on the facades.

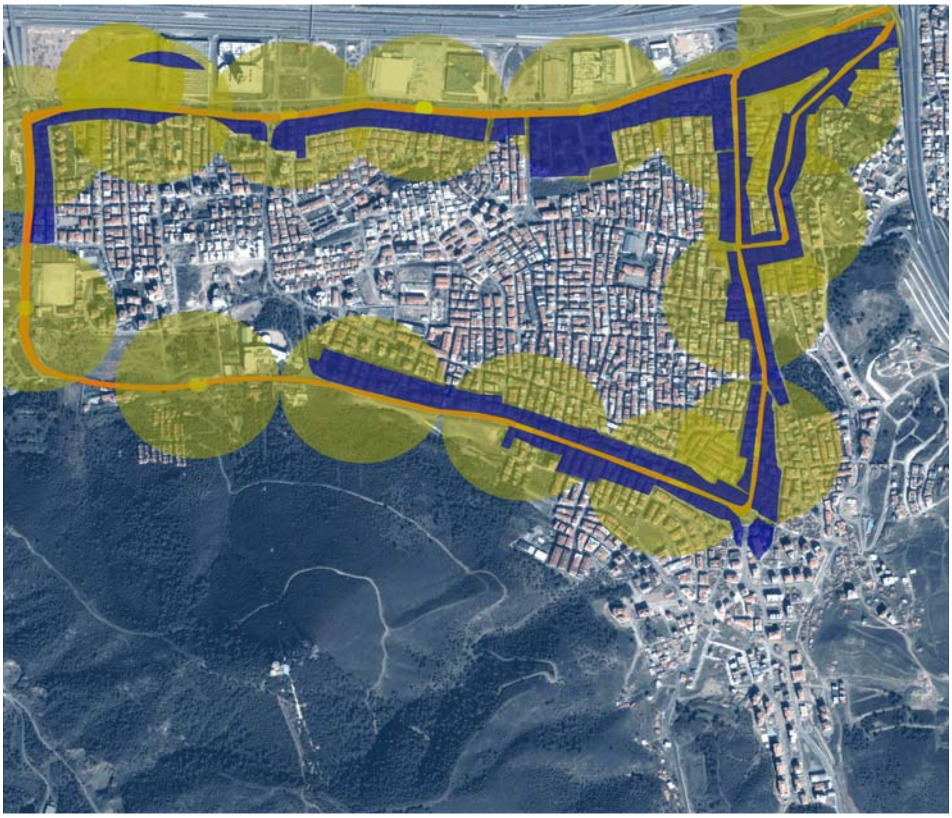


Figure C-5. Bus stops and distance to public transportation points in Balçova district

Building Type

Group of housing types is determined as the fourth and last group. That whether the house is inside the housing complex has great importance especially because of the existence of private security system, private car park, play grounds and sport areas for children. Typology of the house—i.e. it's being whether an apartment or a detached house—is also included in this group. Building order of the house (contiguous or detached building order) also has a role on determining the prices.

Locations in housing complex type come into prominence with respect to the housing types in the research area. First of all their providing security and car park advantages, beside the recreation areas in small sizes, and their being recently built structures constitute important feature (see Figure C-6). Building intensity regarding the storey-heights again takes attention in the group of housing types.

Figure C-6. The site type settlement in Balçova district

While each of above said factors is efficaciously effective by itself, these factors also interact with each other by acting each. Especially use of geothermal energy district heating system in the whole area was articulated as a different comfort material in new houses built later in this region. Move of high-income people to the region with the aims of comfort aroused the necessity of arranging new areas for different facilities in and around the region to correspond the needs of these new comer groups. It was also observed that some householders, who cannot afford the first cost comprising the most expensive part of the system, moved from the region in time by selling their flats in good prices regarding the general situation in İzmir. Detailed findings about these subjects are undertaken in the next sub-titles (see Figure C-7).

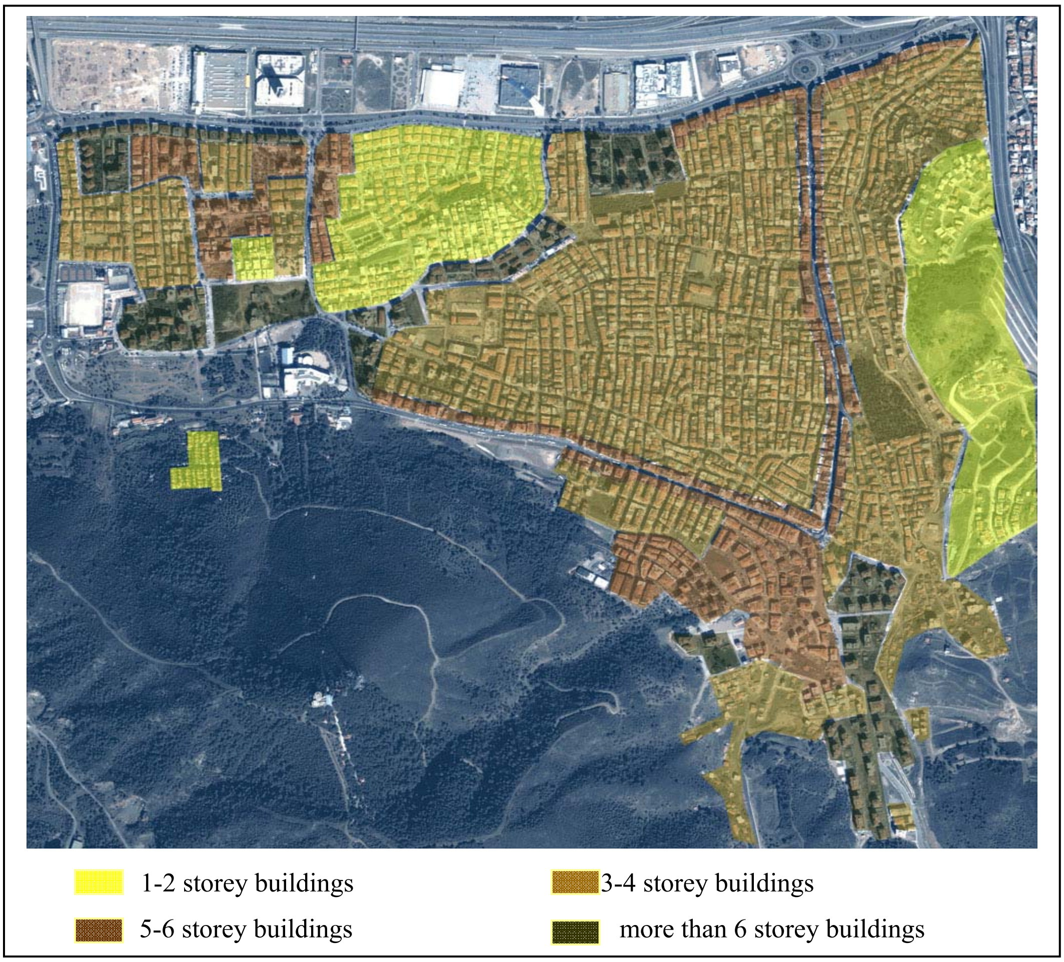


Figure C-7. Different building types in Balçova district

The Effects on Land Value

Another study concerning real estates in the same research area was described as determining the actual values of blocks in the region via the Real Estate Agency of Balçova Municipality. Observation process of the actual values in this study was planned between the years of 1997- 2007. For activation of the geothermal energy district heating system was realized in 1997. In this section, variation seen in the block values since 1997 until today was examined, and it was questioned whether there was a change stemming from the use of geothermal energy.

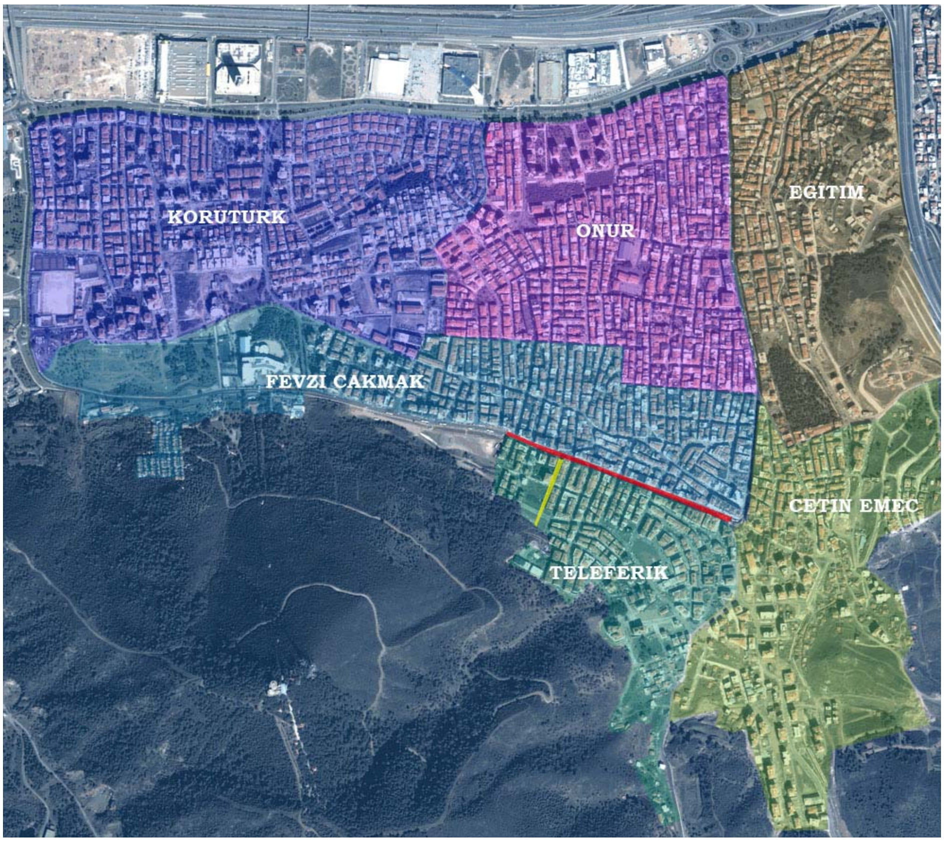


Figure C-8. The sample streets for land value researches in Balçova district

Determining land current value in neighborhood was operated in a general scale of streets and buildings having the least and most prices, examined streets were plotted on the map, and the results obtained from each neighborhood were entered to the charts by regarding time factor. Finally in the whole block, streets with the least and most actual block values were determined.

Street examples selected from the neighborhoods were grouped according to their having the least and most land current values; concurrently in the areas where geothermal system has not been established completely, the streets also classified regarding their having geothermal system (see Figure C-8). About the land current values there are two major problems sourcing from the current data's: the first one comprises changes seen in the general system of country during years. With respect to the Law No: 4751 accepted in 2002, land current values were revised again and increased. Moreover, as another problem, these values have been increased quadrennials until 2002, and the annual changes have not been recorded in detail. Nevertheless, after

2002, annual recordings have been recorded regularly. Therefore, during the evaluation process, while giving the charts demonstrating current data's, periods before and after 2002 are also examined in a portable way according to each other.

This study are organized in neighborhood level and the neighborhoods are classified in three group; user (Korutürk and Teleferik neighborhoods), semi-user (Onur and Fevzi Çakmak neighborhoods) and non-user (Çetin Emeç and Eğitim neighborhoods).

In this view point, Korutürk neighborhood is researched, in first, in six neighborhoods. The geothermal energy neighborhood heating system is used and the first studies about geothermal development in 1997 in there. The neighborhood is studied for land current values and two different streets are found for minimum and maximum land current values; Bora Street which has the lowest values, and Vali Hüseyin Öğütcan Avenue which has the highest value of Korutürk neighborhood (see Figure C-9).

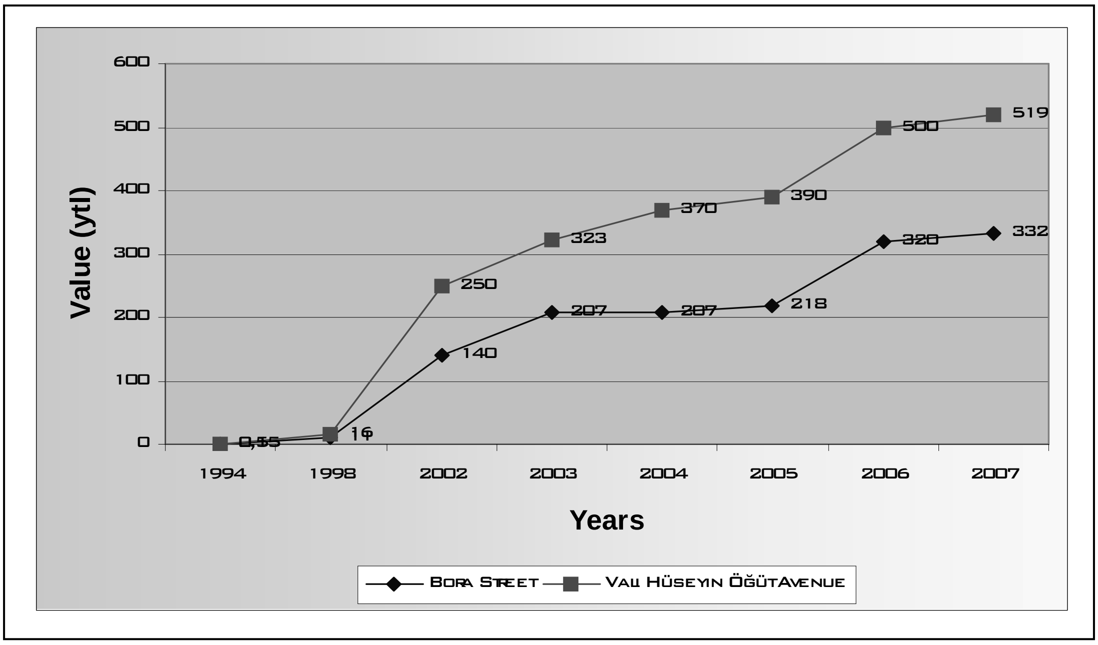


Figure C-9. Land current value (maximum and minimum values) in Koruturk neighborhood

Teleferik neighborhood is the other using of geothermal energy neighborhood heating system in fully in case area. The system which is the started to work in 2006, are used in 3000 building approximately. The highest land current values of parcel are on the Sakarya Avenue, the lowest land current values parcel are on the Cengizhan Street in Teleferik neighborhood (see Figure C-10).

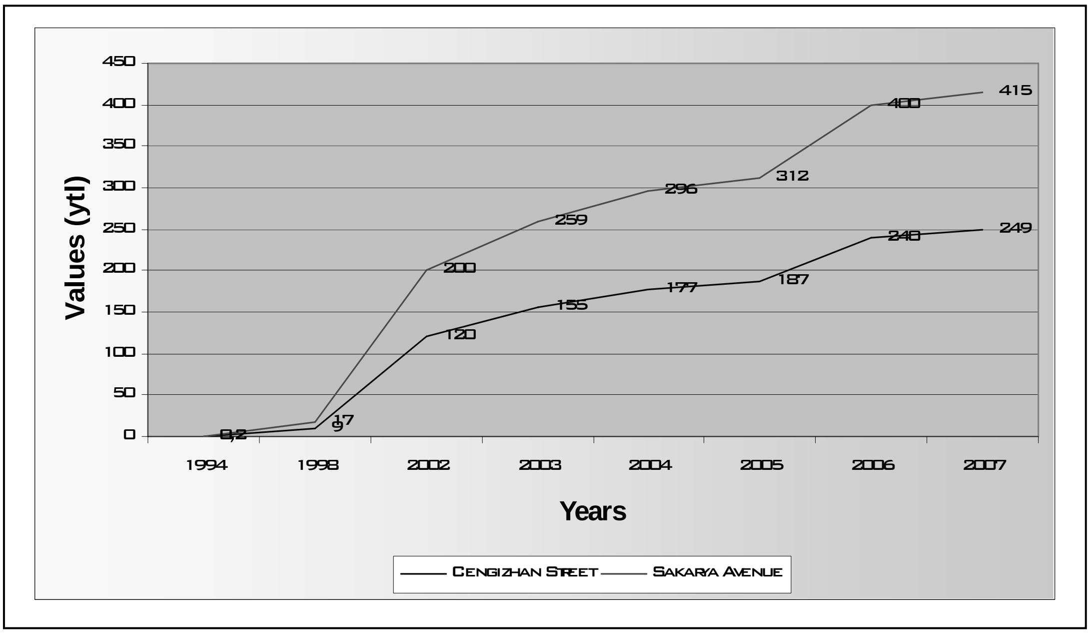


Figure C-10. Land current value (maximum and minimum values) in Teleferik neighborhood

A part of Onur neighborhood profited the first period geothermal district heating system in 1997- 2003, after that the small part of this neighborhood started to use this system in 2007. But, approximately, half of Onur neighborhood is not included the system. The lowest land current value street of the area is established Çagatay Street, the highest land current value street is established Sarmaşık Avenue (see Figure C-11).

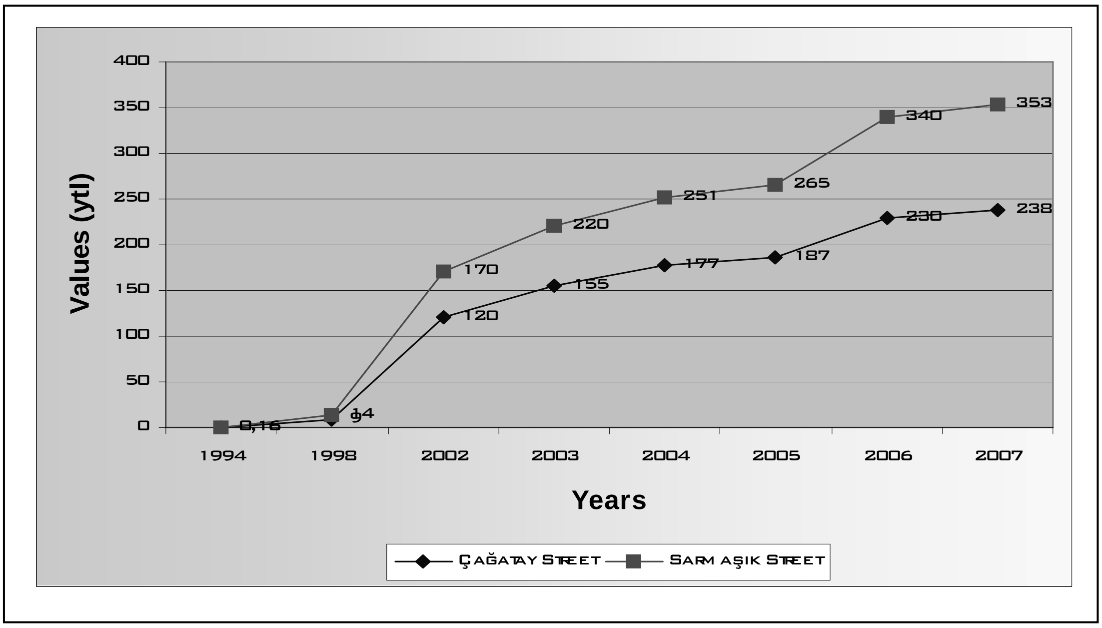


Figure C-11. Land current value (maximum and minimum values) in Onur neighborhood

Fevzi Çakmak neighborhood has the other semi-using neighborhood heating system. Atilla and Demirci Mehmet Efe Streets are chosen for sampling in there (see Figure C-12).

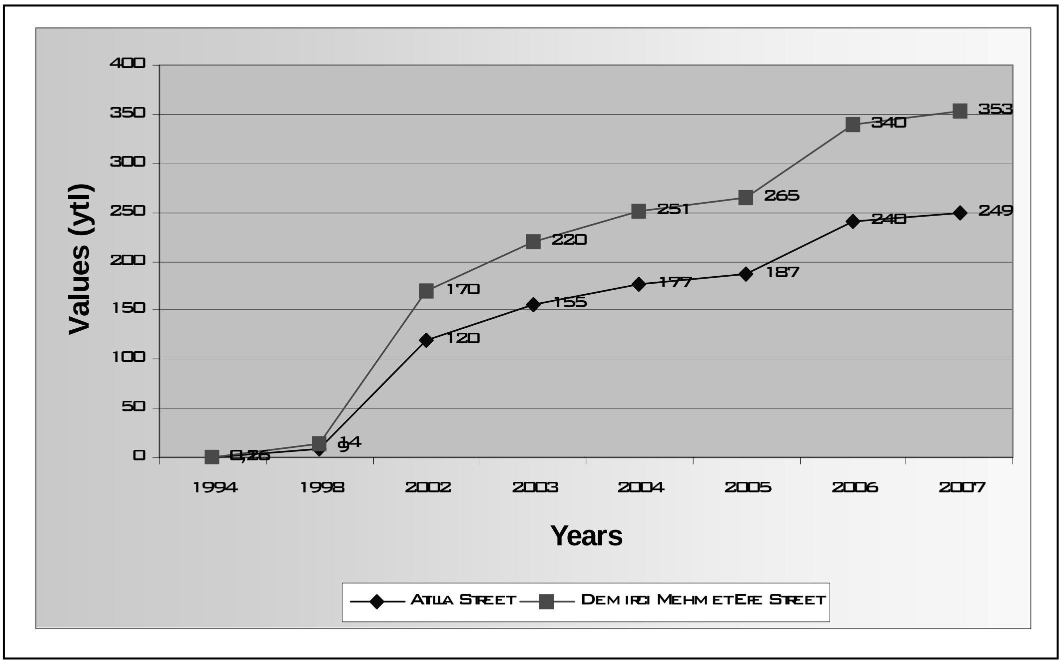


Figure C-12. Land current value (maximum and minimum values) in Fevzi Çakmak neighborhood

Geothermal energy related neighborhood heating system is not used in Çetin Emeç neighborhood. This neighborhood has the second lowest land current value in the case area. The Kadir Paşa Street has the highest and Güven Evler Street has the lowest land current values in there (see Figure C-13)

The finally researched case is Eğitim neighborhood where geothermal district heating system is not in yet. This neighborhood has the lowest land current value in all of them. Abdülhakhamit Street land current value is chosen a sampling in this neighborhood (see Figure C-14)

Eğitim neighborhood land current value is compared with the other neighborhoods which have low land current value and Eğitim neighborhood is fixed the lowest land current value, too.

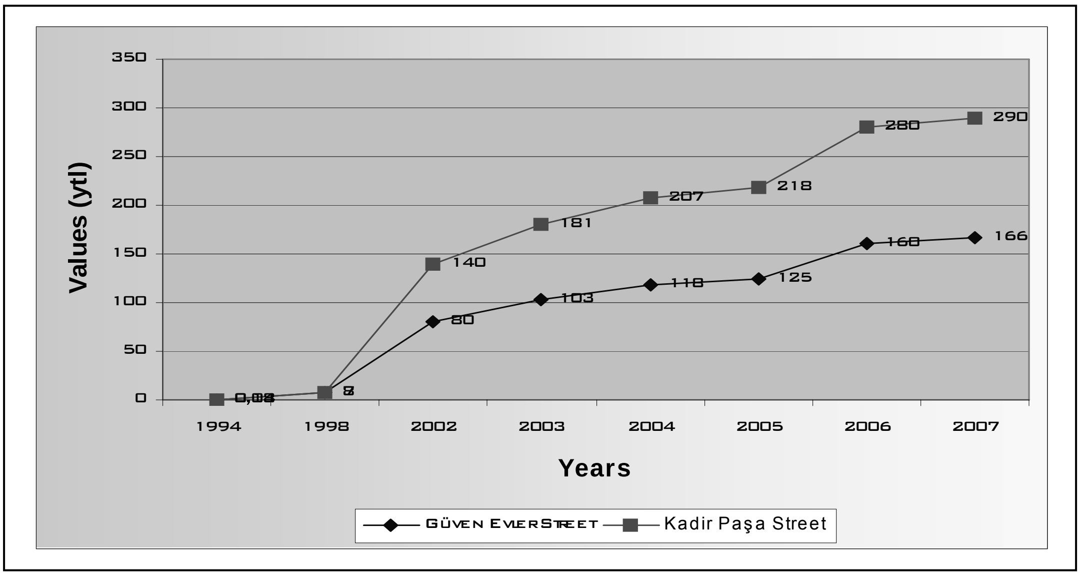


Figure C-13. Land current value (maximum and minimum values) in Çetin Emeç neighborhood

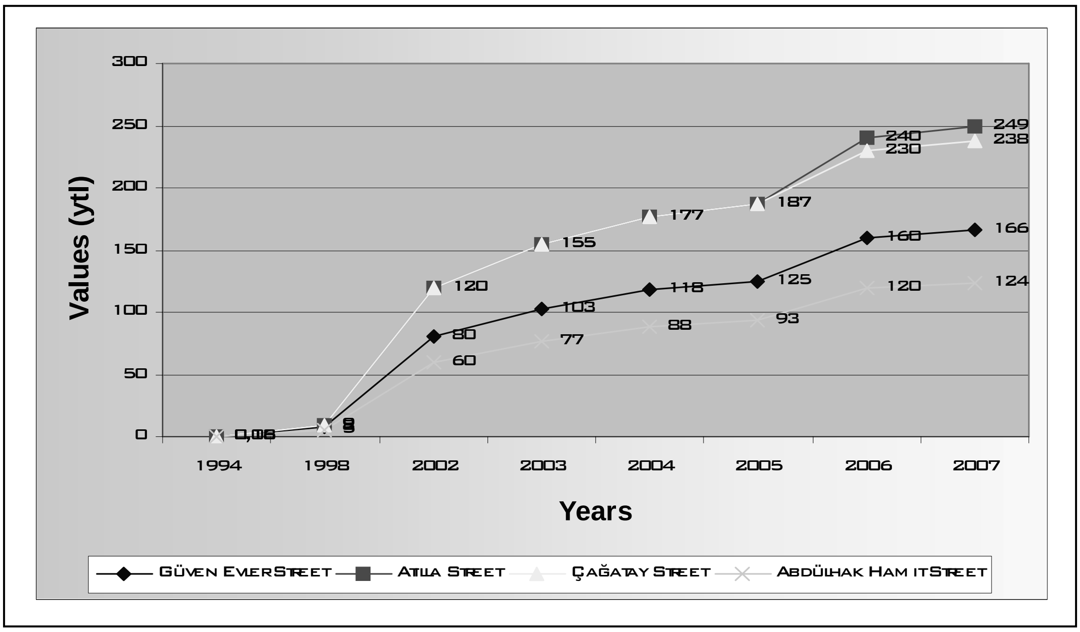


Figure C-14. Land current value (maximum and minimum values) in Eğitim neighborhood

In addition, Mithat Paşa Avenue, Vali Hüseyin Öğütcan Avenue, Sakarya Avenue and Ata Avenue are found the classification of land current value from above to down in case area (see Figure C-15).

According to all these land current values, there are not seen any relationship between land current values and development of the geothermal systems. The geothermal system in Balçova district was developed in different time in different areas.

When the changing of land current values were observed in the geothermal system construction time, increasing or decreasing of these values was not seen, the neighborhoods in Balçova district.

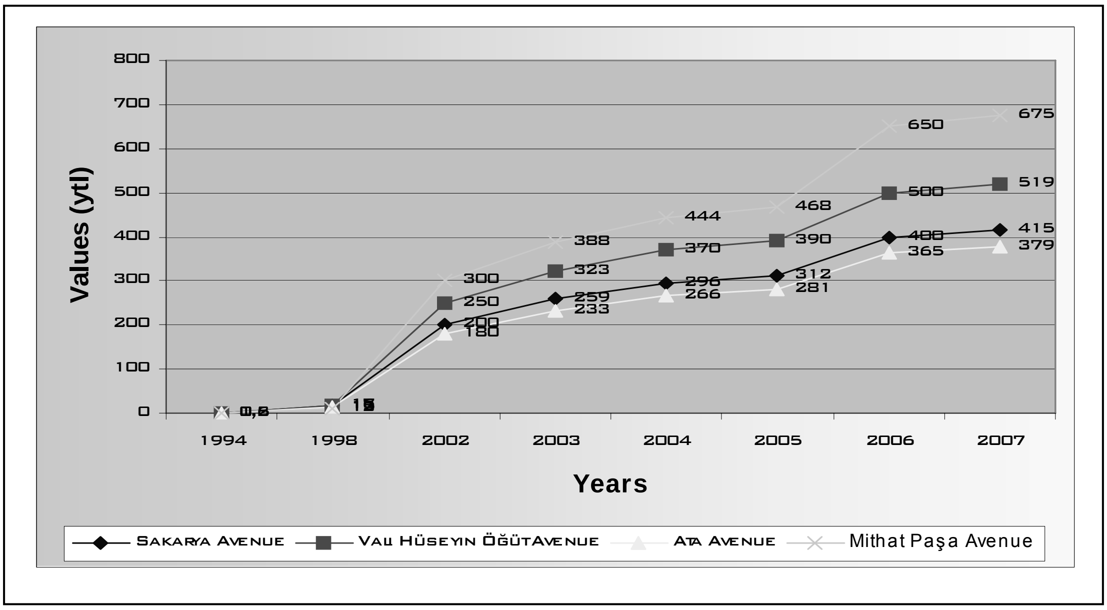


Figure C-15. Land current value (maximum) in major avenues in Balçova district

APPENDIX D

GENERAL SOCIO-ECONOMIC BACKGROUND OF BALÇOVA DISTRICT

Size of Population and Population Growth Rate

In 2000, the population of İzmir is 3370866 and the annual population growth rate is 22.4% in 1990-2000 periods. The annual population growth rate of main municipal area, which contains 9 districts centers (the old administrative division of Greater Municipal of İzmir), is 23.8%, and the same period Balçova district is 11.1% (see Appendix D-1).

Among the neighborhood centers which constitute the main municipal area, while the population of Konak district is the biggest with 781363 the population of Güzelbahçe district is the smallest with 14924. While the neighborhood center with the highest urban population growth rate is Gaziemir district with 56.2%, the one with the lowest is Konak district with 8.1%.

The population density, which is the number of persons living in one square kilometer, is 281 in the province, and in Balçova district the population density is 3185. Among the neighborhoods connected to the main municipal area, in Konak district the population density is the highest with 11338 persons, and in Güzelbahçe district it is the lowest with 155 persons (see Appendix D-2).

Sex and Age Structure

The size of the male population was more than that of the female population in İzmir in the period between 1927 and 2000. The sex ratio showed small fluctuations in this period and had the highest value with approximately 108 in the period between 1960 and 1975 (Turkish Statistics Institution 2000). In İzmir there were 102 males per 100 females in year 2000 and the same time there were 104 females per 100 males in year 2000 for Balçova district (see Appendix D-3 /Appendix D-4).

According to statistical values of “2000 census of population for İzmir”, half of the male population is younger than 28 years of age and half of the female population is younger than 29 years of age in the province. Balçova district center with a median age of 32 years has an older population than other neighborhood centers, and Gaziemir and Narlıdere district centers with the median age of 25 years have the younger populations than others (see Appendix D-5/Appendix D-6).

Education and Literacy Rate

The proportion of the literate population in the province is 92% and a significant difference is observed between sexes. While this proportion is 96% for male population, it is 87% for female population. The literacy rates are 97% and 90% for males and females in the main municipal area, respectively. Among the neighborhood centers which constitute the main municipal area, the literacy rate is the highest with 96% in Balçova district. The literacy rates are 98% for males and 93% for females in the Balçova district (see Appendix D-7/Appendix D-8/Appendix D-9).

Labor Force, Employment and Unemployment

In İzmir, the labor force participation rate of the 12 years of age and over population is 52%, and this rate shows a significant difference by sex. This rate is 29% for Balçova district (see Appendix D-10). The proportion of the employed population in the population in labor force for province total of İzmir is 90% for male population and 87% for female population; in Balçova district is 85% for male population and 77% for female population (see Appendix D-11).

Table D-1. City and village population of İzmir, annual growth rate of population by neighborhoods
(Source: Statistical Institutions of Turkey 2000)

Neighborhoods	Total			City Population			Village Population			Population Density
	Total	*Male*	*Female*	*Total*	*Male*	*Female*	*Total*	*Male*	*Female*	
Balçova	**66,877**	**32,707**	**34,17**	**66,877**	**32,707**	**34,17**	_	_	_	**3,185**
Bornova	396,771	201,968	194,802	391,128	198,931	192,198	5,642	3,038	2,604	1,771
Buca	315,136	157,755	157,381	308,661	154,246	154,415	6,475	3,509	2,966	2,352
Çiğli	113,543	57,259	56,284	106,741	52,611	54,129	6,803	4,648	2,155	1,171
Gaziemir	87,692	47,232	40,46	70,035	38,442	31,593	17,657	8,791	8,867	1,392
Güzelbahçe	18,191	10,307	7,883	14,924	8,615	6,309	3,266	1,692	1,574	155
Karşıyaka	438,764	213,743	225,021	438,431	213,574	224,856	334	169	165	6,648
Konak	782,349	386,701	395,608	781,363	386,218	395,145	946	483	463	11,338
Narlıdere	54,107	30,927	23,181	54,107	30,927	23,181	_	_	_	859

Table D-2. City and village population of İzmir, surface area and population density by neighborhoods
(Source: Statistical Institutions of Turkey 2000)

Neighborhoods	1990			2000			Annual Growth Rate of Population %		
	Total	*City*	*Village*	*Total*	*City*	*Village*	*Total*	*City*	*Village*
Balçova	59,825	59,825	_	66,877	66,877	_	11.14	11.14	_
Bornova	278,301	274,226	4,074	396,770	391,128	5,642	35.46	35.50	32.55
Buca	203,383	199,131	4,253	315,136	308,661	6,475	43.78	43.82	42.02
Çiğli	78,462	73,364	5,098	113,543	106,740	6,803	36.95	37.49	28.84
Gaziemir	44,089	39,905	4,184	87,692	70,035	17,657	68.74	56.23	143.95
Güzelbahçe	14,269	11,624	2,645	18,190	14,924	3,266	24.27	24.98	21.08
Karşıyaka	345,734	345,360	374	438,764	438,431	334	23.82	23.85	-11.31
Konak	721,571	720,502	1,068	782,309	781,363	946	8.08	8.11	-12.13
Narlıdere	34,844	34,844	_	54,107	54,107	_	44.00	44.00	_

Table D-3. Population by age, sex, total, İzmir Greater Municipality and Balçova Municipality
(Source: Statistical Institutions of Turkey, 2000)

Age and Age Group	Balçova	Bornova	Buca	Çiğli	Gaziemir	Güzelbahçe	Karşıyaka	Konak	Narlıdere
Total	66,877	391,128	308,661	106,740	70,035	14,924	438,430	781,363	54,107
00-14	12,772	89,576	77,357	26200	16,757	2,835	101,712	185,669	10,596
15-44	34,627	216,495	167,591	58,172	41,459	8,089	224,612	397,053	31,922
45-64	14,523	65,878	48,607	17,667	9,397	2,962	81,733	141,026	8,912
65-84	4,698	18,230	14,331	4,460	2,254	987	28,550	54,209	2,515
85 +	248	974	731	219	150	48	1,736	3,265	127

Table D-4. Population by age, province center, neighborhood centers and total of sub- neighborhoods
(Source: Statistical Institutions of Turkey 2000)

Age and Age Group	Total			Greater Municipality			Balçova		
	Total	***Male***	***Female***	***Total***	***Male***	***Female***	***Total***	***Male***	***Female***
Total	3,370,866	1,698,819	1,672,047	2,232,265	1,116,270	1,115,995	66,877	32,707	34,171
00-14	797,932	410,118	387,814	523,467	269,452	254,115	12,772	6,523	6,249
15-44	1,036,942	885,767	851,175	1,179,717	595,232	584,685	34,627	16,987	17,640
45-64	605,753	303,086	302,667	605,753	303,086	302,667	14,523	7,068	7455
65-84	217,040	95,321	121,719	130,234	55,718	74,516	4,698	2,057	2641
85 +	12,583	4,211	8,372	7,498	2,453	5,045	248	68	180

Table D-5. Population situation, age groups, sex and localization of neighborhoods in Balçova district
(Source: Executive Offices of Neighborhoods (Mukhtar) 2006)

NEIGHBORHOOD AREA IN BALCOVA SETTLEMENT		# OF BUILDING	AGE	0	1-4	5-14	15-44	45-64	65-84	85 +	TOTAL
1	TELEFERIK NEIGHBORHOOD	2285	E	51	159	505	1905	837	208	4	3669
			K	37	161	491	1985	834	246	10	3764
			T	88	320	996	3890	1671	454	14	7433
2	CETIN EMEC NEIGHBORHOOD	2829	E	45	161	543	2131	1154	317	10	4361
			K	37	155	465	2236	1221	338	12	4464
			T	82	316	1008	4367	2375	655	22	8825
3	BAHCELERARASI NEIGHBORHOOD	299	E	2	21	88	242	106	37	0	496
			K	8	15	57	222	100	44	4	450
			T	10	36	145	464	206	81	4	946
4	ONUR NEIGHBORHOOD	6557	E	72	343	1080	4666	2381	956	39	9536
			K	85	313	1032	4841	2577	1144	51	10024
			T	137	656	2112	9507	4957	2100	90	19560
6	FEVZI CAKMAK NEIGHBORHOOD	3959	E	68	238	714	2889	1527	582	20	6038
			K	50	207	638	3180	1640	672	42	6429
			T	118	445	1352	6069	3167	1253	62	12467
7	KORUTURK NEIGHBORHOOD	4262	E	45	179	549	2696	1680	694	16	5859
			K	53	166	584	2949	1962	660	38	6412
			T	98	345	1133	5645	3642	1354	54	12271
10	INCIRALTI NEIGHBORHOOD	116	E	3	13	27	95	42	23	0	203
			K	2	7	26	93	42	14	2	186
			T	5	20	53	188	84	37	2	389
11	EGITIM NEIGHBORHOOD	4448	E	64	267	831	3232	1565	575	23	6557
			K	52	263	825	3420	1692	767	30	7049
			T	116	530	1656	6652	3257	1342	53	13606
TOTAL		24755	E	349	1381	4337	17856	9292	3392	112	36719
			K	305	1287	4118	18926	10068	3885	189	38778
			T	654	2668	8455	36782	19360	7277	301	75497

Table D-6. Population changing from 1997 to 2006 in Balçova district
(Source: The Healthy Group of Balçova Local Administration 2006)

BALÇOVA NEİGHBORHOOD		AGE	0	1-4	5-14	15-44	45-64	65-84	85 +	TOTAL
1	1997 POPULATION	M	373	1554	5062	17887	7707	1863	60	34504
		F	398	1549	4912	18426	7435	2037	82	34839
		T	771	3103	9974	36313	15142	3900	142	69343
2	2006 POPULATION	M	349	1381	4337	17856	9292	3392	112	36719
		F	305	1287	4118	18926	10068	3885	189	38778
		T	654	2668	8455	36782	19360	7277	301	75497

Table D-7. Education changing in Balçova District
(Source: The Healthy Group of Balçova Local Administration 2006)

NEİGHBORHOOD AREA IN BALÇOVABALÇOVA SETTLEMENT		AGE	Illiterate age (0- 6)	Illiterate	Literate	Primary school	Junior High school	High school	Higher edu.	TOTAL
1	TELEFERIK NEİGHBORHOOD	E	257	31	338	1192	496	915	440	3669
		K	256	198	383	1297	453	816	361	3764
		T	513	229	721	2489	949	1731	801	7433
2	ÇETIN EMEC NEİGHBORHOOD	E	263	29	348	1125	682	1168	746	4361
		K	224	218	369	1382	646	1054	571	4464
		T	487	247	717	2507	1328	2222	1317	8825
3	BAHCELERARASI NEİGHBORHOOD	E	31	17	60	270	53	38	27	496
		K	30	67	57	199	42	41	14	450
		T	61	84	117	469	95	79	41	946
4	ONUR NEİGHBORHOOD	E	501	66	715	2723	1391	2802	1338	9536
		K	484	460	407	1916	1163	2317	1143	10024
		T	985	526	1133	3678	2554	5119	2481	19560
6	FEVZI ÇAKMAK NEİGHBORHOOD	E	369	46	469	1734	770	1730	920	6038
		K	298	298	556	2210	723	1617	727	6429
		T	667	344	1025	3944	1493	3347	1647	12467
7	KORUTÜRK NEİGHBORHOOD	E	272	20	324	962	647	2003	1631	5859
		K	278	155	388	1646	702	1829	1414	6412
		T	550	175	712	2608	1349	3832	3045	12271
10	INCIRALTI NEİGHBORHOOD	E	21	6	17	75	23	27	34	203
		K	10	24	22	56	18	30	26	186
		T	31	30	39	131	41	57	60	389
11	EĞITIM NEİGHBORHOOD	E	410	48	530	2006	1043	1773	747	6557
		K	404	417	584	2567	917	1512	648	7049
		T	814	465	1114	4573	1960	3285	1395	13606
TOTAL		E	2124	263	2801	10087	5105	10456	5883	36719
		K	1984	1837	3138	13035	4664	9216	4904	38778
		T	4108	2100	5939	23122	9769	19672	10787	75497

Table D-8. Education levels of all neighborhoods in Balçova district
(Source: Executive Offices of Neighborhoods (Mukhtar) 2006)

BALÇOVA SETTLEMENT		AGE	Illiterate age (0- 6)	Illiterate	Literate	Primary school	Junior High school	High school	Higher edu.	TOT.
1	1997 EDUCATION LEV. OF POPULATION	M	2671	858	2361	11067	5454	8271	3824	34504
		F	2764	1685	2460	12513	4976	7272	3164	34839
2	2006 EDUCATION LEV. OF POPULATION	M	2124	263	2801	10087	5105	10456	5883	36719
		F	1984	1837	3138	13035	4664	9216	4904	38778

Table D- 9. Population by age, age group, literacy, educational level and sex, Total İzmir area and Balçova center of neighborhood (Source: Statistical Institutions of Turkey 2000)

Age and age group		*Sex*	*Total*	*Literature*	*Total of Literature*	*No school Completed*	*Total*	*Primary education*	*Vocational School at junior high school level*	*High school*	*Vocational school at high school level*	*Higher Education*	*Educational level unknown*	*Literacy status unknown*
00-14	*Total*	M	170,719	7,572	163,147	147,106	16,041	16,041	_	_	_	_	_	_
		F	161,277	7,591	153,686	138,563	15,122	15,102	_	_	_	_	2	_
	Balçova	M	4,350	143	4,207	3,779	428	428	_	_	_	_	_	_
		F	4,144	153	3,901	3,537	463	463	_	_	_	_	_	_
15-44	*Total*	M	593,834	14,806	671,713	14,014	21,781	335,434	2,942	120,750	44,243	70,435	8	2
		F	582,280	28,805	632,410	13,248	20,351	321,368	1,129	118,546	26,889	66,058	101	11
	Balçova	M	15,615	142	16,845	319	16,526	7,571	82	4,756	1,315	2,802	_	_
		F	17,640	350	17,290	376	16,803	8,132	32	4,976	805	3,091	3	_
45-64	*Total*	M	193,305	6,924	186,379	8,047	178,274	117,891	1,064	18,150	9,867	31,302	8	2
		F	197,420	36,980	160,431	18,433	141,947	105,398	963	13,642	6,951	14,994	51	9
	Balçova	M	7,068	104	6,964	172	6,791	3,798	61	1,127	553	1,252	1	_
		F	7,455	774	6,680	534	6,144	4,642	60	609	245	588	2	1
65 +	*Total*	M	58,171	7,515	50,656	7,205	43,450	25,606	389	3,862	2,886	5,986	1	_
		F	79,561	32,355	47,197	11,093	36,063	28,707	421	2,914	2,342	1,679	41	9
	Balçova	M	2,125	137	1,988	166	1,822	1,223	19	222	154	204	_	_
		F	2,821	921	1,899	380	1,517	1,287	18	107	54	51	2	1
Total	*Total*	M	1,017,637	29,425	988,207	176,446	811,743	499,781	4,398	142,801	57,025	107,738	18	5
		F	1,023,157	105,747	917,379	189,889	727,298	470,720	2,512	135,131	36,189	82,746	192	31
	Balçova	M	30,534	526	30,008	4,436	25,571	13,022	162	6,107	2,022	4,258	1	_
		F	32,065	2,199	29,864	4,927	24,930	14,527	110	5,692	1,104	3,497	7	2

Table D-10. Population by labor force and sex, Province Total of İzmir area, The Greater Municipality and Balçova center of neighborhood

(Source: Statistical Institutions of Turkey 2000)

Labor Force														
Total Area	***Total***			***Total***		***Employed***		***Unemployed***		***Not in labor Force***		***Unknown***	
	Total	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*Male*	*Female*	*M*	*F*
Province Total	2,749,328	1,379,433	1,369,895	968,725	467,460	873,949	407,059	94,776	60,401	410,689	902,423	19	12
The Greater Municipality Total	1,824,404	906,743	917,661	596,298	217,819	518,746	167,299	77,552	50,520	310,428	699,832	17	10
Total of Neighborhood	405,935	207,425	198,510	139,049	35,703	123,904	27,484	15,145	8,219	68,374	162,805	2	2
Balçova Neighborhood	57,269	27,792	29,477	16,749	7,268	14,393	5,625	2,356	1,643	11,043	22,209	_	_

Table D-11. Population not in labor force by sex, Province Total of İzmir area, The Greater Municipality and Balçova center of neighborhood

(Source: Statistical Institutions of Turkey 2000)

	Total			*Sought to job, without using any channel in the last three months*		*Student*		*H. wife*	*Retired*		*Income Recipients*		*Other*	
	Total	*Male*	*Female*	*Male*	*Female*	*M*	*F*	*F*	*M*	*F*	*M.*	*F.*	*M.*	*F.*
Province Total	1,313,112	410,689	902,423	28,253	20,819	173,681	154,479	636,218	181,490	82,601	17,644	7,083	9,621	1,223
The Greater Municipality Total	1,010,260	310,428	699,832	22,105	16,623	125,051	110,578	496,726	147,223	70,398	9,828	4,665	6,221	842
Total of Neighborhood	231,179	68,374	162,805	5,390	3,665	25,163	22,220	125,564	30,772	9,672	4,670	1,432	2,379	252
Balçova Neighborhood	33,252	11,043	22,209	666	560	4,334	3,802	15,399	5,606	2,278	324	134	113	36

VITA

Ahmet Kivanc Kutluca was born in Aydın on February 4, 1976. After being awarded his B.S. degree in City and Regional Planning in Nine September University with second place in success both of the Department of City and Regional Planning and Faculty of Architecture in 1997, he continued to study at the Izmir Institute of Technology for his Master's degree in City Planning which was awarded in 2001, his thesis name is "Potential Natural Hazard Areas in Izmir Built-up Zone, A Case: Altındag Landslide Areas".

He was research and teaching assistant from 1998 to 2001 and from 2002 to 2008 in İzmir Institute of Technology, Faculty of Architecture, Department of City and Regional Planning. He is still an instructor in Kocaeli University, Faculty of Architecture and Design, Department of Architecture.

The name of some publications are "Natural hazard risks of İzmir Built-up Zone", "Landslide, earthquake and flood hazard risks of İzmir Metropolitan City", "Appraisal of energy efficiency of urban development plans: The fidelity concept on İzmir-Balcova case" and "The relations between geothermal energy usages and urban planning process: The perspective of legal situations in Turkey".

He is a professional member of "The association of European Schools of Planning-Young Academics" (AESOP-YA) and "Chamber of City Planners of Turkey".

He researches on strategic spatial planning and policies, energy integrated urban planning, renewable energies (geothermal energy based) and sustainability, natural hazard planning and urban simulation concepts.