AN ASSESSMENT OF ENERGY EFFICIENT AND CLIMATE SENSITIVE URBAN DESIGN PRINCIPLES: DESIGN PROPOSALS FOR RESIDENTIAL CITY BLOCKS IN TEMPERATE ARID AND HOT HUMID REGIONS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND
APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

DAMLA KARAGÖZ

IN PARTIAL FULFILLMENT OF THE
REQUIREMENTS
FOR
THE DEGREE OF MASTER OF SCIENCE
IN
URBAN DESIGN
IN
DEPARTMENT OF CITY AND REGIONAL PLANNING

SEPTEMBER 2016

Approval of the thesis:

AN ASSESSMENT OF ENERGY EFFICIENT AND CLIMATE SENSITIVE URBAN DESIGN PRINCIPLES: DESIGN PROPOSALS FOR RESIDENTIAL CITY BLOCKS IN TEMPERATE ARID AND HOT HUMID REGIONS

submitted by **DAMLA KARAGÖZ** in partial fulfillment of the requirements for the degree of **Master of Science in Urban Design, Middle East Technical University** by,

Prof. Dr. Gülbin Dural Ünver
Dean, Graduate School of **Natural and Applied Sciences** ________________

Prof. Dr. H. Çağatay KESKİNOK
Head of Department, **City and Regional Planning** ________________

Assoc. Prof. Dr. Osman BALABAN
Supervisor, **City and Regional Planning Dept., METU** ________________

Prof. Dr. M. Adnan BARLAS
Co-Supervisor, **City and Regional Planning Dept., METU** ________________

Examining Committee Members:

Prof. Dr. Serap Kayasü
City and Regional Planning Dept., METU ________________

Assoc. Prof. Dr. Osman Balaban
City and Regional Planning Dept., METU ________________

Prof. Dr. Adnan Barlas
City and Regional Planning Dept., METU ________________

Assoc. Prof. Dr. Müge Akkar Ercan
City and Regional Planning Dept., METU ________________

Assist. Prof. Dr. Deniz Altay Kaya.
City and Regional Planning Dept., Çankaya University ________________

Date: 08.09.2016

I hereby declare that all information in this document has been obtained and presented in accordance with academic rules and ethical conduct. I also declare that, as required by these rules and conduct, I have fully cited and referenced all material and results that are not original to this work.

Name, Last Name: Damla KARAGÖZ

Signature:

ABSTRACT

AN ASSESSMENT OF ENERGY EFFICIENT AND CLIMATE SENSITIVE URBAN DESIGN PRINCIPLES: DESIGN PROPOSALS FOR RESIDENTIAL CITY BLOCKS IN TEMPERATE ARID AND HOT HUMID REGIONS

Karagöz, Damla

Ms., Department of City and Regional Planning

Supervisor: Assoc. Prof. Dr. Osman Balaban

Co-Supervisor: Prof. Dr. Adnan Barlas

September 2016, 171 pages

Environmental problems caused by urbanization and industrialization processes have almost irreversibly damaged the ecological balance in the natural environment. In the 21st century, when half of the world's population has become urban, the links between urbanization and environmental problems gained more attention and the search for measures and solutions to address the negative impacts of urban development on natural environment increased. Global warming and climate change, the major challenges that contemporary societies face today, have strengthened the links between urban development and environmental problems. Energy efficiency in urban buildings is quite an important issue for Turkey that is highly dependent on foreign sources for energy supply. In this respect, energy efficient and climate sensitive urban design practices have to be developed and implemented extensively to prepare Turkish cities for the future.

In this study, energy efficient and climate sensitive urban design principles (or parameters) have been compiled and assessed with the aim of understanding the merits and benefits they deliver to redevelop inner city residential city blocks in more environmental-friendly manner. Two residential city blocks that comprise high-rise apartments within an inner city quarter in Ankara have been selected as the case study area to apply the design principles. Various urban design proposals have been developed for temperate arid and hot humid climatic regions, and the benefits, constraints and shortcomings of each proposal have been evaluated. The study also aims to help urban planning and design practitioners by means of the lessons derived for redevelopment of inner city residential quarters in Turkish cities.

Keywords: Urban Design, Energy Efficiency, Climate Sensitive Design, and Residential City Blocks

ÖZ

ENERJİ VERİMLİ VE İKLİME DUYARLI KENTSEL TASARIM İLKELERİNİN DEĞERLENDİRİLMESİ: ILIMAN KURU VE SICAK NEMLİ İKLİM BÖLGELERİNDEKİ KONUT ADALARI İÇİN TASARIM SEÇENEKLERİ

Karagöz, Damla

Yüksek Lisans, Kentsel Tasarım – Şehir ve Bölge Planlama Bölümü

Tez Yöneticisi: Doç. Dr. Osman Balaban

Ortak Tez Yôneticisi: Prof. Dr. Adnan Barlas

Eylül 2016, 171 sayfa

Kentleşme ve sanayileşme süreçleri sonucunda ortaya çıkan çevresel sorunlar, doğal çevrenin ekolojik dengesinde geri dönüşümü zor hasarlar meydana getirmiştir. Dünya nüfusunun yarısının kentlerde yaşadığı 21. yüzyılda, kentleşme ve çevresel sorunlar arasındaki ilişki daha çok dikkat çekmeye başlamış ve kentsel gelişimin doğal çevre üzerindeki olumsuz etkilerine yönelik tedbir ve çözüm arayışı artmıştır. Son zamanlarda modern toplumların karşılaştığı büyük sorunlar arasında yer alan küresel ısınma ve iklim değişikliği, kentsel gelişim ve çevresel sorunlar arasındaki ilişkiyi de güçlendirmiştir. Kentsel yapılarda enerji verimliliği, enerji temini konusunda yabancı kaynaklara bağımlı olan Türkiye için oldukça önemli bir konudur. Bu bağlamda, Türkiye'deki şehirlerin geleceğe hazırlanması amacıyla enerji etkin ve iklime duyarlı kentsel tasarım uygulamalarının geliştirilmesi ve yaygın bir şekilde uygulanması gerekmektedir.

Bu çalışma kapsamında enerji etkin ve iklime duyarlı kentsel tasarım ilkeleri (veya parametreleri) şehir içinde yer alan adaların daha çevre dostu bir şekilde yeniden tasarlanmasına yatkınlıklarının ve sağladıkları faydaların anlaşılması amacıyla derlenmiş ve değerlendirilmiştir. Tasarım ilkelerinin uygulanacağı örnek çalışma alanı olarak Ankara'da şehir içinde yüksek apartmanlardan oluşan iki ada seçilmiştir. Ilıman kurak ve sıcak nemli iklim bölgelerine yönelik çeşitli kentsel tasarım önerileri geliştirilmiş ve her bir önerinin faydaları, kısıtları ve eksiklikleri değerlendirilmiştir. Çalışma kapsamında ayrıca, Türkiye'de yerleşimlerin bulunduğu kentsel alanların yeniden tasarlanması hususunda çıkarılan dersler aracılığıyla kentsel planlama ve tasarımla ilgilenen kişilere yardımcı olunması amaçlanmaktadır.

Anahtar kelimeler: Kentsel Tasarım, Enerji Verimliliği, İklime Duyarlı Tasarım, Konut Adaları

To My Dear Family

ACKNOWLEDGEMENTS

First and foremost, I would like to express my deepest gratitude to my supervisor, Assoc. Prof. Dr. Osman Balaban whose profound knowledge, friendly support and encouragement thoroughly guided my study. Without his advice and help this research would not have been possible. I also wish to express my deepest gratitude to my co-supervisor Prof. Adnan Barlas, for his guidance, advice, criticism, encouragements and insight throughout the research. His support and guidance helped me all the time in writing this thesis.

I owe my deepest gratitude to my examining committee members; Prof. Dr. Serap Kayasü, Assoc. Prof. Dr. Müge Akkar Ercan and Assist. Prof. Dr. Deniz Altay Kaya for their contributions and the time they patiently devoted.

I would also like to express my special gratitude to my friends, Deniz Can, Havva Atniş, Çiğdem Fındıklar, Aysun Yılmaz and Sıla Ceren Varış for their technical and emotinal supports.

I owe my innermost thanks to Tahir Emre Gencer, for his tolerance, motivation, sincere help and chering me up during every stage of this thesis. I appreciate him for all of his sensibilities and support.

Last but not least, I would like to express my special and profound gratitude to my family, my beloved parents Nazdar Karagöz and Ercan Yaşar Karagöz, for their confidence, support, care, encouragement and endless love that they shared all the time.

TABLE OF CONTENTS

LIST OF TABLES

TABLES

LIST OF FIGURES

FIGURES

CHAPTER 1

1. INTRODUCTION

1.1 PROBLEM DEFINITION

Climate change and global warming are among the most important environmental and social problems of our age. Emergence of these problems dated back to the period after the start of industrial revolution period. The processes of industrialization and urbanization, which were accelerated following the industrial revolution, resulted in a rapid increase in energy need, and also in ever-increasing use of fossil fuels (directly contributing to climate change and global warming) to meet the need for energy. Overuse of fossil-based energy resources, which were formed in a long period while consumed in a very short period, has gradually depleted such resources as coal, oil, natural gas, etc. worldwide. In addition to the significant decrease in fossil energy reserves, natural environment has been significantly damaged due to extraction and use of fossil fuels. Among the major adverse environmental impacts are reduction in clean drinking water resources, increase in air and water pollution, increasing concentration of greenhouse gases (GHGs) in the atmosphere, and degradation of ecosystems (Yüceer,2015). Due to such reasons, interest in renewable or alternative energy resources has increased in the recent years, and the concepts of energy generation, consumption and transformation concepts have gained vital importance as well as new meanings.

Considering the sectoral distribution of energy consumption, it is observed that energy consumption in buildings comes in the second place, following industrial consumption. Energy consumption in buildings is predominantly used for indoor eating or cooling purposes. At this point, it is required to rethink the energy generation and consumption processes and develop efficient practices for solution of energy problem. One of the most important steps of these practices is to eliminate the conditions substantially causing global warming, climate change and other environmental problems. This is only possible by reducing energy consumption in buildings, substituting fossil-based energy resources with renewable resources and increasing energy efficiency.

Furthermore, prices of fossil fuels are dramatically increasing day by day since they are on the edge of depletion. Especially in Turkey and other countries, which are dependent on foreign oil and natural gas resources, this situation causes both serious ecological and economic problems. When traditional urban planning and architecture initiatives are analysed, it is seen that climatic concerns and factors have been taken into consideration with the aim of developing measures and solutions against the impacts of external environment. Methods of constructing spaces, which are being protected or benefiting from solar radiation or wind, depending on the need, have always been a primary concern for planners and architects. However, due to rapidly growing urban population and its associated needs, climatic and environmental factors have been disregarded after the industrial revolution in many countries. This situation has led to emergence of urban spaces, which are weak in terms of benefiting from sunlight and wind, incompatible with climatic factors and consuming ever increasing energy.

Considering Turkey, in addition to the above mentioned shortcomings, poor planning and design in urbanization and housing, lack of supervision and compliance mechanisms, and irrational energy policies and practices, which are also not environment-friendly, have reached dramatic dimensions since the late 1940s. Therefore, it is an urgent task for central and local governments in Turkey today to identify rational and appropriate planning and design frameworks that help reduce energy consumption in cities and urban buildings, and to find out ways that help use natural resources more effectively and efficiently. This study departs from concerns over the lack of sustainable and environment-friendly urban design practices taking ecological balance, energy efficiency parameters and climatic factors into account as a whole in development of urban policies and plans and in urban decision-making processes. Furthermore, the study aims to understand the pros and cons of urban design initiatives that aim to use energy and natural resources more efficiently with a particular focus on inner city neighborhoods, which were developed based on Flat Ownership Law and Regime in Turkish cities.

1.2. AIM OF THE STUDY

Certain studies have been conducted and approaches have been developed in order to reduce the pressure on and the damage to natural environment caused by various aspects of urbanization. One of the major aims of such studies has been to develop sustainable and environment-friendly urban design solutions based on use of natural resources and renewable or clean energy alternatives. As mentioned earlier, urban districts and buildings have vital roles to play in energy consumption. High levels of energy consumption in urban areas prove the requirement of developing policies and practices that help increase energy efficiency in cities. Supporting energy generation from renewable resources while minimizing energy consumption is crucially important for sustainable energy policy and energy efficiency.

The main aim of this study is to identify an ideal design example taking climatic factors into account based on energy efficiency parameters and climate-sensitive design criteria and to encourage such practices with the aim of minimizing energy consumption in urban buildings. In other words, this study sets out to develop several urban design initiatives as alternative solutions to urban and environmental problems triggered by existing/traditional urban development planning and design frameworks in Turkey. The alternative design solutions are also evaluated as per their applicability to actual urban contexts in Turkey.

In most Turkish cities, inner city residential quarters are composed of high-rise apartment blocks constructed through the Flat Ownership Law. Such residential quarters are now potential sites for urban regeneration due to the age and physical conditions of residential apartments. Considering the contemporary trends of sustainable urbanization, regeneration of inner city residential quarters in Turkey should target for achieving energy efficiency and address climate change-related concerns. However, there are various challenges to achieve energy efficient and climate-friendly urban regeneration in Turkey. Some of these challenges are highly related to such spatial constraints as ownership patterns, block and plot sizes, etc., which influence urban design solutions. In light of this background, another major aim of this study is to develop policy suggestions and implications for regeneration or redevelopment practices to transform existing residential quarters into climate-friendly and energy efficient living environments based on climate sensitive and energy efficient urban design principles.

Integration of energy efficient and climate-sensitive design principles into urban regeneration or redevelopment practices and turning urban redevelopment projects into an opportunity to increase energy efficiency in Turkey, which is an energy importer and vulnerable to various climate change impacts, is of crucial importance. The outcomes of this study, such as the urban design practice developed, design parameters identified and findings and results obtained, could help policy-makers and urban design practitioners, who are in search of alternative urban design solutions to increase energy efficiency in cities of Turkey.

In a nutshell, this study aims to provide plausible and sufficient answers to the following research questions:

- What are the major aspects and merits of energy efficient and climate-sensitive urban design?
- What are the required features and characteristics of urban areas in general, and urban residential quarters in particular, to become energy efficient and climate-sensitive?
- How could an urban residential block be redeveloped or transformed based on energy efficient and climate-sensitive urban design approach in a country like Turkey, where existing planning and design frameworks are ineffective?

- What are the major differences (in terms of advantages, compromises and constraints) between an ideal situation and a realistic option of an energy efficient and climate-sensitive urban design?
- What are the shortcomings in current urban redevelopment policies and practices in Turkey and how could these shortcomings be overcome through the perspective of energy efficient and climate-sensitive urban design?

1.3. SIGNIFICANCE AND METHODOLOGY OF THE RESEARCH

There are various studies that deal with the concepts of energy efficiency, use of active and passive energy systems, use of renewable energy and climate-friendly design in buildings. In most of them, these concepts are handled separately. Efforts that aim to combine the above-mentioned concepts within a holistic approach and from an urban design perspective are newly emerging. The existing work to develop new design practices focuses mostly on single structures rather than urban blocks or neighbourhoods. Furthermore, such work on the Turkish context is almost non-existent. Therefore, this research is an attempt to fill the gap in the previous work and discuss the applicability of energy efficient and climate sensitive urban design principles to redevelop inner city residential areas in major Turkish cities.

To this aim, the study evaluates energy efficient and climate-sensitive design principles or parameters within an integrated approach as a design manual, and applies the set of required parameters in the manual to real life situations within a particular neighbourhood in Ankara.

To achieve the research objectives, first of all, a conceptual framework has been developed based on a comprehensive and detailed literature review on issues of energy efficiency and climate sensitiveness in urban design. Since the main focus of the study is on planning and design of urban areas in ways that ensure lower use of energy and higher adaptation to climate change impacts, the literature review emphasized the minimization of the contribution of urban areas to energy and climate change problems, and the harmonization of the natural environment and urbanization processes. The importance of energy efficient urban design is discussed in detail, and energy-efficient urban design parameters that apply to single buildings and building groups are analysed. The impacts and importance of climatic factors on energy consumption in buildings are also pointed out at this stage, leading to a detailed analysis of climate-sensitive design concept and parameters. Crosscutting aspects between climate-sensitive and energy efficient urban design practices have been analysed, and the impacts of climate elements such as urban temperature, solar radiation, air temperature, air humidity and wind on urban planning and urban design initiatives have been investigated with the aim of optimizing human comfort and reducing energy consumption. The common design parameters that serve for both climate and energy concerns have been specified in detail for five different climatic zones, which exists throughout Turkey. As a result of the literature review, a set of urban design principles and parameters is suggested to increase energy efficiency of urban residential quarters.

The empirical study is composed of a fieldwork that was conducted to analyse the possible outputs of application of the defined set of design parameters to an existing urban setting. As the case study area, an inner city area in Ankara, which is an example of the typical and most common type of residential quarters consisting of high rise apartment blocks in Turkey, has been selected. The case study area is also in need of a redevelopment attempts due to the age, economic and physical conditions of the existing apartment blocks in the area. Several visits have been made to the case study area in order to gather data and information regarding the current situation of the area. In each visit, detailed analyses on the location and orientation of the buildings have been carried out and these analyses have been documented by means of design sketches and photographs. Furthermore, the current master plan of the case study area has been obtained from Çankaya District Municipality in order to conduct further analysis, especially with regard to the property ownership pattern and layout of the urban blocks selected.

As mentioned earlier, the area selected for fieldwork is located within Ankara city. Therefore, as part of the empirical analysis, first of all, the current situation of the area is evaluated as per energy efficiency design parameters suggested for temperate arid climatic zone. Following the evaluation of the existing situation, two alternative scenarios, namely the realist scenario and the reformist scenario, have been developed in order to identify possible arrangements and practices to be implemented in case the area is aimed to be redeveloped in energy-efficient and climate sensitive manners. Then, an ideal scenario, which indicates the ideal design situation that would be achieved if all required design parameters are applied, has been developed and evaluated. While developing the alternative scenarios, the advantages, constraints and shortcomings that each of them delivers have been evaluated separately. Following the analysis of the design parameters for the temperate arid climatic zone that is the actual zone in which Ankara city is located, a similar analysis has been carried out and alternative scenarios have been developed for the hot humid climatic zone, which has opposite characteristics of the temperate arid climatic zone. With the analysis of the application of design parameters to two different zones with opposite climatic characteristics, it is aimed to understand the similarities and differences between the two climatic zones in terms of urban planning and design requirements and outcomes.

To carry out the case study analyses, Google Sketch Up Programme was used for two-dimensional and three-dimensional designs of the scenarios and for the measurement of shadow lengths. Coordinates of the case study area, land topography features and master plan details have been uploaded to the software as data inputs. In order to monitor the shadow lengths of the buildings proposed, the software was set to indicate the shadow lengths that would be seen at noon in December.

CHAPTER 2

2. ENERGY EFFICIENT AND CLIMATE SENSITIVE URBAN DESIGN

Recently, dilemmas and uncertainty on how to use energy and natural resources caused by uncontrolled urban growth are common issues faced by all countries. Humankind has searched for measures and solutions to cope with negative impacts of external environment for long years. Societies have always endeavoured to create shelters and living spaces either protected against or benefiting from the climatic impacts and solar radiation depending on the local needs. For instance, the Eskimo designed snow huts to be protected against cold, while Harran houses served as a shell protecting against hot weather (Demirbilek, 2001 as cited in Yüceer, 2015). However, climate and environment sensitive design started to be abandoned with the industrial revolution. Buildings in the newly emerging dense urban quarters are negatively impacted in terms of catching sunlight, wind and ventilation. Multi-storey building blocks, density of transportation networks, heavy traffic, heat absorbing and waterproof ground coverings and industrial zones located around cities have served as significant factors to change the climatic conditions of urban settlements. All these problems make urban areas a major cause of global warming due to increased energy consumption and land use change. Current urbanization trends in many countries cause loss of traditional environment-friendly urban patterns, loss of fertile agricultural lands, pollution of terrestrial and aquatic environments and extinction of species. Minimizing the amount of energy consumed without compromising from comfort conditions of urban areas and buildings, and preventing environmental damage are of vital importance for future of cities. In this sense, energy efficient and climate-sensitive urban planning and design is an important target to focus on (Yüceer, 2015).

2.1 SIGNIFICANCE OF ENERGY ON HUMAN AND ENVIRONMENTAL SYSTEMS

As the human evolved from hunter gatherer to industrial, people have increasingly damaged the environment upon, especially on air, land, waterways, other species and their fellow humans (Diesendorf, 2014).

It is clear that the greatest damage has inflicted on the atmosphere. Because of the emissions of Green House Gases(GHG) from using fossil fuels, clearing forests and imposing demonstrative agricultural systems, the heat of earth surface has increased at the important rate and it causes important changes to environment especially precipitation, pattern. Droughts, heatwaves, wild fires and floods, rising sea level, declining global food production and an increase in the frequency of severe storms are some of the consequences of it (IPCC, 2013). In addition, air pollution is the most crucial environmental consequences of using fossil fuels (DARA, 2012).

Today, fossil fuels are used as the major sources of energy in world. Overuse of fossil-energy resources were formed in a long term while consumed in a very short term. In addition to the significant decrease in fossil energy reserves, natural environment has been significantly damaged due to extraction and use of fossil fuels. Among the major adverse environmental impacts are reduction in clean drinking water resources, increase in air and water pollution, increasing concentration of greenhouse gases (GHGs) in the atmosphere, and degradation of ecosystems. Energy consumption per sector varies greatly from country to country, depending upon the role of heavy industry in the economy, energy usage in housing and whether transportation by motor vehicle. Because of their damages these energy sources must be replaced by green and sustainable energy sources protect human society and ecology. Therefore, interest in renewable or alternative energy resources has increased in the recent years, and the concepts of energy generation, consumption, transformation and efficiency have gained vital importance as well as new meanings (Howarth et all.,2011: Yüceer, 2015).

As Hinrichs and Kleinbach state that the efforts of energy conservation usually concentrate on the two approaches, which are:

1. The technical fix; this consist of using fuel more efficiently to perform the same duty
2. The lifestyle change; this means consciously using less fuel by such behaviors as turning off the light (Hinrichs, Kleinbach; 2006).

The present system is biased away from energy saving towards energy supply. The term of energy efficiency defined as using less energy to provide the same level of energy services. Moreover, energy conservation is using less energy to achieve a lesser energy service, for example heating one's home less in winter without making improvements in Energy Efficiency. Therefore, energy saving from energy efficiency and energy conservation is quite important in both environmental and economic terms, (Diesendorf, 2014).

Because of the pressing need to reduce environmental problems and to find alternative energy sources, the terms of “sustainability” and “energy efficiency” have become one of the main topics of international policymaking since the late 1970s. A series of milestone events, i.e. the international environmental conferences, have been held in the last several decades so as to raise a global attention to protect the natural environment from degradation. The history of international efforts and policymaking for environment started with the seminal UN conference that was held in Stockholm in 1972 (Figure 2.1). Among the central aims of the conferences held after the 1972 Stockholm Conference is the promotion of sustainability and energy efficiency.

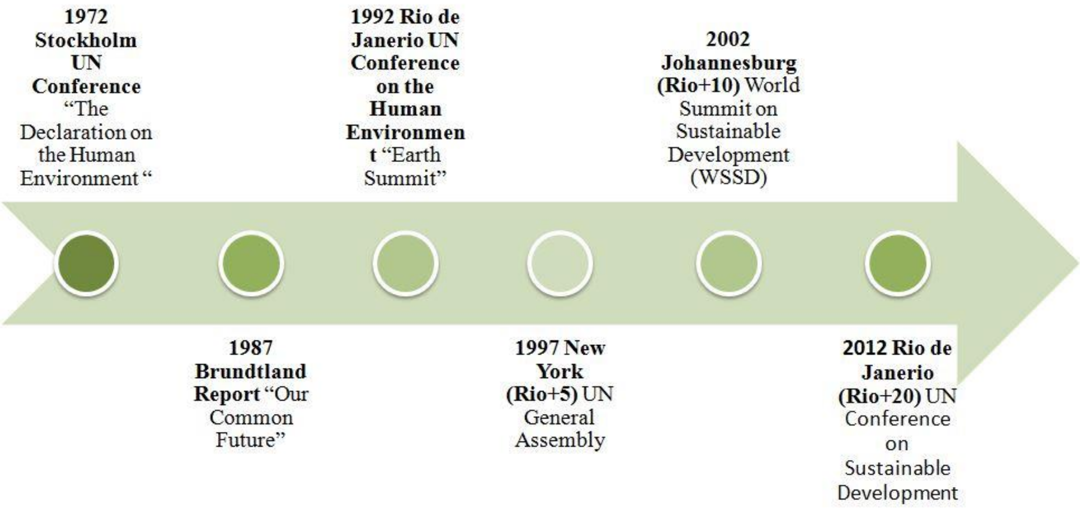


Figure 2.1 Timeline of the Major International Environmental Events and Conferences

The Declaration of the UN Conference on the Human Environment, which was adopted in the 1972 Stockholm Conference, is seen as the first and the most important international document that highlighted the degrading environmental conditions of the earth and the responsibility of the world's nations for environmental problems. Countries with different needs, expectations and socio-economic structures came together for the first time in Stockholm to discuss and evaluate the environmental issues and plan for the common actions and policies to address these issues. The conference has led to the establishment of many national environmental protection agencies in countries and the United Nations Environment Programme (UNEP) along with the adoption of the declaration (UNEP, 1972).

In 1987, the famous Brundtland Report, titled "Our Common Future", was declared by the UN World Commission on Environment, and the term of "sustainable development" was introduced in detail to the international community for the first time. Sustainable development was defined in the report as "*the development that meet the needs of the present without compromising the ability of future generations to meet their own needs*" (UN, 1987). The major goals of this report was to address environmental problems and eliminate poverty at the same time.

The United Nations Conference on Environment and Development, also called as the "Rio Conference" or the "Earth Summit", was held in Rio de Janeiro from 3 to 14 June 1992. The Rio Conference came 20 years after its predecessor, the Stockholm Conference, and led to the establishment of the Commission on Sustainable Development. The United Nations Framework Convention on Climate Change (UNFCCC) and the Convention on Biodiversity are the two other important agreements of the Rio conference. In order to disseminate and facilitate the implementation of the sustainable development paradigm, a comprehensive plan of action, titled the "Agenda 21", has been adopted in this conference (UN, 1992).

In 1997, UN General Assembly (Rio+5) was convened to review and evaluate the implementation of Agenda 2, thereby the sustainable development paradigm. The 2002 World Summit on Sustainable Development (WSSD), which was called as the "Rio+10 Meeting", was held in Johannesburg to monitor the progress since the Rio Conference and plan for the future implementation of sustainable development. The summit promoted "partnerships" as a non-negotiated approach to sustainability and adopted the "Johannesburg Plan of Implementation", which underlined the three pillars of sustainable development: economic, social and environmental development. Ten years after the Johannesburg Summit, the United Nations Conference on Sustainable Development (Rio+20) was held in 2012 in Rio de Janeiro, Brazil in order to set a global sustainability agenda and also to generate an institutional framework for sustainable development (UNCSD, 2012). The international events and efforts have been important to bring environmental issues and alternative development paradigms such as the sustainable development into the policy agenda of the world's nations. However, there is still a long way to go so as to achieve the three major goals of sustainable development.

2.1.1 THE CURRENT SITUATION ON ENERGY CONSUMPTION AND ENERGY POTENTIAL OF TURKEY

Recently, Turkey has become most important emerging markets in the world with high economic growth and a relatively both young and fast-growing population. In the past few decades, GDP has grown by between 5% and 10% annually and GDP per capita has tripled since 2002, reaching US$ 10,500 in 2010. Traditionally, energy demand depending upon economic growth has increased in all sectors. Because of depending on foreign energy sources (imports were needed to meet 72% of its energy demand in 2010), Turkish economy under high pressure. (TUIK, 2012; WP, 2010 cited in Elsland et. al., 2014).

In 2010, 35% of the final energy demand in Turkey was attributed to the residential sector and the importance of this sector is expected to remain significant in terms of the overall final energy demand not only because of its high percentage share in total energy demand, but also due to rising living standards, decreasing average size of households and the increasing demand for new buildings. Despite the government's positive intention to improve energy efficiency, the application and time plan of the defined actions are not well defined. Because of using 35 percentage of total electricity from residential buildings, energy efficiency in building sectors has great importance (TMMOB, 2013; EUROSTAT, 2013; MENR, 2012 cited in Elsland et. all. 2014).

As Bölük and Mert states that, energy demand of Turkey has increased rapidly almost every year and it will continue to grow in the future in parallel to country's population. However, country's self-efficiency ratio is very low compared to growth demand. Turkey is highly dependent on foreign sources for energy supply and this situation affects economy negatively.

The urbanization process and increase in population has caused in energy demand and a lot of environmental and economic problems occur in the country. Because of becoming a member of the Kyoto Protocol in 2009, Turkey should succeed emissions reductions for conform to Kyoto Protocol. Therefore, the country must give an importance to develop energy policies and to adapt sustainability and energy decision (Bölük and Mert, 2015).

Studies by Ministry of Energy and Natural Resources (MENR, 2013a) indicates that the primary energy demand in Turkey increased with an average annual rate of 4.3% between 1990 and 2008. Analyzing at the past 10 years, Turkey has had the highest energy demand growth rate among OECD countries, and is the second largest economy after China ranked by the rate of increase in electricity and natural gas demand.

Residential building hold a high share of the total energy consumption. Dwellings, public and commercial services constitute 35% of the total primary energy use. Heating has the biggest share in dwellings, lighting, cooling and other home appliances are the other energy consumption items. Energy consumption of residendial buildings is continuously increasing alongside economic growth, rising population and the number of existing buildings (Düzgün and Kömürgöz, 2014).

2.1.2 RECENT ENERGY EFFICIENCY POLICIES OF TURKEY

According to Ministry of Energy and Natural Resources, Turkey has a high potential for energy efficiency improvements in many areas as up to 30% savings in residential buildings. Due to its high level of energy consumption, the residential buildings particularly become an important target for energy efficiency improvements.

Because of increasing environmental problems people began to awareness on energy usage and the importance of energy efficiency and the sustainable use of energy resources has increased. Turkey targets to reduce its energy intensity by 20% up to 2023, and in order to achieve this aim, the country plans to use energy more effectively in various sectors and disposed to develop energy efficient mechanism and sources (Elsland et. all. 2014).

Energy efficiency plays a very important role in overcoming energy and environmental problems. Turkey has developed some policies to reach its goal of a reduction in energy intensity by at least 20% (based on the energy intensity value of 2011) until the year 2023. The Energy Efficiency Law, The Energy Efficiency Regulation, The Building Energy Performance (BEP) Regulation, the National Standard of Thermal Insulation Requirements for Buildings TS 825 are some important policies were developed to improve energy efficiency in the Turkish residential sector (Düzgün and Kömürgöz, 2014).

Table 2.1 Regulations of Energy Efficiency in Residential Sector in Turkey (Elsland et. al., 2014)

Law / regulation	Aim and scope with regard to the residential sector	Implementation (latest revision)
Laws and regulations addressing residential buildings		
Energy Efficiency Law (no. 5627) (EEL, 2013)	A broad frame for energy-efficiency policies in all sectors and the implementation of more specific regulations.	2007
Energy Efficiency Regulation (EER, 2013a, 2013b)	Authorization and standards for energy efficiency consulting companies (ESCOs) including training curricula for energy managers, public entities energy efficiency programs.	2008 (revised 2011)
Building Energy Performance Regulation (BEPR, 2013a, 2013b)	Setting minimum energy performance standards (MEPS) for buildings, regulation of MEPS calculation, use of renewable energies and HVAC systems.	2008 (superseded Reg. on Heat Insulation in 2009, revised 2010)
Regulation on Heat Insulation in Buildings (RHIB, 2013a, 2013b)	Requirements for thermal performance of building insulation.	2000 (superseded in 2009)
National Standard of Thermal Insulation Requirements for Buildings (TS 825) (TS, 2013)	Calculation procedures for standards for building insulation.	2000 (revised 2008)
Laws and regulations addressing residential appliances		
Directive on Eco-Design Requirements for Energy-Related Products (ECO, 2013)	Defines MEPS for energy-related products (refrigerators, freezers, dish washers, washing machines, dryers, air-conditioning and televisions) and stand-by and off-mode losses of electronic equipment. Related to relevant EU Directive and Regulations.	2010
Directive on Displaying Standard Product Information and Labelling (LAB, 2013)	Requires energy labels for energy-related products (currently refrigerators, dish washers, washing machines and televisions) also aligned to EU law.	2011

The Strategic Energy Efficiency Plan (SEEP) which is published in 2012, aims framework to for the development of energy efficiency policy by 2023 and aims to improve energy efficiency targets and actions. Both, targets and actions will be revised annually according to changes in governmental and EU policies. The main target is to reduce the amount of energy depletion per unit of GDP (energy intensity) by at least 20% by 2023 compared to 2011. The SEEP contains a total of seven strategic aims totally and one of them that is “Reduce the energy demand and carbon emissions of buildings and promote sustainable and environmental friendly buildings with using renewable energy source” specifically address the residential sector (SEEP, 2013 cited in Elsland et. al., 2014).

2.1.3 ENERGY EFFICIENCY IN URBAN REGENERATION

Urban regeneration can be a solution to economic, physical and social problems of inner-city areas. It is implemented to improve the social, economic, and physical and environmental situation of disrupted urban areas with holistic approaches (Akkar, 2006).
As Sunikka states;

"*Buildings conformed with the most cost-effective sectors where carbon dioxide (CO2) reductions and energy efficiency can be realized. Also urban regeneration offers a good intervention point for switching to sustainable fuel sources. However, the potential energy savings that are feasible do not match the more ambitious policy targets (Sunikka, 2006)".*

Increase energy efficiency in current buildings and integrate the energy efficiency policies and implementations on urban regeneration projects are important point to increase sustainability and reduce environmental problems that caused by energy usage. Urban regeneration provides a good intervention point to realize synergy between energy efficiency and build environment. Therefore, integrated regeneration as neighborhood is required to reduce energy consumption, as the energy demand of building depends not only on the quality of the building itself, but also on that of the surrounding buildings, the infrastructure and the neighborhood. However, energy efficiency plays a part essentially in urban environment policy, and the environmental issues has a small role in urban regeneration projects (Priemus, 1999; Ashford, 1999; Lowe, 2000; Van der Waals, 2001; Kohler and Hassler, 2002; Awano, 2005 cited in Sunikka, 2006)

Moreover, the quality of urban spaces and climate sensitivity of cities can be increased with the interventions that is made in the regeneration process. Although existing urban regeneration projects allows the solution of some urban problems, they could not contribute to eliminate the problem of climate change and energy and they do not involve the policies and reorganizations that take into account the climatic factors and climate change. Since a major part of energy consumption occurs by urban areas and built environment, the city makes a significant contribution to the climate change. Redeveloping current settlement pattern can help to the reduce effects of cities to climate change and adapt cities to results of climate change. Therefore, urban redevelopment projects and policies should be regulated in the way take into consideration climate change and its effects (Balaban, O., & Puppim de Oliveira, J. A, 2014).

Heating, ventilation, air conditioning and cooling are the major energy consumer to adapt climatic conditions within residential building use. Most of the buildings in Turkey were built years before 2000 and not regulated on energy performance. Although several energy efficiency policies were implemented and a lot of effort has been made to improve energy efficiency in the country, more additional policies such as integrated energy efficiency principles on urban regeneration projects are still necessary to address and handle these challenging subjects. As reducing energy consumption, carbon emission and effects of climate change should be important parts of urban regeneration, it has been reorganized that urban regeneration, energy efficiency and climate sensitivity should be combined together to provide environmental sustainability. Energy efficiency is a major way for meeting the needs and maintaining an urban regeneration.

2.2. ENERGY EFFICIENCY IN URBAN DESIGN

It has been identified that energy consumption increased up to sixteen fold while the world population quadrupled in the 20th century (Mega, 2005). Energy need and energy usage exist in almost all stages of uman activities. Due to rapid increase in nergy ned with the industrial revolution, use of natural resources and pressure of the people on the natural environment increased as well as, and this situation caused ecological problems and deteriorations. The double increase in energy consumption in the last 40 years and the relation of indispensable elements of daily life such as electricity, heating, hot water and transportation with energy, required radical changes in energy strategy, political will and financial incentives. The significant increase in energy consumption forced governments to search for different methods of energy conservation and smart use of energy. Therefore, efficient use of energy and reducing energy consumption have been one of the most important issues of today’s world (Gauzin-Müller, 2002 cited in Karaca & Varol, 2012).

With the increase in energy consumption due to urbanization and industrialization processes, many problems such as disturbance of ecological balance, environmental pollution, global warming and climate change have arisen. Energy has been a fundamental source in the daily life of humankind and it is required in every aspect of life. Fossil fuels (petroleum, natural gas, coal, etc.) maintain its position as the main source of energy and meet a considerable part of world's energy need currently. However, since fossil fuel reserves are being rapidly exhausted and their negative impacts on natural environment have become evident, alternative energy resources have been sought and efficient use of current resources have been put on the agenda of policy and decision-makers. Furthermore, the appropriate use of energy has gained more importance along with generation of energy from alternative sources. Urban areas in general and urban buildings in particular are defined as spaces consuming large amount of energy (Roaf et al., 2003).

Considering this fact, energy efficient urban design is becoming more important day by day. Minimizing the energy need and the demand for energy use in urban areas and buildings, while preserving the current living standards can be possible by using energy more efficiently in cities. Therefore, urban design practices that ensure energy efficiency, while improving urban environmental conditions, protecting ecological balance and meeting comfort and health conditions required for human life should be developed (Yüceer, 2015). According to most of the previous research that related to the subject of energy efficient urban design, variables tend to be divided into two parts: settlement scale and building scale.

2.3. ENERGY EFFICIENT URBAN DESIGN PARAMETERS ON SETTLEMENT SCALE

Urban form, land use, density, site selection and orientation, wind and site design, shading, landscape and vegetation are the most important aspects of energy efficient urban design parameters on settlements scale.

2.3.1. URBAN FORM

Urban form is the physical layout and morphological structure of a city. The physical form of urban areas influence the energy performance and energy consumption of urban systems including buildings. It can be taken as a main criteria that an ideal urban form help loose the minimum amount of heating in winter and gains the least amount of heating in summer (Olgyay, 1992).

As Owens (1987) claims that energy efficient urban form has to;

- consume less energy for heating and cooling
- encourage walking and cycling facilities
- be accessible via public transport system
- have sun-oriented buildings and streets.

According to the recent debate in academic literature, compact urban form is deemed an ideal form of urban development in terms of reduced energy consumption, increased resource conservation and waste minimization. High density quarters, contained inner spaces, mixed land use structure and a well-organized public transport system are the main characteristics of a compact city.

Golany (1995: 156 cited in Peker, 1999) states that a compact city can be characterised by the following features:

1. Provide good solutions to negative effects of climate such as intense radiation, dryness, cold winds,
1. Reduces energy consumption for air conditioning, cooling and heating,
2. Reduces infrastructure networks costs,
3. Provide good access to daily use, services and business area,
4. Saves time and energy,
5. Minimize negative impacts of built environments on ecology and environment.

2.3.2. LAND USE

Land use pattern crucially influences energy consumption and urban design enabling energy efficiency. Intense and compact urban design patterns including mixed land use ensure energy savings. Furthermore, arranging the position of buildings, streets and public areas in line with climatic and environmental circumstances can lower energy need and demand. According to Newman and Kenworthy (1989), intensive land use structure ensures more efficiency in energy use in urban areas (Newman & Kenworthy,1989 cited in Peker, 1998).

2.3.3. DENSITY

Density, which is the number of people living in unit construction area of buildings, is another important issue which help achieve energy efficiency. Higher density urban quarters and buildings are known to be more efficient in terms of land use-related merits that higher densities deliver. In dense urban quarters, people live in close proximity to different functions and thereby energy use to access these functions can be lowered. According to Knowles (1974), high density urban development can bring about more energy efficient buildings and settlements. For example, the multi-family housing is more efficient than single-family housing in terms of energy consumption per household and per capita. Moreover, lower energy consumption of multi-family housing and high-density urban development can also diminish urban heat island effect (Ko, 2013).

Density affects energy consumption in two ways (Göksu, 1999), described as follows:

1. In case the settlement density is increased, buildings should be more compact so as to reduce heat loses of buildings.
2. Compact buildings increase benefit from solar energy. As density increases, building heat load per unit area decreases.

2.3.4. SITE SELECTION AND ORIENTATION

Site selection and orientation influence energy consumption in cities and buildings. Where you build shows how much energy you consume. In other words, energy efficiency in urban areas can be obtained by site selection and orientation of buildings and city blocks. Choosing the best location for buildings is directly related to climatic conditions and building types. In addition, slope orientations should be determined by climatic conditions and building types to reduce energy use. Lechner (2014) suggests that south slope is the optimal choice for most buildings because it is the warmest location in winter (Figure 2.2). However, the best site and slope orientation is directly related to local climatic conditions and building types in question (Lechner, 2014).

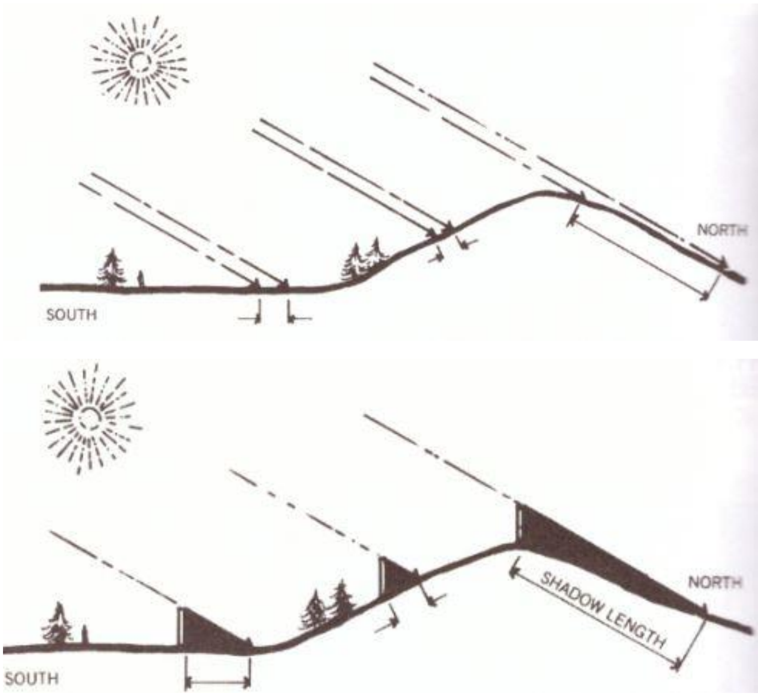


Figure 2.2: Proposed site selection area (Source: Lechner, 2014)

Street layout and orientation are significant variables that affect the amount of shadowing and radiation, light and air movement, intensity of city ventilation and duration of relative humidity in the air (Golany, 1995). Lechner (2014) has proven that there are some design recommendations for street layout to improve energy efficiency of buildings;

Streets that run east-west has best orientations in terms of meeting energy needs of all buildings (Figure 2.3). While designing new development areas, maximizing the number of lots that oriented east-west direction has great importance for reducing energy consumption (Lechner, 2014).

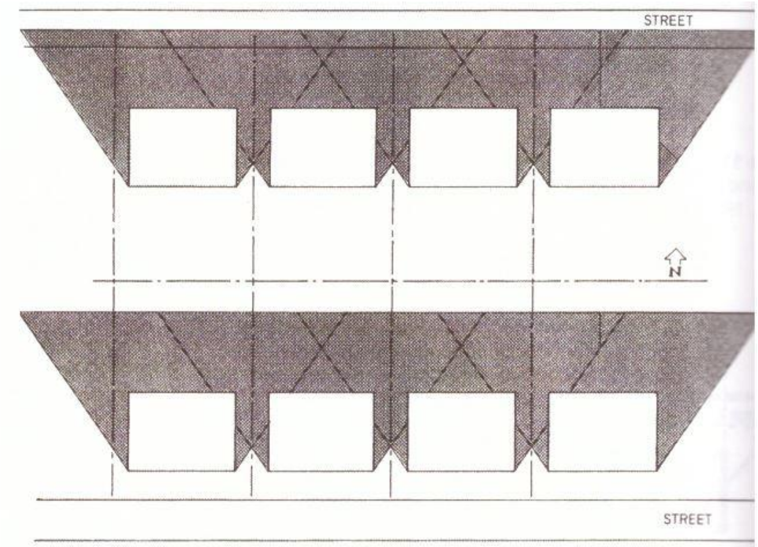


Figure 2.3 East-west oriented streets (Source: Lechner, 2014)

The north-south oriented streets provide neither solar acces in winter times nor shading on east-west facade in summer times.

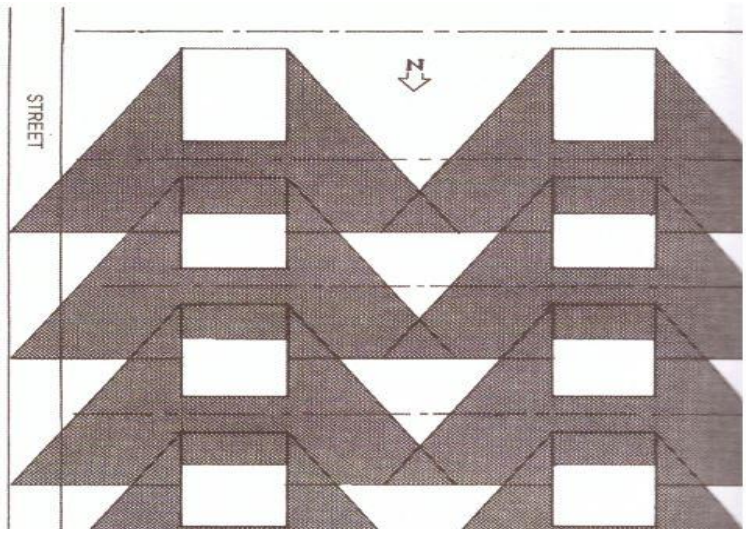


Figure 2.4 The north-south oriented streets (Source: Lechner, 2014)

Diagonal streets are alternative arrangements that provides benefits for south oriented streets.

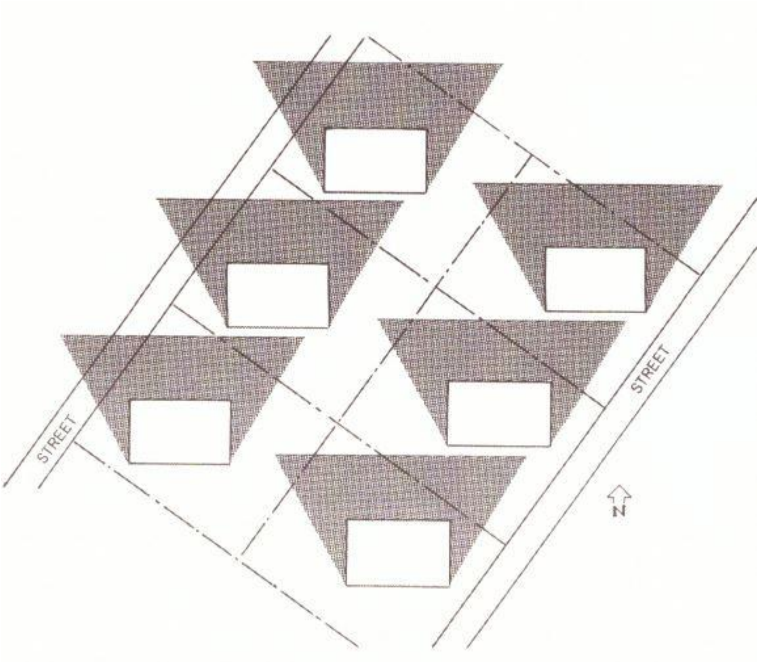


Figure 2.5 The diagonal street (Source: Lechner 2014)

Deep lots are better than wide lots on east-west streets as shown on Figure 2.6.

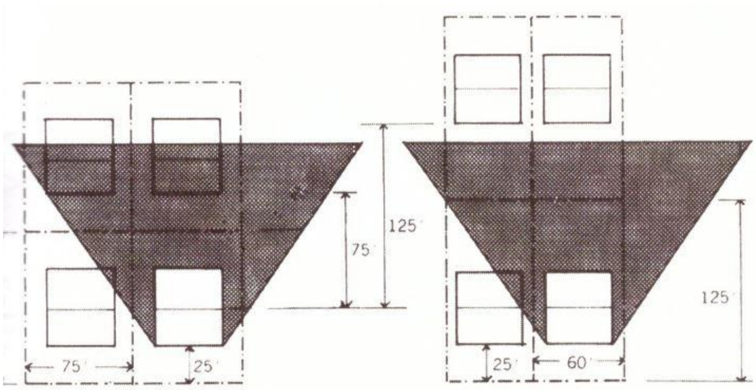


Figure 2.6 Deep lots on east-west oriented streets (Source: Lechner, 2014)

Uneven and large setbacks may cause majör problems both in winter and summer periods. Therefore, very small setbacks that used in row housing are deemed more feasible (Figure 2.7).

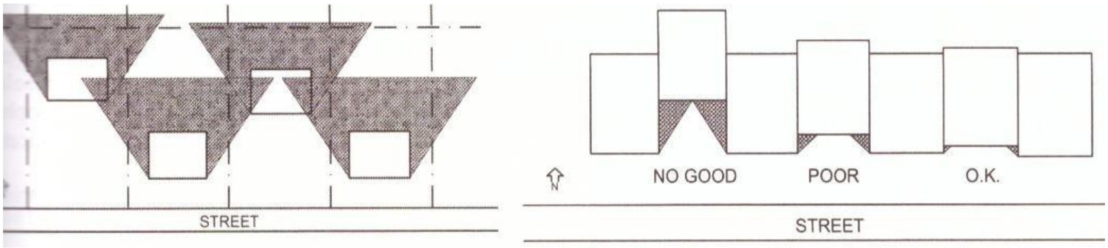


Figure 2.7 Effects of uneven and small setbacks (Source: Lechner, 2014)

2.3.5. WIND AND SITE DESIGN

Determining the design methods according to wind is important in the context of energy efficiency on site design. The variations of prevalence, the velocity and the temperature of winds should be analyzed in order to understand the effects of wind on human comfort and energy efficient design. Adaptation for wind orientation in non-airconditioned high-rise buildings is much more important than low-rise buildings. Designing in order to wind protection is crucial for both outdoor comfort and house heating (Olgyay, 1992).

Moreover, Leichner (2014) states that wind strategy should be differenciated for summer and winter conditions. Preventing the wind to reduce heat loss and protect ourdoor space from cold winds are major aims in winter times. In summer months, however, promoting the wind effect to achieve natural ventilation is the main purpose. Decelerating the wind speed through windbreaks is an effective strategy to reduce heat loss and infiltration. For example; the reduction of wind velocity is determined by the height and porosity of a windbreak (Figure 2.8).

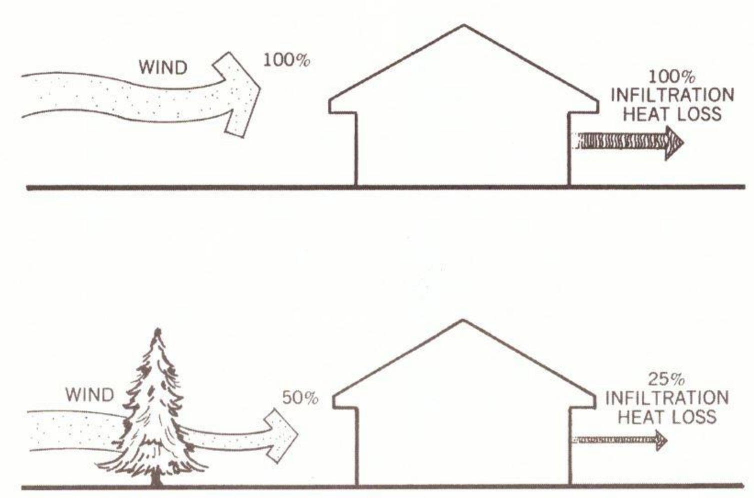


Figure 2.8 A small reduction in wind velocity caused a high in heat loss (Source: Lechner, 2014)

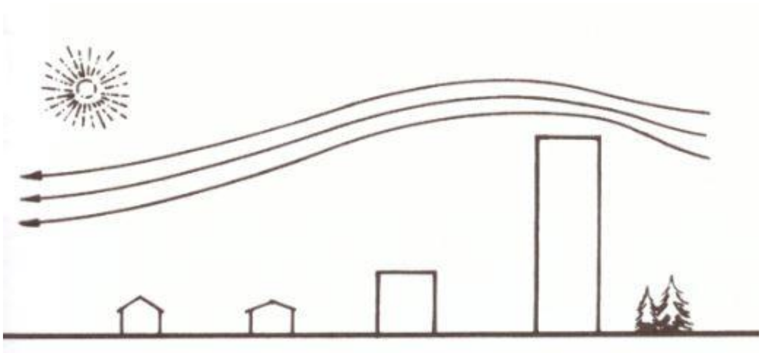


Figure 2.9 Tall buildings placed north of a site both protect it from cold winter winds and provide good solar access (Source: Lechner, 2014)

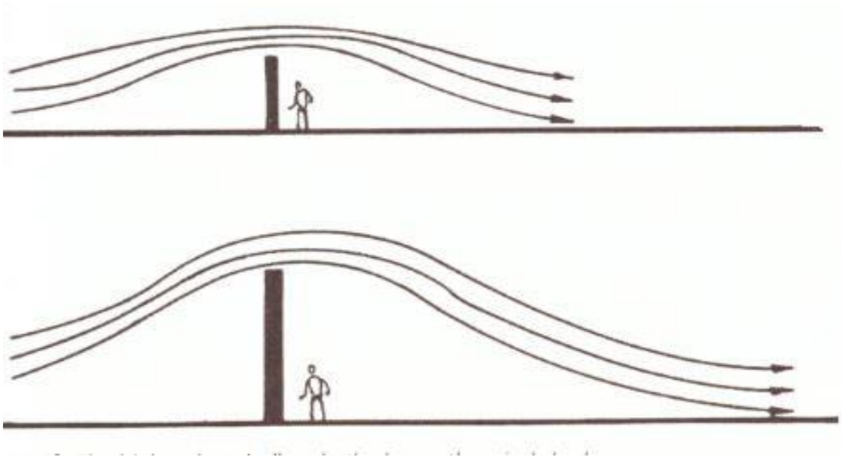


Figure 2.10 The higher the windbreak, the larger the wind shadow (Source: Lechner, 2014)

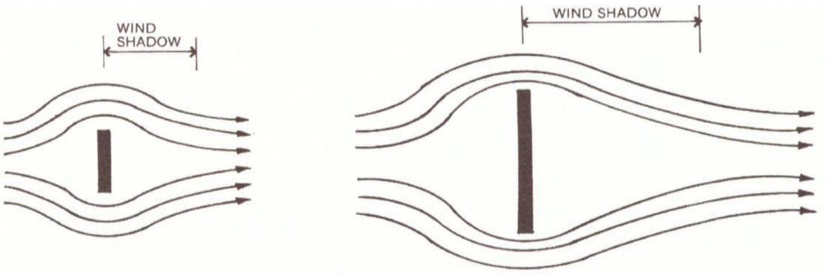


Figure 2.11 Width of a windbreak also affects the length of wind shadow. In this figure, the lengths of windbreaks are same (Source: Lechner, 2014)

2.3.6. SHADING

In summer periods, energy consumption is high because of the need for air conditioning. Therefore, shading is one of the most important energy efficient design strategies to reduce heat gain during summer times. There are a lot of shading elements as fixed exterior shading devices, movable shading devices, reflective roof and wall, and glazing. Exterior shading is more efficient than interior shading and glazing. Moreover, maximization of south and north glazing, and minimization of east and west glazing are crucial strategies for effective shading. Decidious vegetations and plants can also be excellent shading elements (Lechner, 2014).

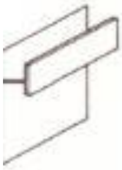
	Descriptive Name	Best Orientation*	Comments
	Overhang Horizontal panel or awning	South, east, west	Traps hot air Can be loaded by snow and wind Can be slanted
	Overhang Horizontal louvers in horizontal plane	South, east, west	Free air movement Snow or wind load is small Small scale Best buy!
	Overhang Horizontal louvers in vertical plane	South, east, west	Reduces length of overhang View restricted Also available with miniature louvers
	Overhang Vertical panel	South, east, west	Free air movement No snow load View restricted
	Vertical fin	North	Restricts view if used on east and west orientations
	Vertical fin slanted	East, west	Slant toward north in hot climates and south in cold climates Restricts view significantly **Not recommended**
	Eggcrate	East, west	For very hot climates View very restricted Traps hot air **Not recommended**

Figure 2.12 Examples of fixed shading devices (Source: Lechner, 2014)

	Descriptive Name	Best Orientation	Comments
	Overhang Awning	South, east, west	Fully adjustable for annual, daily, or hourly conditions Traps hot air Good for view Can be retracted during storms Best buy!
	Overhang Rotating horizontal louvers	South, east, west	Will block some view and winter sun
	Fin Rotating fins	East, west	Much more effective than fixed fins Less restricted view than slanted fixed fins
	Deciduous plants Trees Vines	East, west southeast, southwest northeast northwest	View restricted but attractive for low-canopy trees Self-cooling **Highly recommended**
	Exterior roller shade	East, west, southeast, southwest northeast northwest	Very flexible, from completely open to completely closed View is restricted when shade is used **Provides security**

Figure 2.13 Examples of movable shading devices (Source: Lechner, 2014)

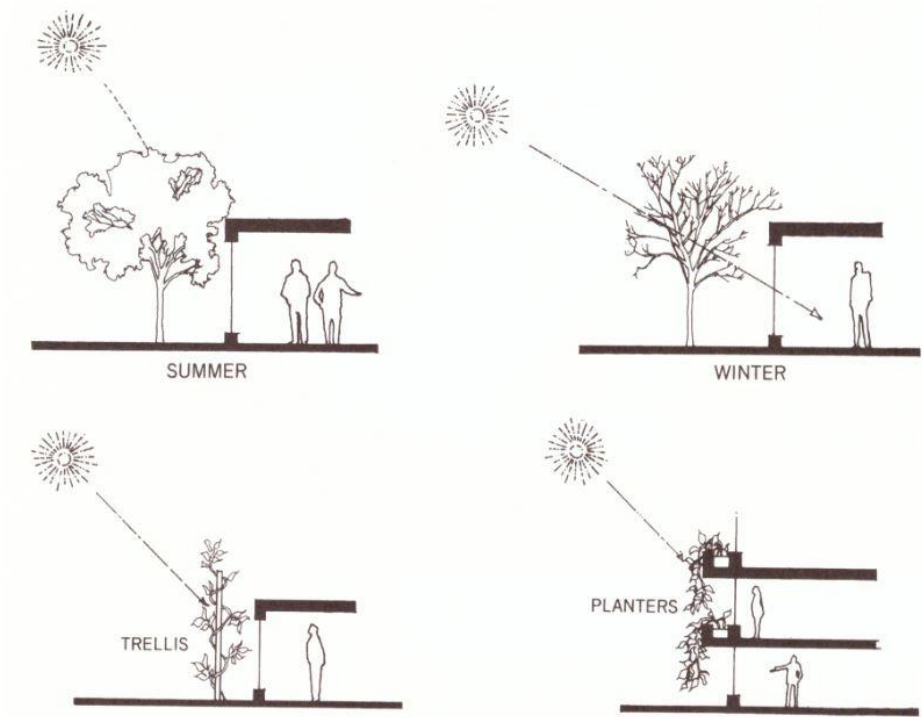


Figure 2.14 Shading from trees depend on species, pruning, and maturity of plants (Source: Lechner, 2014)

2.3.7. VEGETATION AND LANDSCAPING

Vegetated areas are several degrees cooler than urban areas because buildings and paving elements tend to retain more heat. Trees are among energy efficient design elements that reduce energy demands of buildings. The cooling effect of a tree shade, promote natural ventilation and evapotranspiration are the widely known features of trees in terms of efficient use of energy. Moreover vegetation and plants can moderate heat island effect by absorbing and reflecting solar radiation and creating calm air zone under canopy and cooling mechanisms. Trees should be located strategically to obtain effective shading and ventilation. Trees show the best performance on the east-south east and on west, south-west sides of buildings in mornings and afternoons. If trees are not available to shade east west and north, high bushes and shrubs should be used (Ko, 2013; Olgyay,1992; Lechner, 2014).

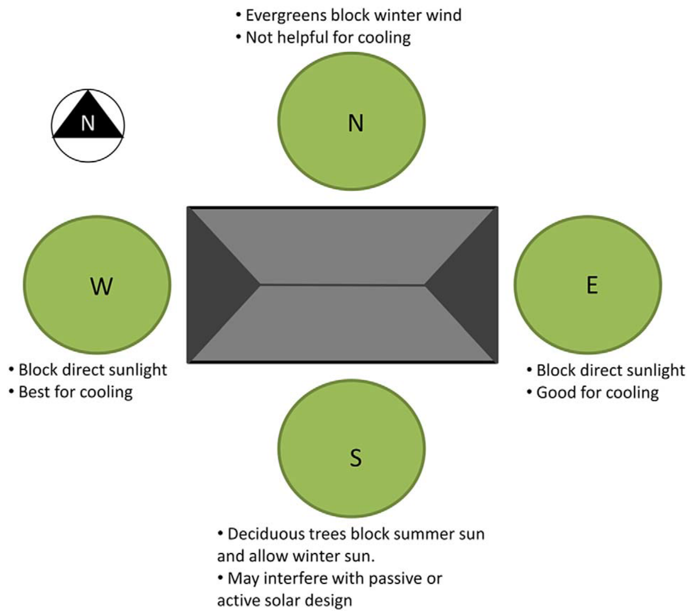


Figure 2.15 Typical effects of trees planted around a building (Northern hemisphere) (Source: Ko, 2013)

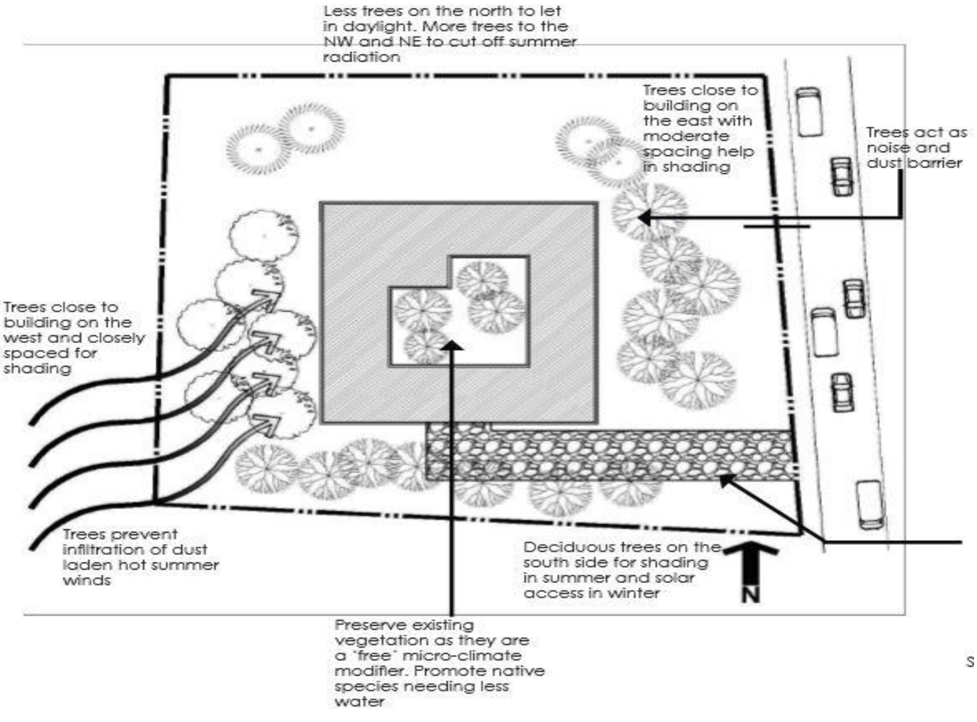


Figure 2.16 Planting Plantation (Source: Central Public Works Department, 2013)

2.4. ENERGY EFFICIENT URBAN DESIGN PARAMETERS ON BUILDING SCALE

Building form, housing types, solar access and sol-air approach, distance between buildings, daylighting, natural ventilation and building materials are the most important variables of energy efficient urban design on buildings scale. These variables highly influence the use of energy in and through urban space.

2.4.1. BUILDING FORM (SIZE AND SHAPE)

Building form is an important variable to provide energy efficiency and reduce building's energy demand. Creating a building form is a crucial part of design. Climatic and environmental conditions, building's intended purpose, functionality are some of the factors that affect the decision-making on a building's form. In addition, building's height, depth and facades relates to the rate of heat loss and gain in the interior space. Therefore, building form, size and volume are among the most important factors affecting energy efficiency. Form and surface area of a building should be chosen according to local climate conditions and most efficient building form and surface area can be detected in this way (Yüceer, 2014).

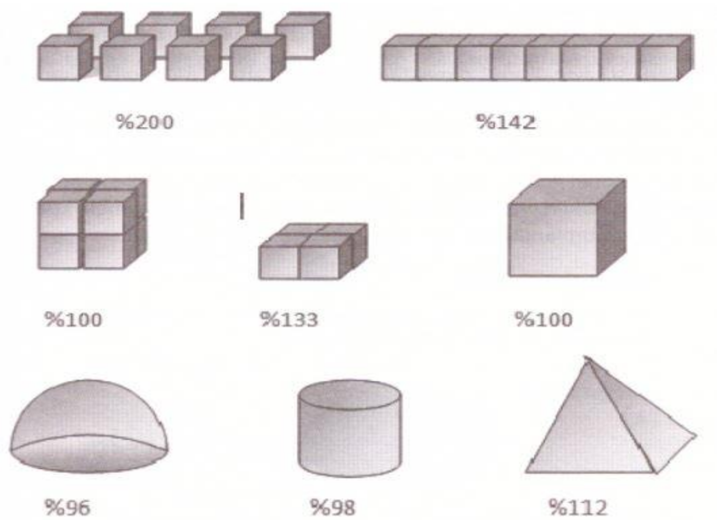


Figure 2.17 Relationship between building forms and surface area (Source: Yüceer, 2015)

Along with the building form, the ways that several buildings may vary the rate of heat loss in the building. For example, heat loss in detached buildings is higher than heat loss in attached or adjacent buildings (Tönük, 2001).

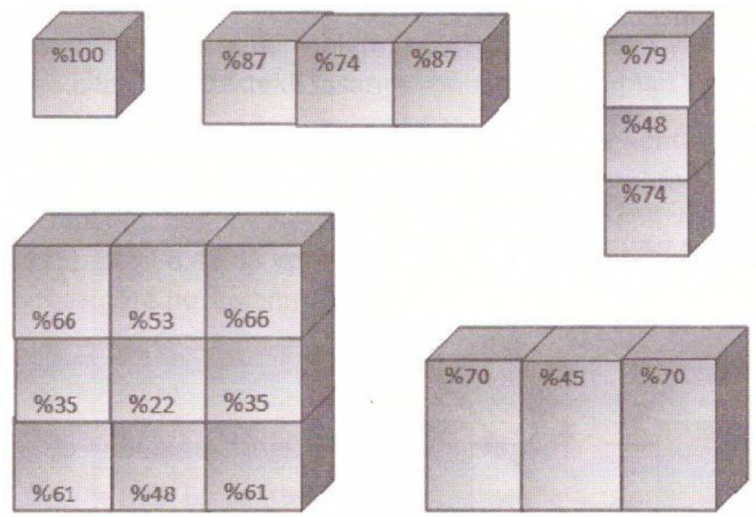


Figure 2.18 Heat loss rates of buildings (Source: Tönük, 2001)

Knowles (1974, 63) acknowledges in his study that "the maintaining cost of a structure expresses the energy amount needed to maintain the desired stable internal situation whilst the external environment experiences cyclic variations". With the aim of clarifying his statements, he underlines two terms: "stress" and "susceptibility". It is possible to measure stress with energy amount required to maintain the structure and the energy amount for maintenance is a function of the variation in force effect on the arrangement. Besides, the term susceptibility widely used as "skin phenomenon" can be identified as a function of the ratio between exposed surface and contained volume. When the exposed surface for contained volume increases, susceptibility of the arrangement increases as well. This surface-to-volume ratio (S/V) or the coefficient of susceptibility can be correlated with the stress range on a site. Moreover, complexity of a shape influence S/V. Complex shapes usually have higher S/V than large and simple shapes (Knowles, 1974: 67).

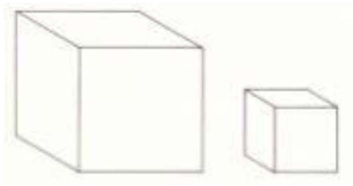


Figure 2.19 Doubling the dimensions of a cube decreases its surface-to-volume ratio but one half (Source: Knowles, 1974)

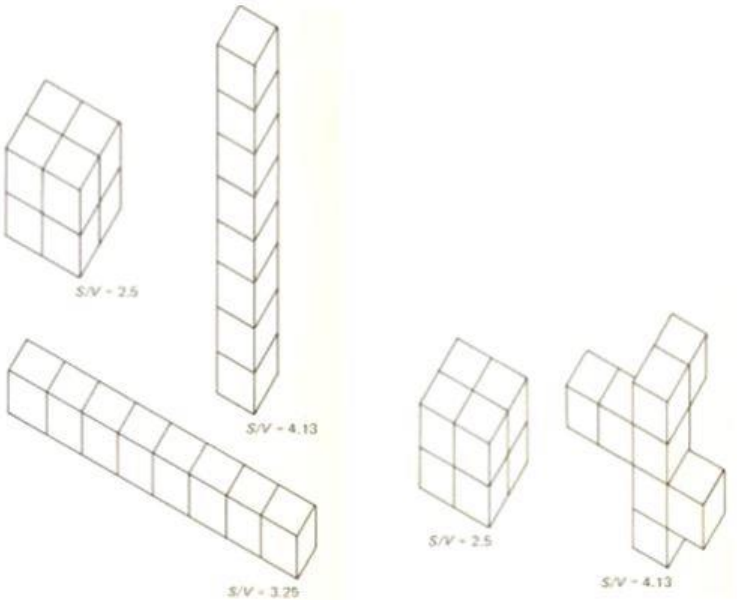


Figure 2.20 The shape of the form has an effect on its S/V ratio b: Simple shapes have lower S/V ratio (Source: Knowles, 1974)

2.4.2. HOUSING TYPES

Housing types is the another variable of energy efficient urban design. There is a considerable effect of housing types in providing heat gain, ventilation, air conditioning, orientation, etc. Different types of housing represents different responsivities to climatic conditions.

First housing type is the “detached housing” that is a single building, which is not attached to any other building. Although it is less sensitive to orientation with respect to sun and wind direction, this types provides a good potential for ventilation and air conditioning. Therefore energy consumption of this type may be lower because of decreasing energy demand for cooling.

“Row buildings”, which is a group of several single family units, attached to each other on their sidewalks, forms a row of dwelling units. They are much more responsive than single family houses, in terms of ventilation aspect and orientation to the wind direction. The exposed area of the building envelope is smaller. The external walls may thus minimize the exposure of the townhouse to sun in summer and maximize its potential for solar heating in winter. Therefore, row housing has important merits in terms of energy efficiency (Peker,1999).

“Multi-storey apartments” are also efficient in terms of energy usage. Because of the smallest surface area of the envelope of all building types, the rate of heat gain in summer and the rate of heat loss in winter are also the lowest in multi-storey apartments (Cook, 1991).

2.4.3. SOLAR ACCESS AND SOL-AIR ORIENTATION

The sun is the basic need for almost all aspects of human life. Various components of the quality of life, such as human comfort, humidity, air movement, light and sound levels and a lot of properties of the physical environment are related to sun directly. Therefore, the quality of our life may be affected negatively without access to sun (Knowles,1981). Solar access of urban quarters and buildings is another important variable to promote energy efficiency, reduce energy consumption in cities. Solar access directly influences the buildings’ heating and cooling needs. Because of the inaccuracy of site selection and orientation or unsuitable building height and form, buildings can be prevented from accessing the sun (Peker, 1999). Moreover, south orientation of a vertical surface (wall) is exposed to maximum solar radiation in December whereas minimum in June. In summer times, horizontal surface gets the most solar radiation, and solar radiation of horizantal surfaces in winters is more less than southeast and southwest surface (Buldurur, 1983).

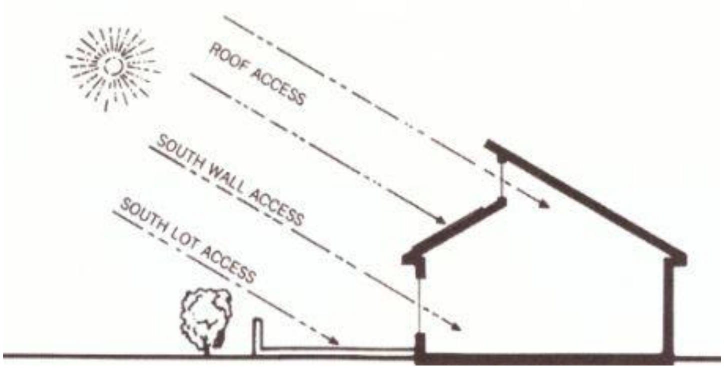


Figure 2.21 Clerestories and active roof (Source: Lechner, 2014)

As Knowles (1974: 77) indicates: **“***the area of influence, which is based on a unit height, must be converted into a dimensional relationship between height and the area influenced. This is done by means of the height-to-area ratio (HIA). This conversion required several descriptive steps leading to a building increment*”.

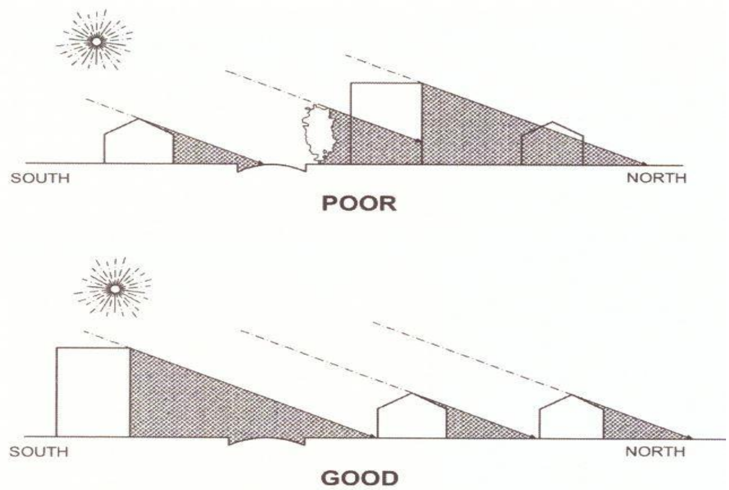


Figure 2.22 Place taller buildings and trees on south side of east-west streets to take advantage of the wide range of solar access (Source: Lechner, 2014)

In addition, Olgyay (1994: 54) states that “the Sol-Air Approach to orientation recognizes that air temperature and solar radiation act together to produce one sensation of heat in the human body”.

2.4.4. DISTANCE BETWEEN BUILDINGS

Determination of distance between buildings accordance with access to solar radiation is extremely important in terms of energy efficiency. It can be said that besides building heights, the utilization of solar radiation as passive heating or air conditioning is also the function of open spaces between buildings. When solar radiation strikes to a surface, then there occurs a shaded area. The dimensions of that shaded area alters according to the sun's angle. If the preferred condition is receiving maximum direct solar radiation then the distance between buildings should be equal or more than the highest depth of shaded area. It was given in Figure2. 23 that the depth of shaded area of the building in horizantal plane (Berköz,1995).

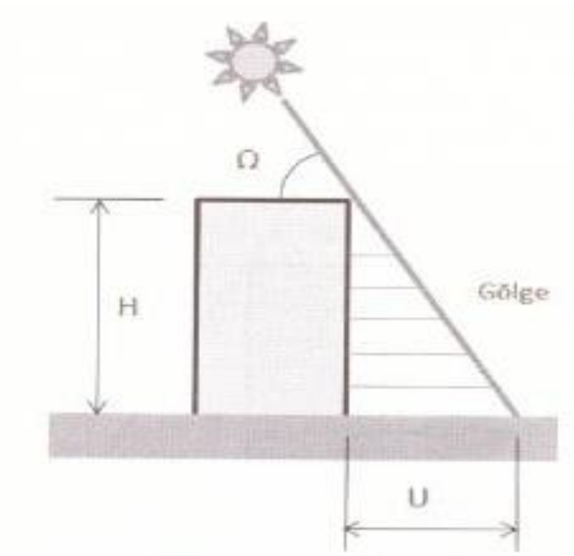


Figure 2.23 Depth of shaded area of the building in horizontal plane (Source: Berköz, 1995)

To receive maximum direct solar radiation, the distance between buildings should be equal or more than the highest depth of shaded area. The factors in determining the distance between buildings are:

The formula to evaluating the depth of shaded area *(u);*

***(u)* = cot Ω.H**

Ω= profile angle

H= building heights

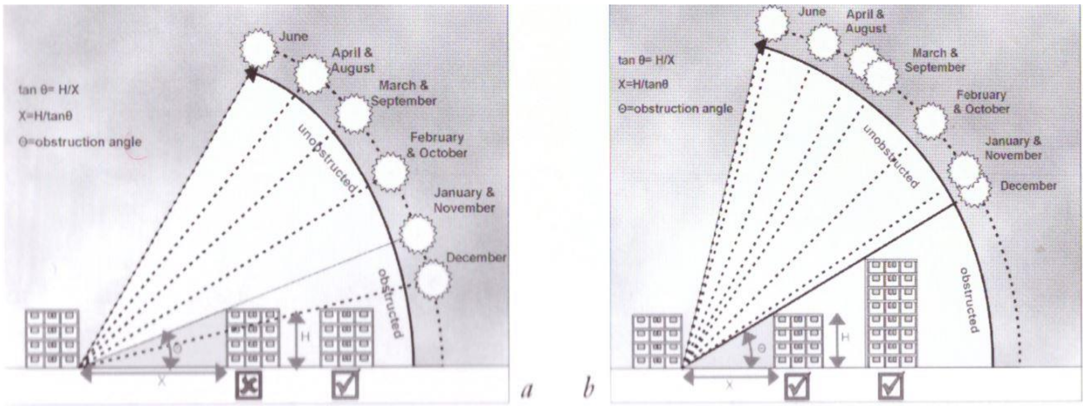


Figure 2.24 a) The obstruction angle (North latitude) b) The obstruction angle (South latitude) (Source: Santamouris et. al., 2011).

In addition, climatic conditions, site orientation, topography, slope angle and latitude are the some other variables that affect the determine distance between buildings.

2.4.5. DAYLIGHTING

The amount of total energy used in a building that is taken by artificial lighting system is much higher than we thought. Therefore, natural daylighting design in building is significant to reduce energy use and costs that related to artificial lighting. A good and correct daylighting design provide energy efficiency. As stated by Goulding et. al (1993) there are several sources of natural daylight received from outdoor area:

- direct sun light
- clear sky and clouds
- reflections from the ground and other surfaces like buildings

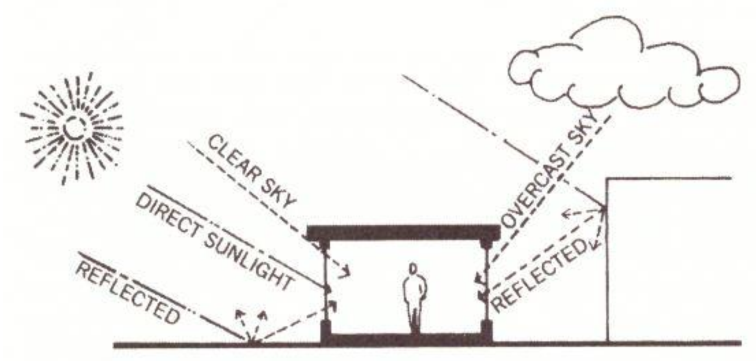


Figure 2.25 The sources of daylight (Source: Lechner, 2014)

The penetration and distribution of daylight in the buildig mostly depends on the size and location of the openings.

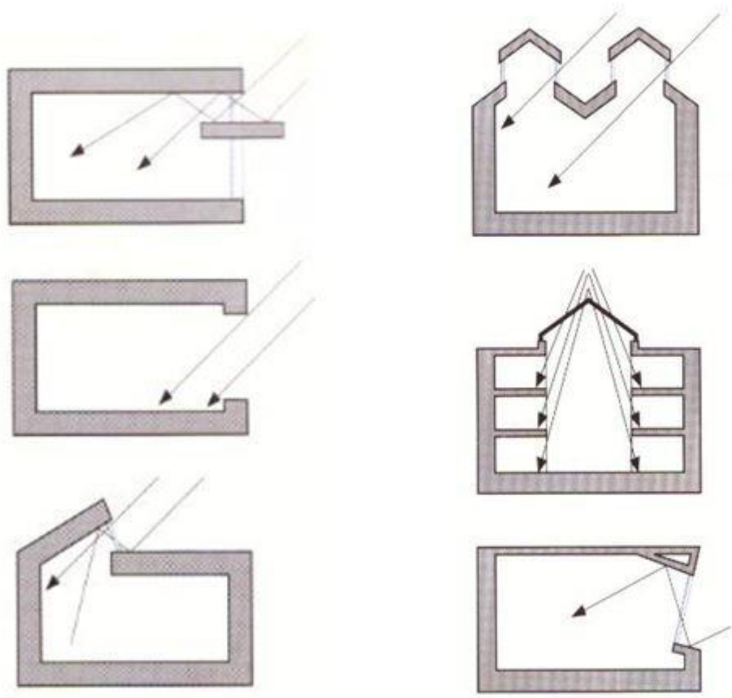


Figure 2.26 Typical side and top openings for good daylighting penetration
(Source: Goulding et. al, 1993**)**

The orientation of the building are important to correct daylighting design. The south orientation is the best to get direct daylight. The north is the second best orientation side for daylighting. The east and west are the worst orientations in terms of gain natural light. Because of reflecting more light, using light colors is important to get much more daylight. Therefore the light colored exterior walls, roof facades are preferable. Windows height should be high for good daylight penetration (Lechner, 2014).

2.4.6. NATURAL VENTILATION

Natural ventilation and cooling are important variables to reduce energy consumption of buildings, which is used to achieve thermal comfort in summers. The aim of natural ventilation is to minimize the heat gain and maximize heat loss in buildings. To increase the heat loss, natural air flow should be provided with interior and exterior surface of buildings (Ok, 2007). The building openings and windows has direct effect on indoor thermal comfort.

According to Watsons (1989), there are some design principles to provide natural ventilation and cooling at building scale:

- Use “open plan” interior to promote airflow,
- Provide vertical airshafts to promote “thermal chimney” or stack-effect airflow,
- Use double roof construction for ventilation within the building shell,
- Orient door and window openings to facilitate natural ventilation from prevailing summer breezes,
- Use wing walls, overhangs, and louvers to direct summer wind flow into interior,
- Use louvered wall openings for maximum ventilation control and use roof monitors for “stack effect” ventilation.

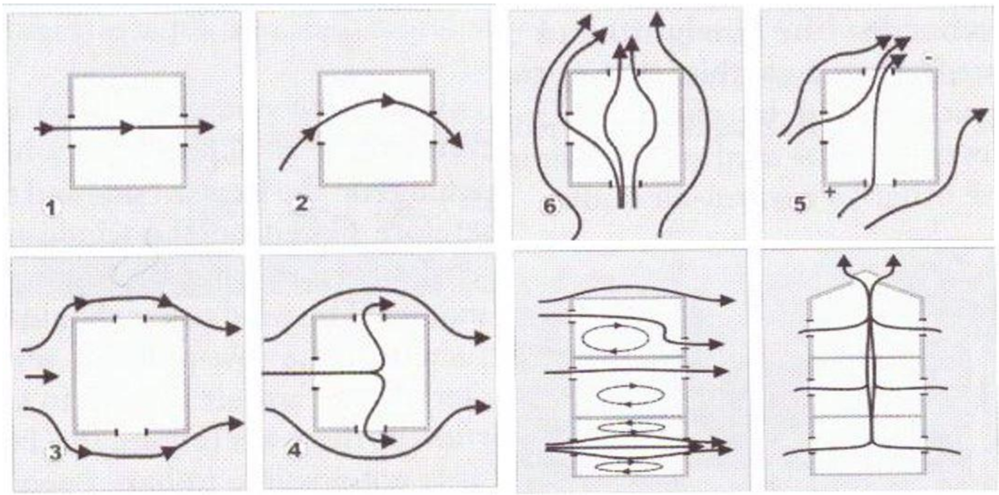


Figure 2.27 Ventilation strategies by the arrangement of openings (Source: Santamorous et. al, 2001)

Moreover, vegetations can act as a wind control devices and the wind velocity or direction can by controlled by correct landscape design and landscape elements.

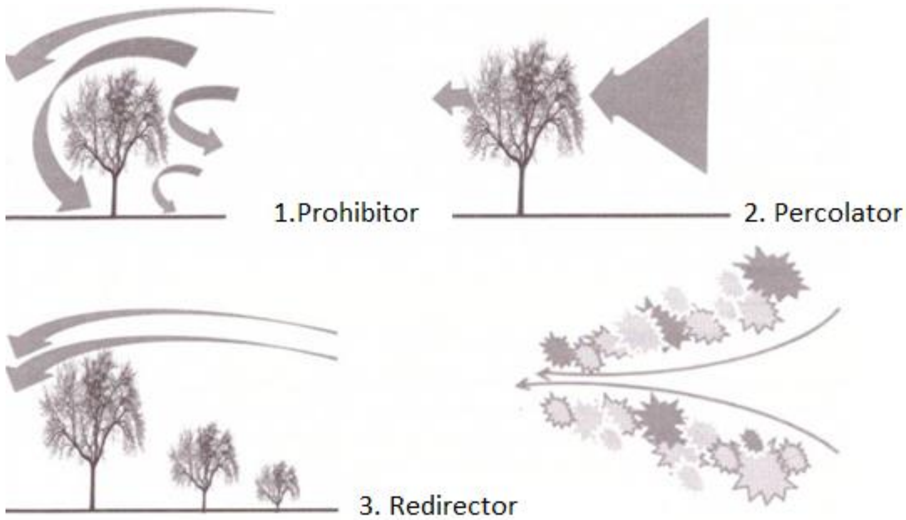


Figure 2.28 The effects of vegetation on wind velocity and direction (Source: Yüceer, 2015**)**

2.4.7. BUILDING ELEMENTS

The **transparent elements** like glazing can provide heat loss easily because of poor thermal properties. They also admit solar radiation and size, locations and material features of transparent elements are important to flows of energy in buildings. Using curtains, shutters or other movable insulation enhance thermal resistance of transparent elements. External devices are better than internal devices for insulation of windows (Goulding et. al., 1993).

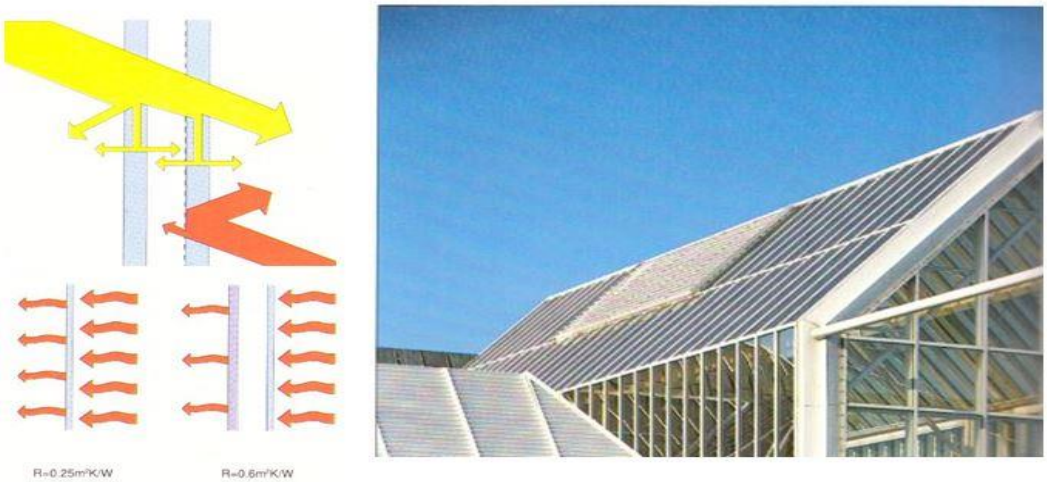


Figure 2.29 Transparent Elements of Buildings (Source: Goulding et al., 1993)

“Transparent materials readily allow short wavelengths of solar radiation to pass through. However, after striking interior surfaces, the reflected rays are long in wavelength and these do not pass through so readily. This way of trapping of heat is called the greenhouse effect” (Lyle, 1994).

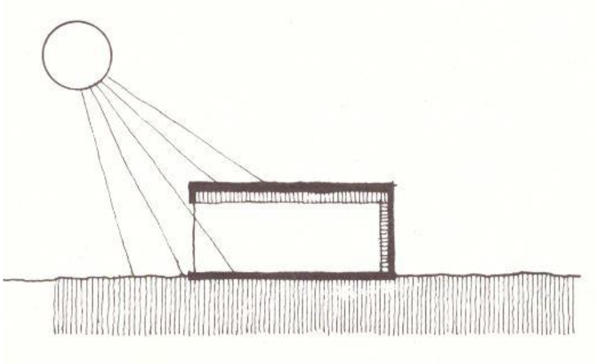


Figure 2.30 Transparent elements (Source: Lyle, 1994)

The **opaque elements** of buildings like walls and roofs should provide permanent thermal insulation to reduce heat losses. The insulation with opaque elements may prevent heat flow by conduction and promote indoor temperature. The dry and still air is better insulation material than the wetter. Insulation can be applied on outside, inside and within the wall (Goulding et. al., 1993).

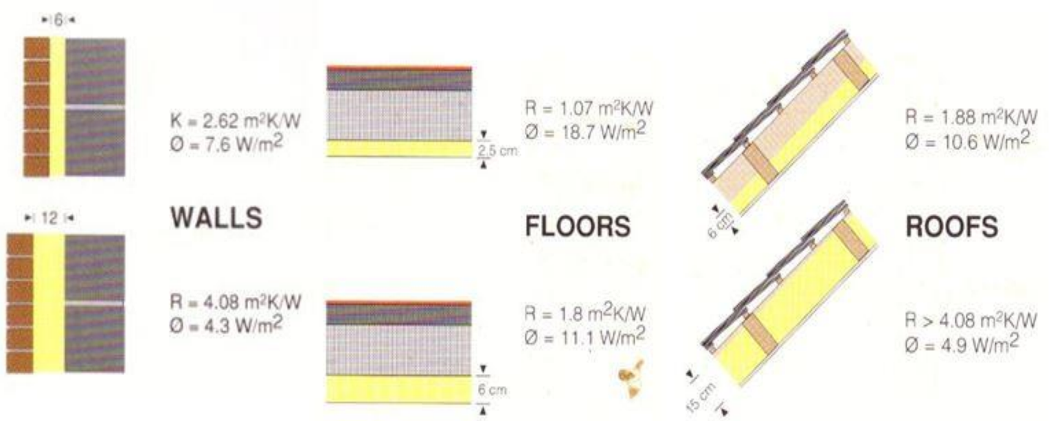


Figure 2.31 Features of opaque elements (Source: Goulding et. al., 1993)

As Santamorous et al. (2001) claim that the external wall elements can be insulated on the outer side in the cavity of a double wall or on the inner side to provide energy efficiency (Figure 2.32).

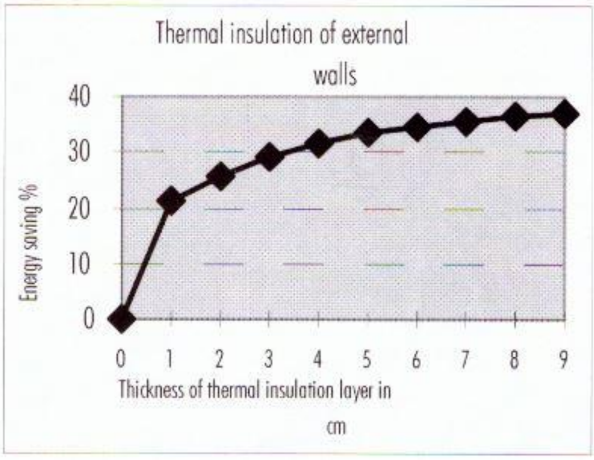


Figure 2.32 Energy saving by insulating the external wall of a non-insulated urban buildings (Source: Santamorous et al., 2001)

By insulating the floor over the ground, energy savings are significantly smaller than those of other building elements (Figure 2.33).

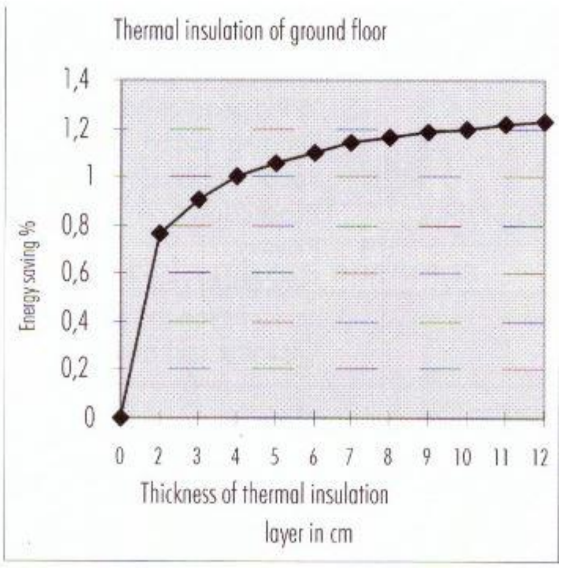


Figure 2.33 Energy saving by insulating the floor over the ground of an uninsulated urban building (Source: Santamorous et al, 2001)

Thermal insulation of roofs plays an important role in increasing energy savings. Roofs, as one of the structural elements of the building shell, usually designed to be inclined (Figure 2.34).

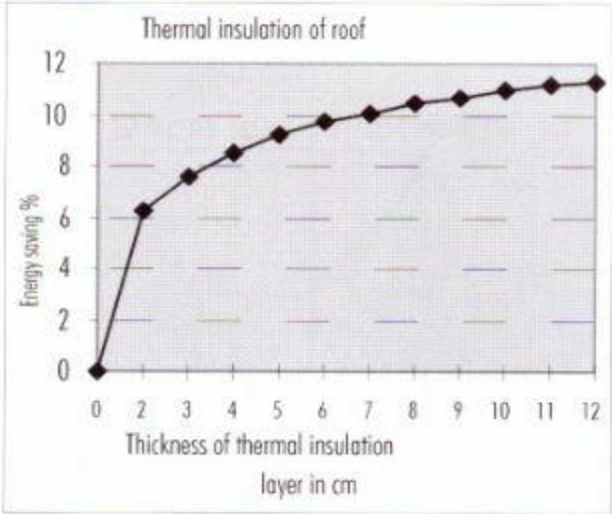


Figure 2.34 Energy savings by insulating the roof of an uninsulated urban building (Source: Santamorous et al, 2001)

Shading is another element of building-based energy efficient urban design practice. Shading the windows is the most effective way to prevent unwanted direct sunlight at building scale. The building's form and orientation as well as the position of sun identifiy the degree and type of shading received. In summers, less solar radiation reaches the south side of buildings because sun is high in sky. Therefore, protecting of south windows is easy. However, east and west side of buildings are problematic in summers because the sun is low in sky. Due to the fact that excessive solar radiation reaches these windows, the east-west-facing glazing should be reduced as far as possible. Also movable or adjustable shading devices are more flexible and sentive than fixed devices to provide control (Goulding et. al., 1993).

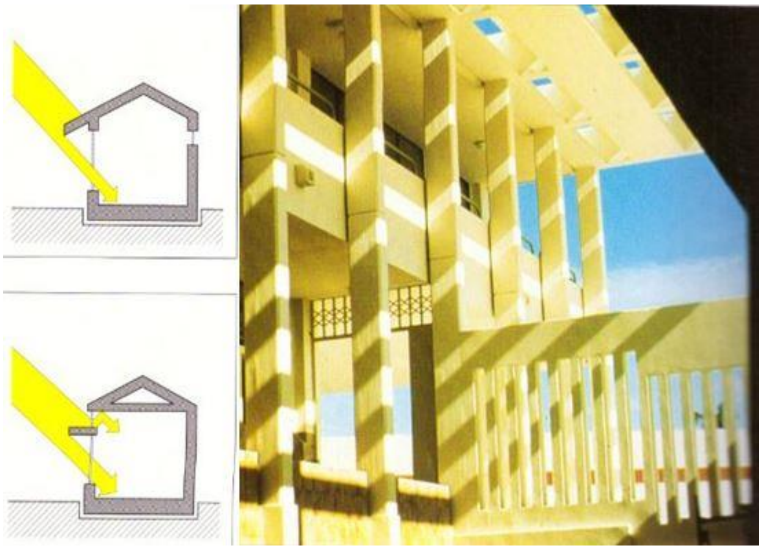


Figure 2.35 Fixed shading devices of building (Goulding et. al., 1993)

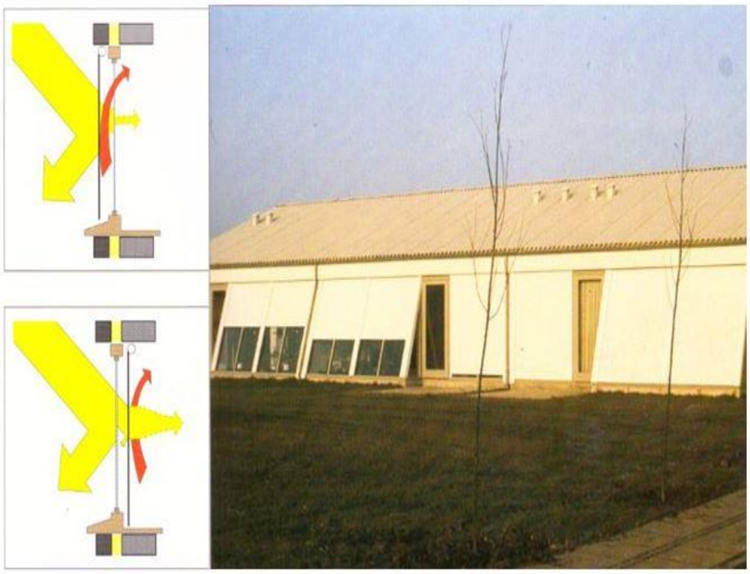


Figure 2.36 Movable or adjustable shading devices (Goulding et. al., 1993)

As Santamorois et. al. (2001, 287) indicates: “a combination of external and internal shading devives can offer efficient solar control. An ideal solution is to have shades that can be moved either seasonally or on daily basis”.

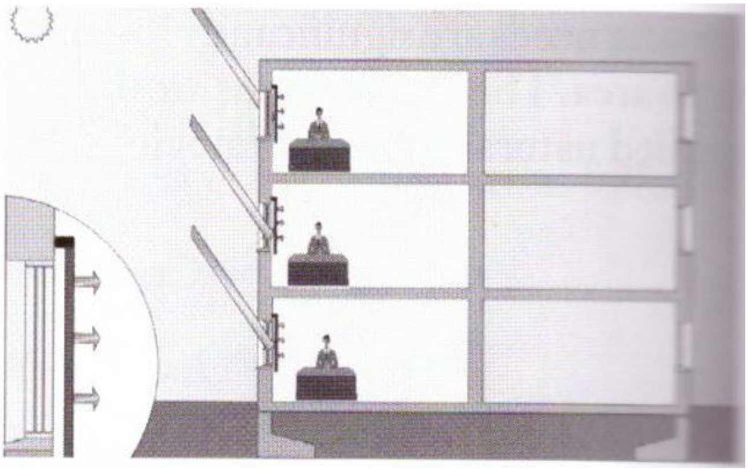


Figure 2.37 Interior shading devices (roller shades, venetian blinds and drapes)
(Source: Santamouris et al., 2001)

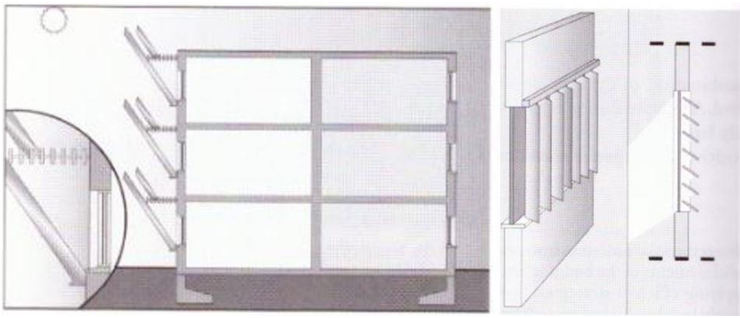


Figure 2.38 Exterior horizontal and exterior vertical shading devices (Source: Santamouris et al., 2001)

Openings are among other variables that influence thermal comfort and energy usage in buildings. The air movement, heating, cooling and ventilation are controlled by openings of building. As Lyle (1994, 108) indicates: "*if openings are located in walls on the two opposite sides, the difference in pressure causes movement of air. If the openings are large and equal in size, the volume of air flowing through will be large and its speed somewhat greater than the wind speed outside. A higher placement causes air to move upward. An overhanging placed above the inlet side increases the pressure and thus the movement of air through opening*".

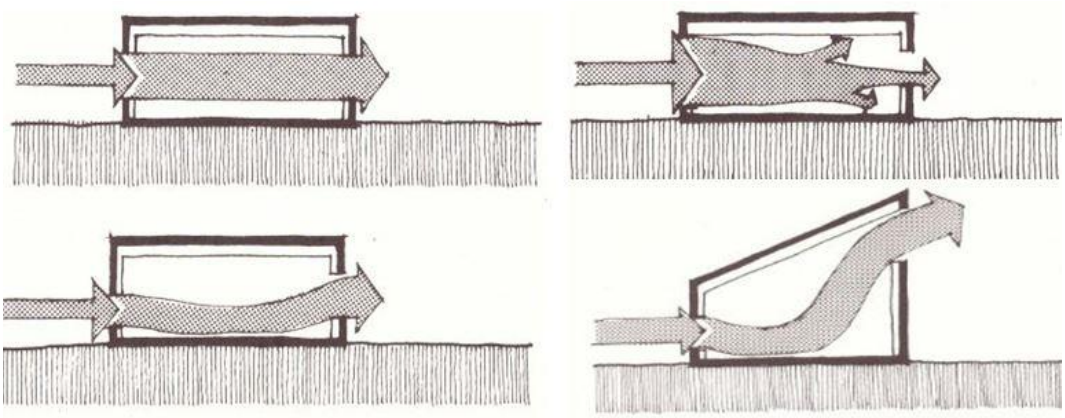


Figure 2.39 Interior air movement (Source: Lyle, 1994)

Basic requirements – large surfaces	Secondary requirements – small surfaces
Selective maximization of solar heat gains	Thermal insulation (in winter and summer)
Daylighting	Wind protection
Ventilation	Sun protection
Sunlighting	Sound protection
Functional and visual connection of the interior and exterior spaces	Protection from unwanted viewing
	Privacy
	Functional requirements of the space; closed surfaces for the positioning of furniture
	Cleaning and maintenance

Figure 2.40 Requirements of Openings (Source: Santamouris et al., 2001)

South openings of buildings provide better solar gain compared to other openings. They are more useful during summers and they cause energy savings in heating. Also, unintendent solar radiation can be prevented with simple shading devices in summers.

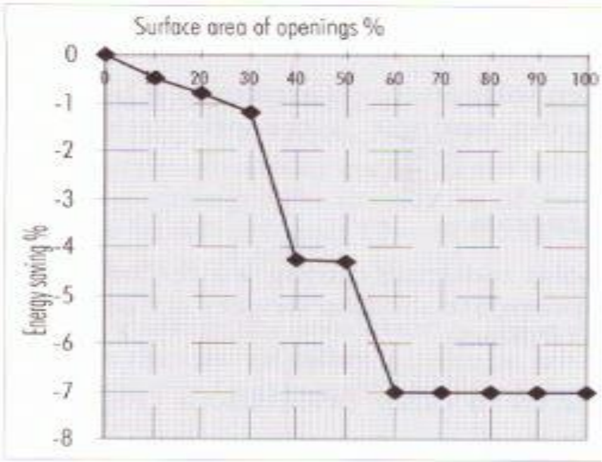


Figure 2.41 Energy saved by increasing the number of size of the south openings (Source: Santamouris et al., 2001)

North openings of buildings are more useful in summers because of better quality of lighting. But they cause more energy consumption because of high thermal losses during winters. Therefore, it is proposed that they should be small size.

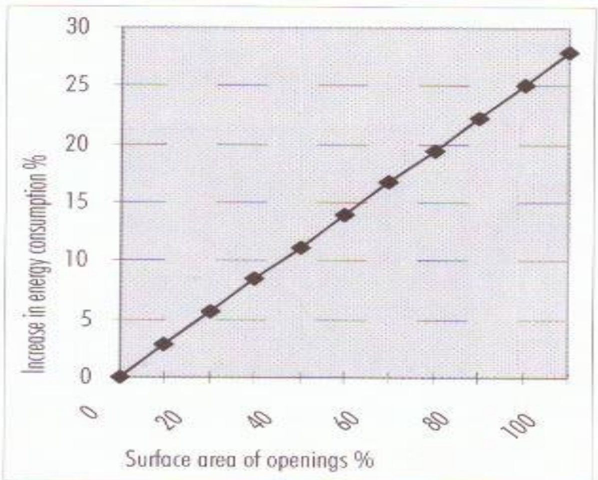


Figure 2.42 Energy consumption in relation to North openings (Source: Santamouris et al., 2001)

East and west openings of buildings increase the interior temperature because they allow direct radiation in mornings and afternoons. Therefore, shading devices should be used on each side openings and limited size of openings should be used to prevent unintendent solar gain (Santamouris et al., 2001)

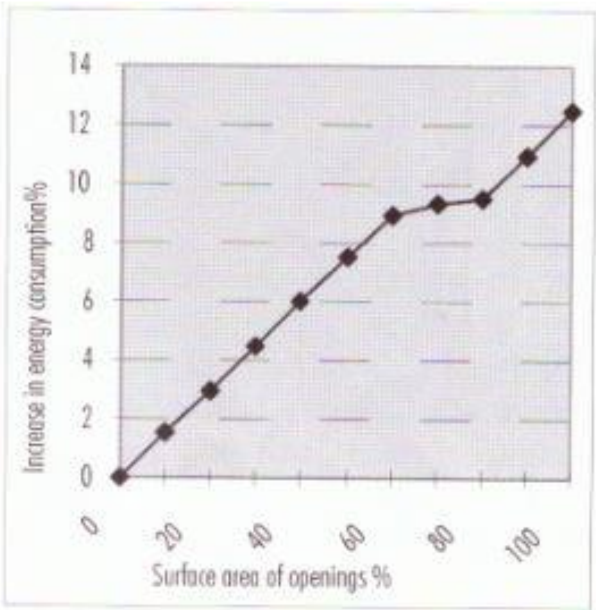


Figure 2.43 Energy consumption in relation to East-West openings (Source: Santamouris et al., 2001**)**

2.5. CLIMATE: A BASIC COMPONENT TO PROVIDE ENERGY EFFICIENCY

Urban climate is a basic design component that help create energy efficient environments. To reduce energy consumption and design better living environments, it is essential to understand the climatic conditions of and heat exchange in the locality that will be planned. At the same time, understanding of the climatic conditions in urban areas may also help us design spaces accordingly to improve indoor and outdoor conditions.

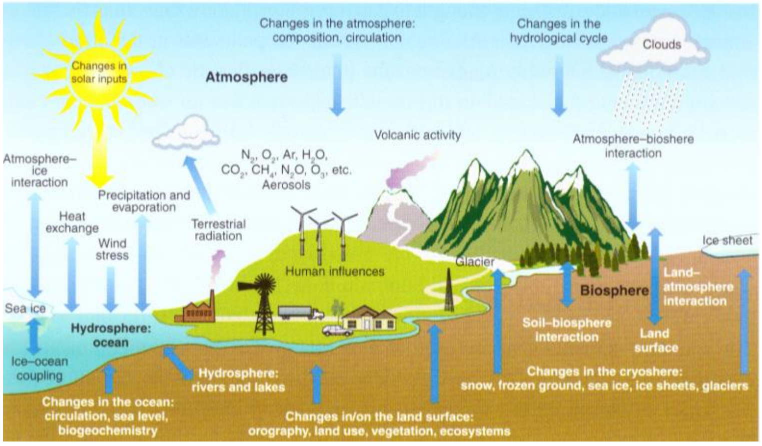


Figure 2.44 The climate system (Source: Solomon et. al., 2007)

Previous work on climate sensitive architecture or design indicated that energy consumption in urban buildings can be reduced by 50% by means of climate-friendly design strategies, including the use of green and renewable energy. Climate-friendly design relies on criterias of climate and it protects building from unintendent climatic conditions. Protection of a building's internal energy in cold periods (winter time), and improving ventilation and cooling facilities in hot periods (summer time) are the main purposes of climate-friendly or responsive architectural and urban design attempts (Zeren, 1978 and 1987; Oglyay, 1992; Watson and Labs, 1992; Ayan, 1985; Zuhairy, 1993; Colombo et. al., 1994; Karaman, 1995; Givoni, 1998; cited in Ovalı, 2007).

At the same time, “solar architecture” has gained attention and importance based on the need for climate sensitive design attempts. The previous work mostly focused on the use of passive solar heating and cooling systems, and on the relationship between sun and building envelope (Colombo et. al., 1994; Givoni, 1998; Göksal, 1998; Roaf, 2003; Ovalı, 2007). It can be concluded that since the 1960s, various academic research and studies on climate-responsive urban design and solar architecture have been made worldwide and particularly in Turkey.

2.5.1. CLIMATIC ELEMENTS

Climate is the average of the weather conditions that generally prevail at a particular location or over a region in a given time period. It is the key element of the environment which affects human Daily lives in rural or urban areas. (Barry& Hall-McKim, 2014). In other words, as a combination of main winds and seasons, climate is a set of meteorological parameters that is collected at least thirty years (World Meteorological Organization, 2001). The climate is defined in terms of climtic elements. When human comfort and urban areas or building design are being considered the principal climatic elements are listed as solar radiation, air temperature, air humidity and precipitation, air pressure and wind (Hausladen et al,2012; Weawer, 1954; Berköz, 1969; Givoni,1976). Except for these elements, the effects of other factors, such as chemical differences, physical contamination and the electric charge in the air, can be ignored. Because of their insignificant impact on climate (Olgyay, 1992).

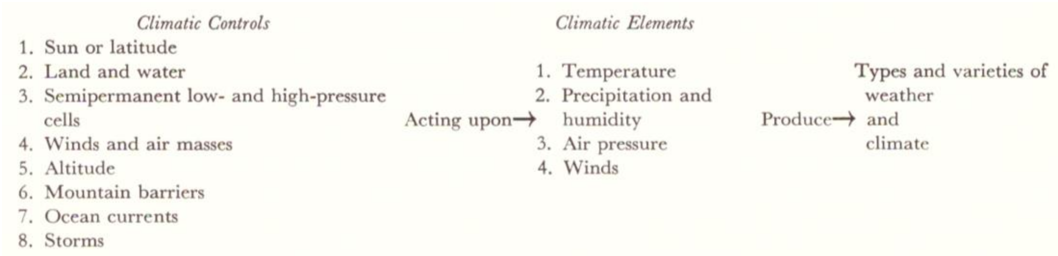


Figure 2.45 The relationship between climatic controls and elements (Weaver, 1954)

Solar radiation is the most important planning factor as a source of light and energy that determines the climatic conditions of the earth and it is an electromagnetic radiation emitted from the sun. The solar radiation decrases the heating energy demand. A good plan should involve sufficient solar heating and daylight provisionWhile some part of the solar radiation that reaches the earth's surface are reflected back to the atmosphere, the other part of it is absorbed by the earth's surface and the oceans. A part of the reflected radiation is blocked in the atmosphere and thereby makes the earth's atmopshere warm enough for human survival. What determine the level of blocked radiation in the atmosphere are the concentration of greenhouse gases, cloudiness and air pollution. **Solar radiation level** consists of two components; the "direct solar radiation level" that reaches directly to the earth's surfaceand diffuse sky radiaion/sky clearence level (Hausladen et al,2012; Givoni,1976).

The power of **solar radiation** that reaches to the earth depends on various factors such as solar constant, latitude, atmospheric conditions, angle of incoming solar radiation, angle of reflected solar radiation and the elevation of the area from sea level (Berköz, 1969). A portion of energy that held by the molecules in the atmospher is recycled by way of radiation. While a portion of recycled energy is retroreflected by the globe, a large part of it is reabsorbed by the globe. The reabsorbed energy is returned to air and it increases the temperature of everything in the environment such as air, place, ground etc. (Olgyay, 1992). The situation of the sun is determined with angle of elevation and azimuth angle. Angle of elevation is the angle between solar radiation and the projection of solar radiation. Moreover, the azimuth angle of the sun is the angle between earth projection and northern direction. The azimuth and the angle of elevation in relation to the building facade. Therefore, they affect intensity of solar radiation received by the building (Özdeniz, 1984; Hausladen et al,2012).

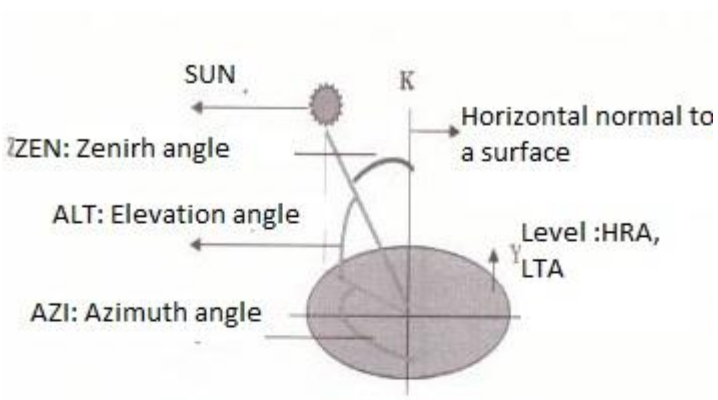


Figure 2.46 Solar radiation angles (Source: Berköz, 1969).

Air temperature is the rate of heating and cooling of the surface of the earth. Changing in altitude alters the ait temperature (Givoni, 1976). Moreover the solar radiation and the temperature of incoming air masses influences the outdorr air temperature. Buildings energy demand based on heating, cooling and ventilation needs depends on average air temperature over the year (Hausladen et al,2012). When analyzed on a seasonal basis, if the sky is open during summer months and there is a clear sky, the air temperature is higher because more solar energy reaches on the atmosphere and the earth surface. If the sky is open in winter months, the air temperature would be cooler than the temperature under cloudy air (Olgyay, 1992).

Air pressure and wind on side is critical elements in contruction planning. The global and local factors such as seasonal global dsitribution of air pressure, the rotation of the earth, the topography, sea, prevailing wind situation, buildings form and its surroundings determine the air flow around a building and characteristics of the wind (Hausladen et al,2012; Givoni,1976). Preferred wind speed range is determined by examining the effect of wind on people. To ensure the comfort conditions for people, wind speed should be in the range of 0,15 m/s to 0.25 m/s generally depending on summer and winter climate conditions (Yiğit ve Atmaca, 2007).

Air humidity is defined as the ratio of current water vapour to the amount of maximum water vapour per unit vapour of air. Relative and absolute air humidity are tthe two different measurements of air humidity humidity is used for determining the comfort conditions. The value of relative humidity is usually higher in the morning; lower in the afternoon. The differences between night and daytime is low in the high relative humidity area. In contrast, the differences between night and daytime are high in the low relative humidity area. Minumum values of humidity ocucurs on cold days, while msximum vluees are reached at high temperatures. Comfort temperature can be readjusted according to limits of comfort region and the ambient temperature can be decreased (Hausladen et al,2012; Givoni,1976; Olgyay, 1992; Özdeniz, 1984; Berköz, 1969).

2.5.2. THE RELATIONSHIP BETWEEN CLIMATIC ELEMENTS AND HUMAN COMFORT

Ensuring thermal comfort according to seasonal requirements is important in the city (Djukic, Vukmirovic, & Stankovic, 2015). Human thermal comfort is both physiological and perceptual. Climate is the most important element of the physical environment that influence human health, and comfort. Physiological functions of the human body react to changes in the weather and some diseases occur by uncomfortable climatic and seasonal conditions. (Erell et al., 2011; Critchfield, 1974).

Olgyay (1992) desrcibes a “comfort zone” as the environment, where people could efficiently and successfully adapt to weather conditions. The value of a desirable comfort zone lies between 30% and 65% relative humidity. The main aim of arhitechture should be to create an environment, which provides comfortable conditions. Structural comfort is one of the most important factors that affects human health, productivity and psychology. The comfort zone differs with individuals, types of clothes, types of activities carried on, sex, age and geographical conditions. For example, women often feel comfortable at 1 degree higher than men and people over 40 years of age usually prefer 1 degree higher external temperature than people below this age (Olgyay, 1992).

As Erell et al. (2012, 109) indicate: “Thermal discomfort is caused by heating or cooling of the body. Our physiology includes mechanism for maintaining thermal equilibrium with the environment and our preferences tend to lead us to avoid the extreme loss or gain of thermal energy. Therefore any understanding of how the design of urban environment may promote thermal comfort will necessarily include a description of the mechanism through which the body exchanges energy with its surroundings.”

2.5.3. RELATION BETWEEN CLIMATE AND ENERGY EFFICIENT URBAN DESIGN

Humankind has been looking for measures and solutions against impacts of external environment since the beginning of their existence. Climatic factors have been handled as the main factor in settlement planning and construction processes. Searching for climatic comfort is one of the most important factors increasing energy consumption in urban space. Buildings need to be heated or cooled in different seasons depending on climate in order to ensure comfortable conditions in urban spaces. Reducing energy consumption while ensuring comfort requires climate-sensitive design solutions with energy conservation.

2.6. CLIMATE SENSITIVE DESIGN

Within the scope of this study, climate-sensitive design criteria based on taking climatic factors into account in urban design process in order to ensure energy efficiency have been analysed. Olgyay (1992) describes “the structure which reduces undesired stresses under the given environmental conditions while using all natural resources for the benefit of user comfort as climate-balanced”. On the other hand, Özdeniz (1984) describes the structure which ensures environmental requirements such as climate, light and sound while minimizing artificial heating, ventilation and lighting control using the position, orientation, form, elements and materials of the structure as “environmentally-conscious structure”.

Microclimatic urban design and analysis of urban microclimate help to urban designers to create comfortable and healthy urban areas. Ensuring thermal comfort according to seasonal requirements is important in the city. One of the most important problems is urban areas is the temperature rise which is caused by global warming. Therefore, design proposals which prevent and diminish the temperature rise have to be developed (Djukic, Vukmirovic, & Stankovic, 2015, pp. 23-35).

The approach of ensuring climate-sensitive environment is a complex process since it is an interdisciplinary approach among climatology, biology, technology and architecture. According to Olgyay (1992), the main goal of the design should be fighting against nature and creating good living spaces by benefiting from its potential. Accordingly, the process of designing climate-sensitive building consists of four steps (Olgyay, 1992:12). The figure represents the four components of a climate-sensitive structure.

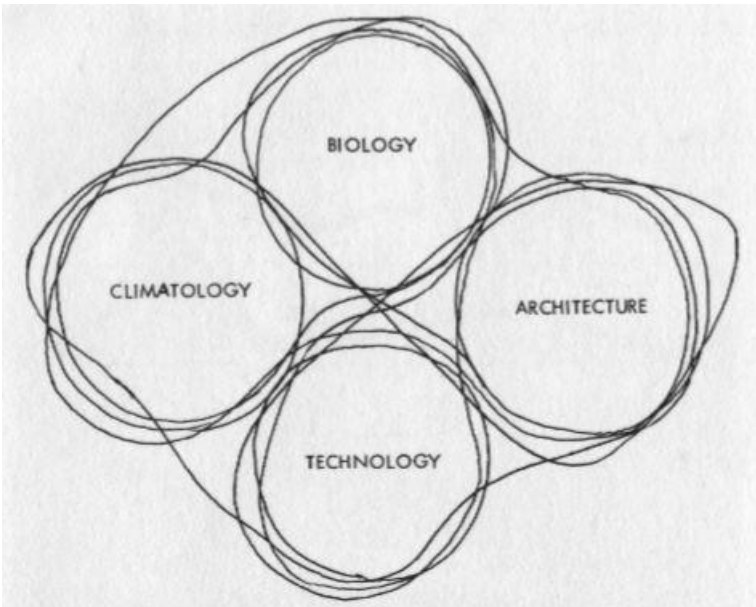


Figure 2.47 Interlocking fields of climate balance (Source: Olgyay, 1963)

2.6.1. THE AIM OF CLIMATIC DESIGN PRINCIPLES

The principles of climatic design have been derived from the requirement for creating human comfort in buildings, using the elements of the natural climate which vary throughout the year depending upon whether the prevailing climatic condition is "under heated" compared to what is required for comfort (i.e., like winter) or "overheated" (i.e., like summer). It is possible to define strategies under nine headings, which can be used to ensure optimum indoor comfort during the coldest and hottest seasons according to different climatic zones (Watson and Labs, 1992).

1- **Minimize conductive heat flow:** This strategy refers to prevention of heat transmission using insulation materials in the building covering to conserve the heat inside.
2- **Minimize external airflow**: Transparent surfaces or spaces oriented to the south are used as heating elements. Thermal energy stored through opaque construction elements is transmitted to the interior area.
3- **Minimize external airflow:** When the cold wind blowing towards the external surface of the building gets stronger and blows for a longer period of time, heat loss of the building cover increases. At this point, green cover is used as an element to reduce the undesired impact of the climate.
4- **Minimize infiltration:** The aim is to reduce heat losses that may be caused by air leak from indoor to outdoor or vice versa. The air leaking through cracks should be kept under control.
5- **Promote earth cooling:** Forming the building envelope with opaque components with high heat retention capacity ensures thermal energy conservation.
6- **Minimize solar gain:** Sunlight control is ensured by preventing, reflecting or identifying the orientation and sized of transparent surfaces in order to eliminate discomfort.
7- **Promote ventilation:** Passive-cooling alternatives should be used to balance the internal climatic comfort.
8- **Promote evaporative cooling:** Cooling is ensured by evaporating water through natural or artificial methods. It can be provided with evaporated water, air stream and vaporisation on the external surfaces.
9- **Promote radiant cooling**: The building envelope transfers the thermal energy stored during the night to the external environment through convection and transmission. In this case, the building actively diffuses the heat and cools down.

At the figure given below, a comprehensive set of climatic design principles that follow logically from these climatic extremes is summarized.

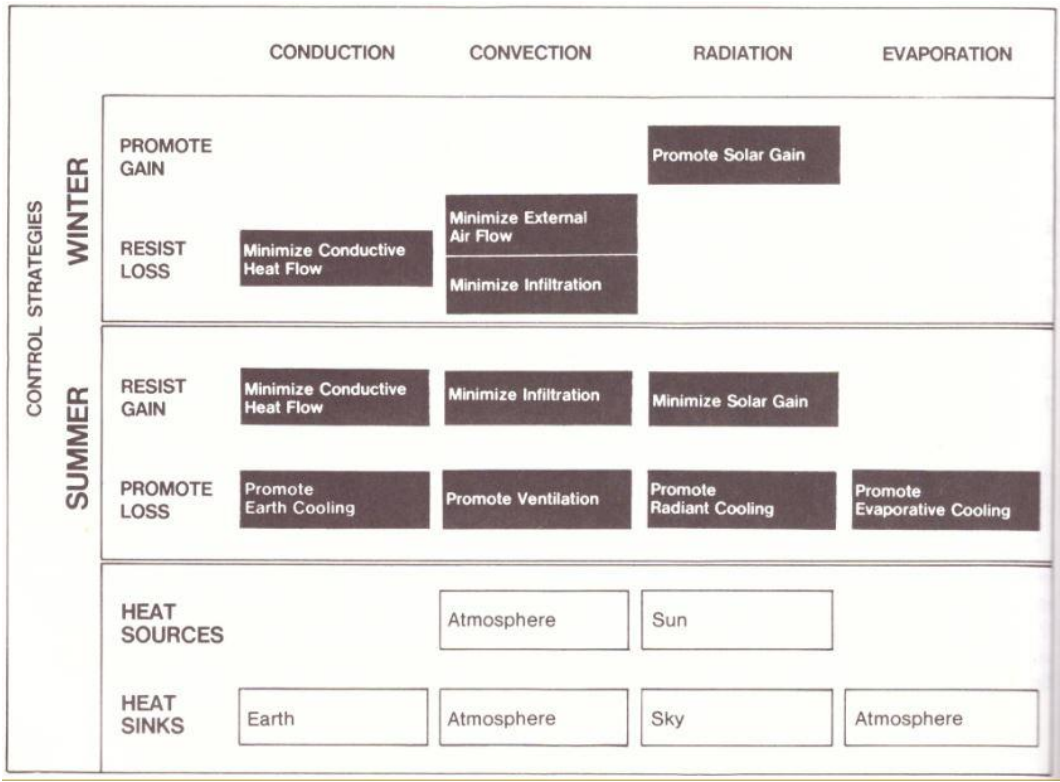


Figure 2.48 Climatic design principles (Source: Watson and Labs, 1992)

2.7. MAIN CLIMATIC REGIONS IN TURKEY

Turkey is situated in large Mediterranean geographical location where climatic conditions are temperate. Because of the diverse nature of the landscape, and the mountains that run parallel to the coasts, there is significant differences in climatic conditions from one region to the other. While the coastal areas enjoy milder climates, the inland Anatolian plateau experiences extremes of hot summers and cold winters with limited rainfall (Şensoy et. al., 2008). Temperate zone climates are quite feasible in terms of natural heating, cooling and ventilation of buildings. In the southern regions, it is possible to ensure heating through passive systems without needing artificial air conditioning systems during winters. During summers, domestic comfort can easily be ensured through passive systems without any cooling system in the Central Anatolia Region. This situation is an important advantage in terms of energy efficiency. Therefore, climate factor should be handled as the primary design element in design and planning (Yüceer, 2015). As Yüceer (2002) states, it is observed that examples of Turkish traditional architecture are designed considering the climate and ecology of the place where buildings are located. Stone buildings with adjacent yards in hot arid climates such as Mardin, wooden and masonry buildings in cold climates and cool streets covered with trees and white buildings in harmony with the environment in humid regions such as Mediterranean Region have maintained their existence so far. Traditional urban layout has dramatically changed since 1930s due to the conflict between east and west on one hand, and industry, migration and population growth on the other hand (Yüceer, 2002)

In several studies and research, climatic zones of Turkey are discussed in different classifications. In this study, the climatic zones of Turkey are discussed under five categories as cold, temperate-humid, temperate-arid, hot-humid and hot-arid based on the study of Zeren (1978 and 1987), Karaman (1995), Akşit (2005) and Koca (2006).

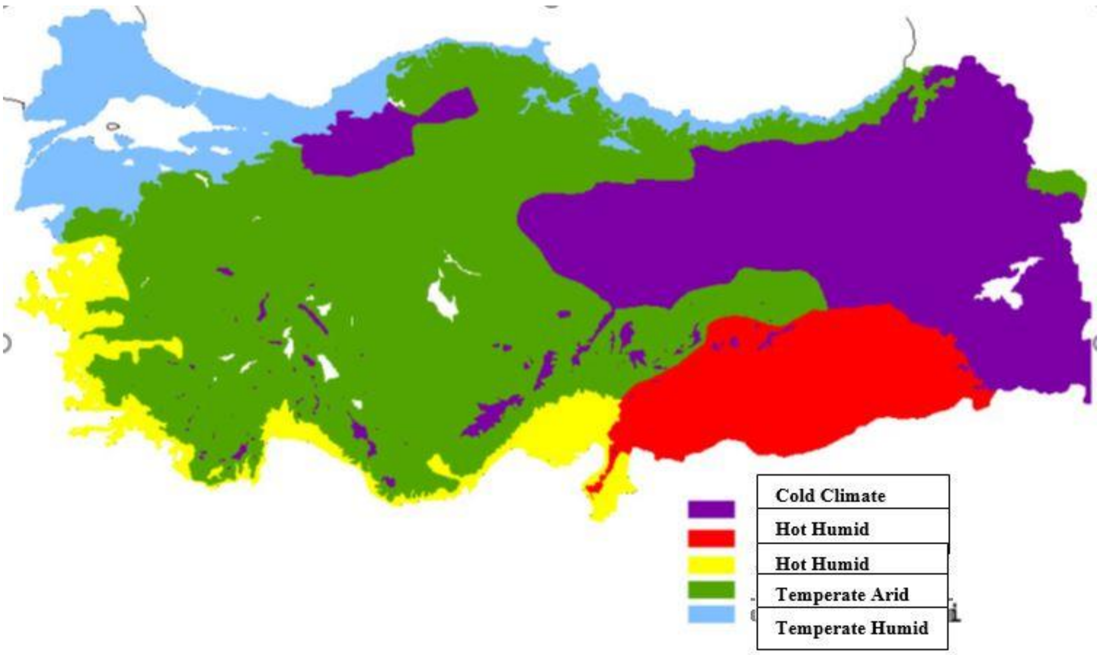


Figure 2.49 Climatic zones in Turkey (Koca, 2006)

Strategies and criteria guiding settlement and building design in the stated climatic zones are important in terms of reducing energy consumption and creating climatic comfort. Positive climate impacts should be used and measures should be taken against negative impacts in the buildings and settlement layouts to be designed in different climatic zones.

2.7.1. CLIMATE-SENSITIVE DESIGN PARAMETERS FOR COLD CLIMATIC REGION

In the cold climatic zone, temperature is below 0^{o}C during almost half of the year. Harsh climatic conditions become more challenging with the wind. Winter seasons are long and harsh, and summer seasons are short and cool. Ağrı, Ardahan, Bayburt, Bingöl, Bitlis, Bolu, Erzurum, Gümüşhane, Hakkâri, Kastamonu, Kars, Muş, Sivas, Tunceli, Van and Yozgat provinces are located within this climatic zone (Orhon et al., 1988, Akşit, 2005, Ovalı, 2007). The main aim in cold climatic zone is to increase radiation absorption and reduce heat loss to increase heat generation.

2.7.1.1. Settlement Layout

Settlements should be designed in a way to shelter from sunlight in hot seasons and from wind in cold seasons (Yüceer, 2002). According to Olgyay (1992), effect of the wind should be minimized with the design. While grouping huge building units, spaces that will provide the utmost benefit should be created. Heat loss should be reduced with minimum floor area in the houses. General structure of urban areas should be intensively in bulks.

2.7.1.2. Site Selection and Public Spaces

Southern and south-eastern sides should be preferred to obtain maximum benefit from sunlight. Furthermore, middle parts of these sides are appropriate positions to reduce the effect of wind and shelter from cold airstreams. Open areas sheltered from the wind and shaded time-to-time should be arranged as common areas (Olgyay, 1992).

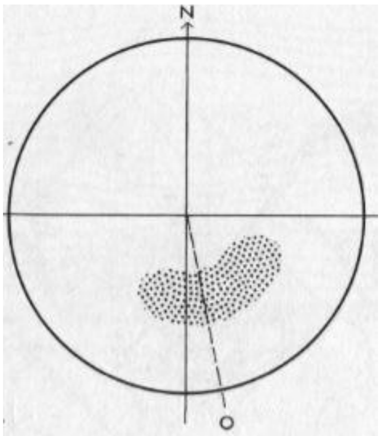


Figure 2.50 Desirable site locations for cold climate (Source: Olgyay, 1992)

2.7.1.3. Housing Types

Due to minimum floor area and roof, two-storey houses or a few houses under a single roof should be arranged. Terraced or semi-detached houses are advantageous in terms of reducing heat loss. Block apartments or tower apartments should be arranged in bulks and maximum benefit should be sought from the sunlight.

2.7.1.4. Building Form and Volume

Intensive and bulk forms that would minimize the facade area should be preferred to reduce heat loss. Buildings with 1:1.1 or 1:1.3 proportions and located on east-west axis provide the optimum impact in terms of comfort conditions (Olgyay, 1992).

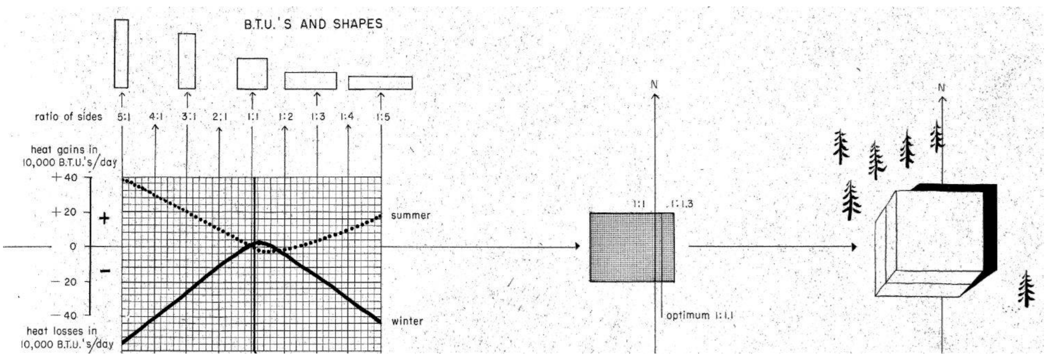


Figure 2.51 Basic building forms for cold regions (Source: Olgyay, 1992)

2.7.1.5. Building Orientation

Optimum sunlight orientation suggested for cold climatic zones is the southern position facing 22º southeast. Good orientations are between 20º southwest and 45º southeast while valid orientations are between 31º southwest and 86º southeast (Orhon et al., 1988 cited in Ovalı, 2007).

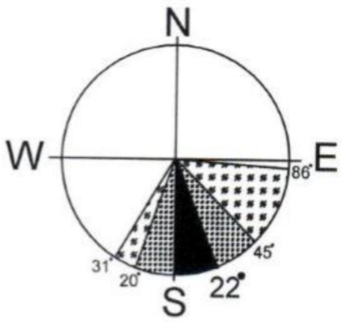


Figure 2.52 Optimum, good and valid building orientations for cold climate

(Source: Orhon et al., 1988)

2.7.1.6. Distance between Buildings

In order to obtain maximum benefit from direct sunlight during sunshine hours, distance between buildings should be between 1 ½ - 2 ½ H in the direction of north-south (H: obstacle building height) (Orhon et al., 1985).

2.7.1.7. Color

Facades exposed to sunlight should not be painted with too light or dark colours while the ones, which do not receive any sunlight can be painted with dark colors.

2.7.1.8. Windows and Roof

On the facades, except for south and east sides, small windows with reduced transparent surface should be used and windows should be insulated. Inclination of the roof should be steep to prevent snow accumulation (Olgyay, 1992).

2.7.1.9. Vegetation

Vegetation cover should prevent wind blowing and reflect solar radiation. Deciduous trees should not be planted near the houses, and intensive plantation should not be preferred quite close to the structures to prevent moisture (Olgyay, 1963). In north-eastern and western parts, evergreen shrubs and bushes should be preferred while windbreaker bushes and grass should be used in the western parts. Furthermore, small hills on northern side may block the wind (Yüceer, 2002).

2.7.2. CLIMATE-SENSITIVE DESIGN PARAMETERS FOR TEMPERATE-ARID CLIMATIC REGION

Temperature difference between day and night is major in temperate-arid climatic zones. Average outside temperature varies between +30ºC and -5ºC. Afyon, Aksaray, Ankara, Burdur, Çankırı, Çorum, Elazığ, Erzincan, Eskişehir, Iğdır, Isparta, Karaman, Kayseri, Kırıkkale, Kırşehir, Konya, Kütahya, Malatya, Nevşehir, Niğde and Uşak provinces are located within temperate-arid climatic zone (Orhon et al., 1988, Akşit, 2005, Ovalı, 2007).

2.7.2.1. Settlement Layout

In the coldest season, compact layouts should be created to obtain benefit and reduce the cooling effect of the wind. Medium-intensive closed bulks sheltered from the wind should be used (Yüceer, 2002).

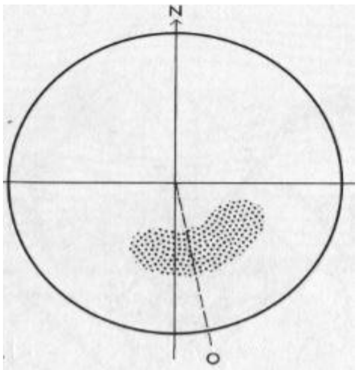


Figure 2.53 Desirable site locations for temperate-arid climate regions (Source: Olgyay, 1963)

2.7.2.2. Site Selection and Public Spaces

Sides facing southeast should be preferred in general. Below and upper parts of the sides can be used on the condition that measures are taken against the wind and also it is advantageous in terms of benefiting from cool breezes during hot seasons.

2.7.2.3. Housing Types

Close relation should be established between nature and the house, and planning should be arranged freely. Compact buildings providing lowest volume/surface ratio should be designed in a way to obtain maximum benefit from the sunlight.

2.7.2.4. Building Form and Volume

Intensive and bulk forms should be preferred to reduce heat loss. Buildings with 1:1.1 or 1:1.3 proportions and located on east west axis provide the optimum impact (Olgyay, 1992).

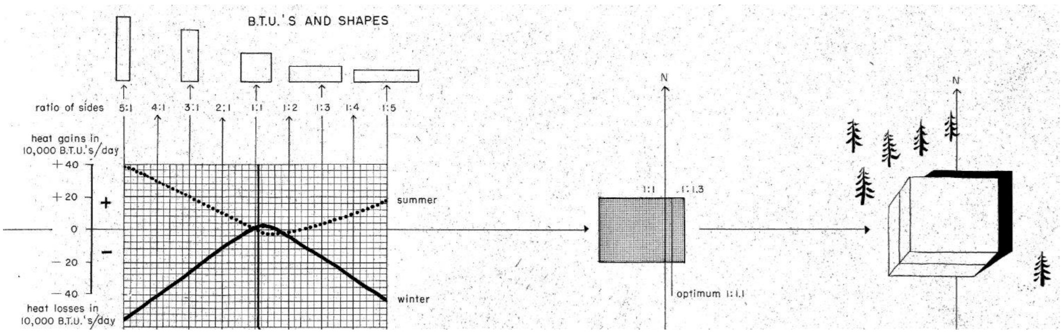


Figure 2.54 Basic building forms for temperate-arid regions (Source: Olgyay, 1963)

2.7.2.5. Building Orientation

Optimum sunlight orientation for temperate arid climate is the southern positions facing 27º southeast. Good orientations are between 10º southwest and 56º southeast while valid orientations are between 14º southwest and 83º southeast (Orhon et al., 1988 cited in Ovalı, 2007).

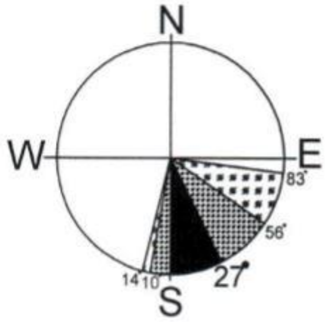


Figure 2.55 Optimum, good and valid building orientations for temperate-arid climates (Source: Orhon et al., 1988).

2.7.2.6 Distance between Buildings

In order to ensure climatic comfort, building spacing should be between 2H-3H in the direction of north-south (H: obstacle building height) (Orhon et al., 1985).

2.7.2.7 Color

Medium-dark colours are advantageous. Dark colours can be used on the facades sheltered from sunlight. Terrace surfaces should be in medium-dark colors.

2.7.2.8 Windows and Roof

Windows' resistance to heat conductivity should be high. Windows on eastern and western facades should be smaller than the ones on southern facade. Windows and openings on the northern facade should be in minimum size. Roofs should be well insulated and steep to prevent snow accumulation (Olgyay, 1992).

2.7.2.9 Vegetation

Wind-breaker trees should be positioned in a way not to prevent the wind blowing from the south and southwest in summer season while preventing cold winds blowing from the northwest in winter season (Olgyay, 1992). Shrubs and bushes should be used in the south while evergreen trees should be planted in the north against the cold. In the east and west, tree species blocking the sun and allowing ventilation should be planted (Yüceer, 2002).

2.7.3 CLIMATE-SENSITIVE DESIGN PARAMETERS FOR TEMPERATE-HUMID CLIMATIC REGION

It is temperate during summers while slightly cold in winters. Severe winter seasons and very hot summer seasons are not common. Temperature difference between summer and winter seasons in generally low and this climate demonstrates the closest characteristics to human comfort. Amasya, Artvin, Balıkesir, Bartın, Bilecik, Bursa, Çanakkale, Düzce, Edirne, Giresun, İstanbul, Karabük, Kırklareli, Kocaeli, Ordu, Rize, Sakarya, Samsun, Sinop, Tekirdağ, Tokat, Trabzon, Yalova and Zonguldak provinces are located within temperate-humid climatic zone (Orhon et al., 1988, Akşit, 2005, Ovalı, 2007).

2.7.3.1 Settlement Layout

Spread settlements exposed to winds during hot seasons and sunlight during cold seasons should be planned (Yüceer, 2002). Open and free arrangements in harmony and integrated with nature can be made. In the formation of urban layout, all features of free arrangements can be used. Wind effect should be taken into consideration in orientation of high buildings.

2.7.3.2 Site Selection and Public Spaces

Sides facing southeast should be preferred in general. Below and upper parts of the sides can be used on the condition that measures are taken against the wind and also it is advantageous in terms of benefiting from cool breezes during hot seasons (Olgyay, 1992).

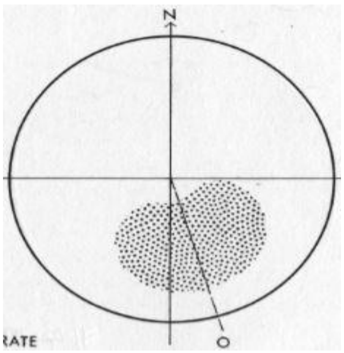


Figure 2.56 Desirable site locations for temperate-humid climate regions

(Source: Olgyay, 1992)

2.7.3.3 Housing Types

This climate zones offer the highest number of solutions in terms of architecture. Close relation should be established between nature and the house, and planning should be arranged freely. Free plans with a strong relation between indoor and outdoor should be designed. Buildings should be open towards the south and southeast while closed towards the west.

2.7.3.4 Building Form and Volume

Cross-like and free building forms can be used due to the climatic characteristics; however, long buildings should be preferred in the direction of east west. Long buildings with 1:1.6 or 1:2.4 proportions provide optimum impact in terms of comfort conditions (Olgyay, 1992).

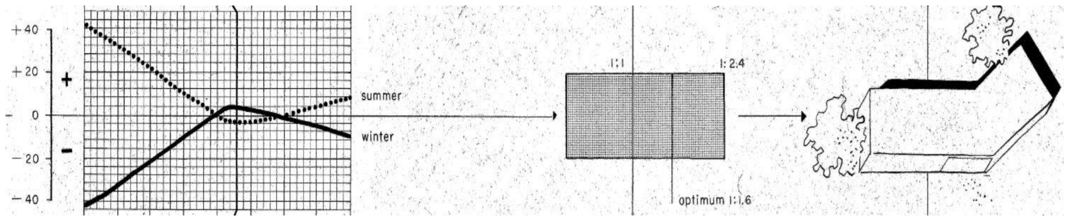


Figure 2.57 Basic building forms for temperate-humid regions (Source: Olgyay, 1992)

2.7.3.5 Building Orientation

Optimum sunlight orientation is the southern positions facing 10º southeast. Good orientations are between 13º southwest and 35º southeast, while valid orientations are between 23º southwest and 49º southeast (Orhon et al., 1988 cited in Ovalı, 2007).

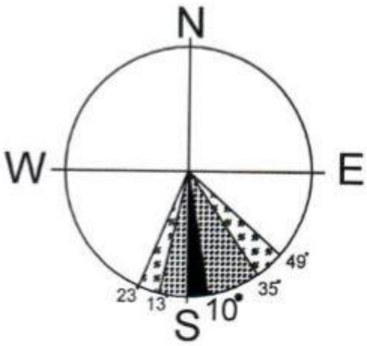


Figure 2.58 Optimum, good and valid building orientations for temperate-humid climate regions (Source: Orhon et al., 1988)

2.7.3.6 Distance Between Building

In order to ensure climatic comfort, building spacing should be between 2H-3H in the direction of north-south (H: obstacle building height) (Orhon et al., 1985).

2.7.3.7 Color

Medium-dark colours are advantageous. Dark colours can be used on the facades sheltered from sunlight. Terrace surfaces should be in light colors.

2.7.3.8 Windows and Roof

Location of the windows should be suitable for cross-ventilation. Windows on western and northern facades should be smaller compared to the ones on other facades. Roofs should be well insulated and sheltered against rain and snow (Olgyay, 1992).

2.7.3.9 Vegetation

In the south, scrub and shrubs should be used while evergreen trees should be planted in the north against the cold. In the east and west, tree species blocking the sunlight and allowing ventilation should be planted (Yüceer, 2002).

2.7.4 CLIMATE-SENSITIVE DESIGN PARAMETERS FOR HOT-ARID CLIMATIC REGION

Characteristics of this climatic region are as follows: the difference between daily and annual temperature values are quite high; winds carry a large amount of dust and sand; relative humidity rate is low; and cloudiness is at medium level (KAYNAK???). Another important climate feature is solar radiation impact. Summer seasons are hot and dry due to low humidity rate (Koca, 2006). Adıyaman, Batman, Diyarbakır, Gaziantep, Kahramanmaraş, Kilis, Mardin, Siirt, Şırnak and Urfa provinces are located within hot-arid climatic zone (Orhon et al, 1988, Akşit, 2005, Ovalı, 2007).

2.7.4.1 Settlement Layout

Dense and intensive settlements with low buildings that are protected against sunlight and wind in hot seasons should be planned (Yüceer, 2002). Urban structure should allow dense settlements increasing shaded areas in a way to be protected against heat. Walls of the houses and gardens should provide shades for outdoors. Pedestrian pathways should be created between the houses.

2.7.4.2 Site Selection and Public Spaces

Below parts of the eastern and south-eastern sides, which are exposed to cold weather, should be preferred. In high places, parts allowing evaporation are advantageous. Close relations should be established between common areas and housing areas. Protection with semi or full shades is a desired feature.

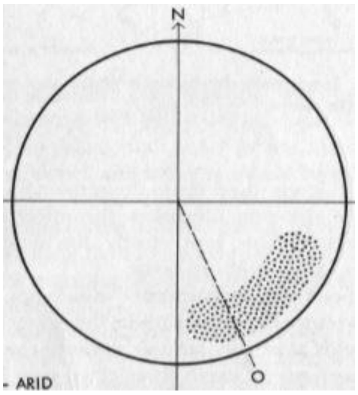


Figure 2.59 Desirable site locations for hot-arid climate (Source: Olgyay, 1992)

2.7.4.3 Housing Types

Dense atrium type houses should be preferred. Terraced and semi-detached houses or masses creating volume in groups should be used in the direction of east west. High but solid buildings can be used.

2.7.4.4 Building Form and Volume

Dense and bulk forms should be preferred, or building depth increasing thermal capacity should be ensured. Building forms should be affected by solar impact at the minimum level. The most suitable building proportion is 1:1,3. (Olgyay, 1992).

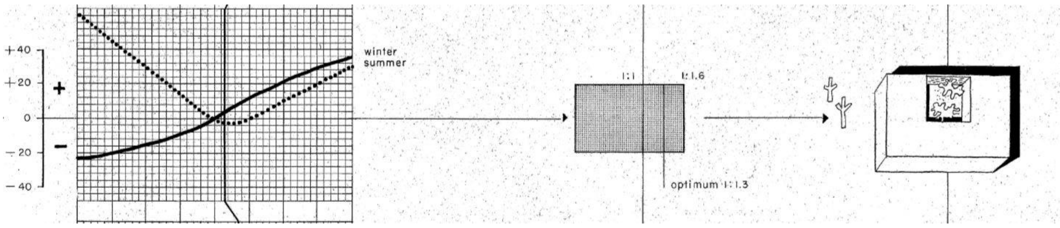


Figure 2.60 Basic building forms for hot-arid regions (Olgyay, 1992)

2.7.4.5 Building Orientation

Optimum sunlight orientation suggested for hot arid climatic zones is the southern positions facing 18º southeast. Good orientations are between 0º southwest and 40º southeast while valid orientations are between 8º southwest and 50º southeast (Orhon et al., 1988 cited in Ovalı, 2007).

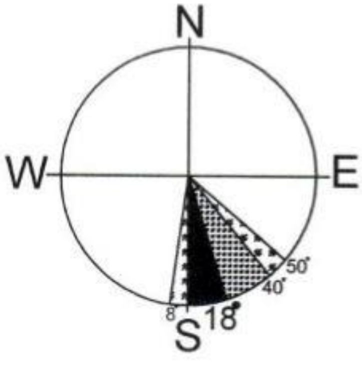


Figure 2.61 Optimum, good and valid building orientations for hot-arid climate regions (Orhon et al., 1988).

2.7.4.6 Distance between Buildings

In order to obtain maximum benefit from the direct sunlight during sunshine hours, building spacing should be between 1 ½ - 2 ½ H in the direction of north-south (H: obstacle building height) (Orhon et al., 1985).

2.7.4.7 Color

White colour is especially preferred on the facades exposed to the sunlight due to its heat-reflecting feature. Dark and absorbent colors can be used on the parts where reflections are expected. Bright and contrast colors can be used in line with the general characteristics of the region.

2.7.4.8 Windows and Roof

Small windows are suggested since they will ensure protection against the sunlight. Furthermore, windows should be protected with shading elements to ensure minimum effect of solar radiation. Inclined roofs with low heat retention, rooftop pools or green roofs should be used. Furthermore, shading and ventilation should be ensured at the maximum level on the roofs (Olgyay, 1992).

2.7.4.9 Vegetation

Trees should not be planted in the direction of north and south; however, creeping plants should be used on the walls if humidity is required (Yüceer, 2014). Vegetation cover is desired in terms of both creating radiation absorbent surfaces and ensuring evaporation and shading (Olgyay, 1992).

2.7.5 CLIMATE-SENSITIVE DESIGN PARAMETERS FOR HOT-HUMID CLIMATIC ZONE

The most important characteristics of hot-humid climate region are heavy precipitation, high humidity and temperature level. Temperature difference between summer and winter seasons is low. Winter seasons receive precipitation. Prevailing wind or air streams between mountain-lowland and sea-land have desired characteristics (Göksu, 1999). Adana, Antalya, Aydın, Denizli, Hatay, İzmir, Manisa, Mersin, Muğla and Osmaniye provinces are located within hot-humid climatic zone (Orhon et al., 1988, Akşit, 2005, Ovalı, 2007).

2.7.5.1 Settlement Layout

Scattered settlements allowing ventilation in hot seasons and benefiting from sunlight in cold seasons should be planned (Yüceer, 2002). Houses should be located separately so that they can benefit from air streams. Shaded environment is a desired characteristic in general. Urban settlements should be scattered and free to benefit from air streams.

2.7.5.2 Site Selection and Public Spaces

High places exposed to wind should be preferred. North and south sides of the hills should be preferred over east and west sides since they are exposed to less radiation. Common areas should be shaded areas within minimum walking distance (Olgyay, 1992).

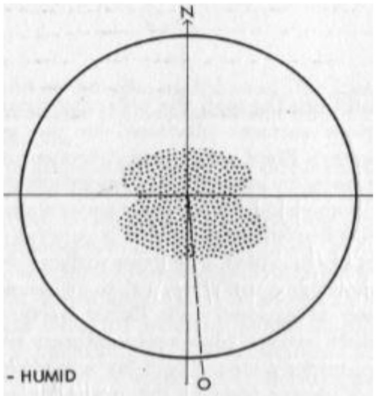


Figure 2.61 Desirable site locations for hot-humid climate (Source: Olgyay, 1992)

2.7.5.3 Housing Types

Single houses erected on columns are advantageous. Long and high buildings freely located in low density are preferred.

2.7.5.4 Building Form and Volume

Buildings in the east and west should be thin and high since the maximum radiation effect would be in this direction. Buildings with 1:1,7 or 1:1,3 proportions and located on the hills in the direction of east west (Zeren, 1987, Orhon et al., 1988) provide the optimum impact in terms of comfort conditions. Volumetric impact is not required (Olgyay, 1992).

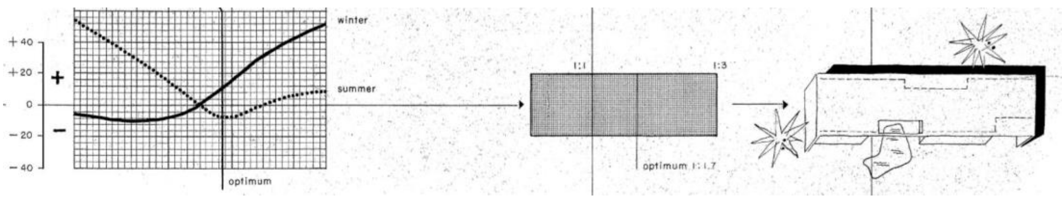


Figure 2.62 Basic building forms for hot-humid regions (Olgyay, 1992)

2.7.5.5 Building Orientation

Optimum sunlight orientation suggested for cold climatic zones is the southern positions facing 3º southeast. Good orientations are between 10º southwest and 19º southeast while valid orientations are between 19º southwest and 30º southeast (Orhon et al., 1988 cited in Ovalı, 2007).

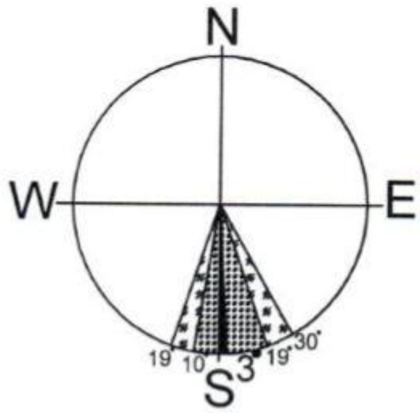


Figure 2.63 Optimum, good and valid building orientations for hot-humid climates (Source: Orhon et al., 1988).

2.7.5.6 Distance between Buildings

In order to obtain maximum benefit from direct sunlight during sunshine hours, building spacing should be between 1 ½ - 2 ½ H in the direction of north-south (H: obstacle building height) (Orhon et al., 1988).

2.7.5.7 Color

Reflective, pastel and light colours are the ideal ones. Radiant and reflective colours should be avoided inside and outside.

2.7.5.8 Windows and Roof

Wide openings and windows that will allow maximum east-west ventilation should be used on these facades. Furthermore, east, west and south sides should be protected against sunlight using shading tools at the maximum level. Inclined roofs with low heat retention or green roofs should be used (Olgyay, 1992).

2.7.5.9 Vegetation

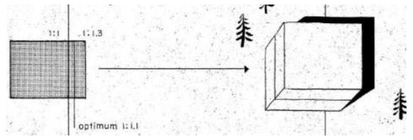
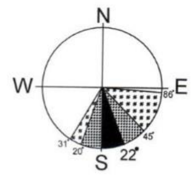
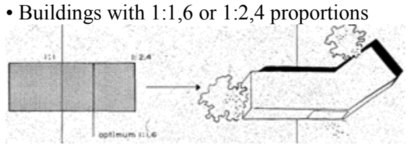
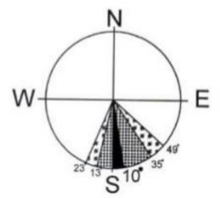
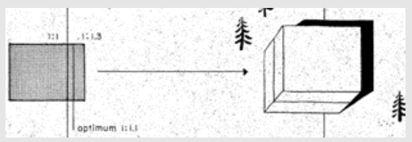
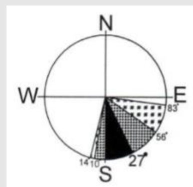
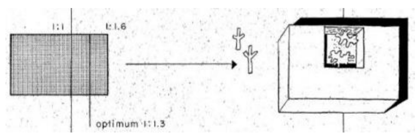
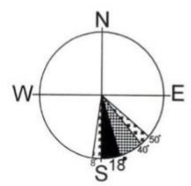
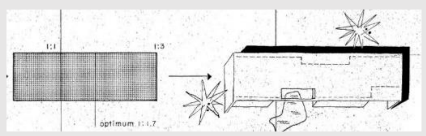
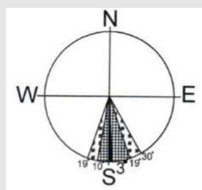
Trees with long trunks and wide branches should be preferred. Thus, cool air and wind would be blocked. Air stream moving towards the building are expected to pass through shaded grass surfaces before reaching the building. Deciduous trees and plants shedding leaves during winter and providing shades during summer should be planted in the southern, eastern and western sides in a way not to block ventilation during summer (Yüceer, 2012).

2.8. CONCLUSION

Climate-sensitive design parameters identified to ensure energy efficiency are summarized below in the table according to the climatic zones in Turkey. Data in the table are organized in a way to provide optimum conditions in terms of climate and energy use for each climatic zone. Since the empirical research on the case study area will be conducted for temperate-arid and hot-humid climatic regions, design parameters to be used for these climatic zones are emphasized with darker color in the following table (Table 2.2).

Needless to say, the below table should be regarded as a general framework to clarify and specify the key design parameters as well as the key fields of action in urban design for energy efficiency. Neither the table nor the parameters in the table are “panaceas” that can be implemented everywhere. In other words, there is no “one size fits all” situation in design and production of urban space. Instead, the local conditions and circumstances have to be taken into account before any concrete action. When particular urban areas are aimed to be redesigned or redeveloped according to energy efficient and climate sensitive design parameters, local and specific circumstances of the area such as social, cultural, historical and architectural characteristics, should be considered thoroughly. Besides, climatic conditions and local patterns of the areas should be evaluated together and holistic design approach should be developed.

Table 2.2 Climate-Sensitive Design Parameters

DESIGN PARAMETER / CLIMATIC REGIONS	SETTLEMENT LAYOUT	SITE SELECTION &PUBLIC SPACES	HOUSING TYPES	BUILDING FORM AND VOLUME	BUILDING ORIENTATION	DISTANCE BETWEEN BUILDINGS	COLOR	WINDOWS AND ROOF	VEGETATION
COLD CLIMATIC REGION	•Shelter from sunlight in hot seasons shelter from sunlight in hot seasons •Shelter from wind in cold seasons	•Southern and south-eastern sides of slope for solar Access is desirable. - Middle or lower middle of slope is preferable •Open areas sheltered from the wind	•Two-story houses under one roof for compactness •Row houses or adjoining buildings In larger volumed apartments, compact type such "pointhouse	•Buildings with 1:1,1 or 1:1,3 proportions •Elongated on east-west axis •Compact with minimum exterior surface 	• Optimum sun orientation lies **22º E of S.** 	•Distance between buildings should be between 1 ½ - 2 ½ H in the direction of North-South	•Sun exposed surfaces in medium colors, recessed surfaces can be of dark absorbed colors	•Except for south and east sides, small windows with reduced transparent surface, double glazing •A inclined and insulated roof	• In north-eastern and western parts, evergreen shrubs and bushes • Wind-breaker bushes and grass in the western parts •Deciduous shade trees near house
TEMPERATE HUMID CLIMATIC REGION	• Spread settlements exposed to winds during hot seasons •Open and free arrangements in harmony and integrated with nature	• South-eastern sides of slope wind protected, below and upper parts of the sides and lower inclined portions	• Unilateral buildings can be developed with relatively free formations • Free plans with a strong relation between indoor and outdoor	•Cross-like and free building forms •Long buildings should be preferred in the direction of east-west • Buildings with 1:1,6 or 1:2,4 proportions 	• Optimum sun orientation lies 10º E of S. 	• Distance between buildings should be between 2-3 H in the direction of North-South	• Medium-dark colours are advantageous. •Terrace surfaces should be in medium-dark colours	• Location of the windows should be suitable for cross-ventilation. Windows on western and northern facades should be smaller than others •A well insulated and sheltered roof	• In the south, scrub and shrubs •Evergreen trees should be planted in the north against the cold. •In the east and west, tree species blocking the sunlight
TEMPERATE ARID CLIMATIC REGION	•Compact layouts to obtain benefit and reduce the cooling effect of the wind. •Medium-intensive closed bulks sheltered from the wind	• South-eastern sides of slope wind protected, below and upper parts of the sides and lower inclined portions	• Compact buildings providing lowest volume/surface ratio •Close relation between buildings and nature	•Buildings with 1:1,1 or 1:1,3 proportions •Elongated on east-west axis •Compact with minimum exterior surface 	• Optimum sun orientation lies **27º E of S.** 	• Distance between buildings should be between 2 - 3 H in the direction of North-South	• Medium-dark colours are advantageous. •Terrace surfaces should be in medium-dark colours	• Windows on eastern and western facades should be smaller than southern facade. Windows on northern facade should be in minimum. •A inclined and insulated roof	• Shrubs and bushes should be used in the south •Evergreen trees should be planted in the north. •Tree species in the east and west
HOT ARID CLIMATIC REGION	• Dense and intensive settlements with low buildings • Walls of the houses and gardens should provide	• Below parts of the eastern and south-eastern sides •In the high places, parts allowing evaporation	•Dense atrium type houses •Terraced and semi-detached houses or masses creating volume in groups	• Buildings with 1:1,1 or 1:1,6 proportions • •Dense and bulk forms 	• Optimum sun orientation lies **3º E of S.** 	• Distance between buildings should be between 1 ½ - 2 ½ H in the direction of North-South	• White colour is especially preferred on the facades •Bright and contrast colours can be used in line	• Small windows are suggested • windows should be protected with shading elements • Inclined roofs, rooftop pools or green roofs	•Trees should not be planted in the direction of north and south •Creeping plants should be used on the walls if humidity
HOT HUMID CLIMATIC REGION	• Scattered settlements allowing ventilation in hot seasons •Separated housing •Shaded environment	• High places exposed to wind • North and south sides of the hills should be preferred • Shaded common areas	• Single houses erected on columns •Long and high buildings freely located in low density	•Buildings with 1:1,7 or 1:3 proportions •Buildings in the east and west should be thin and high 	• Optimum sun orientation lies **3º E of S.** 	• Distance between buildings should be between 1 ½ - 2 ½ H in the direction of North-South	• Reflective light colors in pastels range are the best E-W cross ventilation is essential.	• Wide openings and windows that will allow maximum east-west ventilation should be used on these facades. •A ventilated double roof or greenroof	• Deciduous trees and plants should be planted in the southern, eastern and western sides in way not to block ventilation during summer

CHAPTER 3

3. THE CASE STUDY ANALYSIS

3.1. THE CASE STUDY AREA

As the case study of this research, an existing residential area, which consists of two city blocks, is analyzed. The case study aims for a) understanding the current level of design-related energy efficiency in the area, and b) evaluating the pros and cons of different urban design measures and layouts in achieving energy efficiency and climatic friendly solutions in existing urban environments. This case study area is located on Güvenevler Neighborhood within the border of Çankaya District Municipality in Ankara. The two case study blocks are bordered by the Güvenlik Road on the West, Cinnah Road on the East, Farabi Street on the South and Yeşilyurt Street on the North, as shown on the figure below.

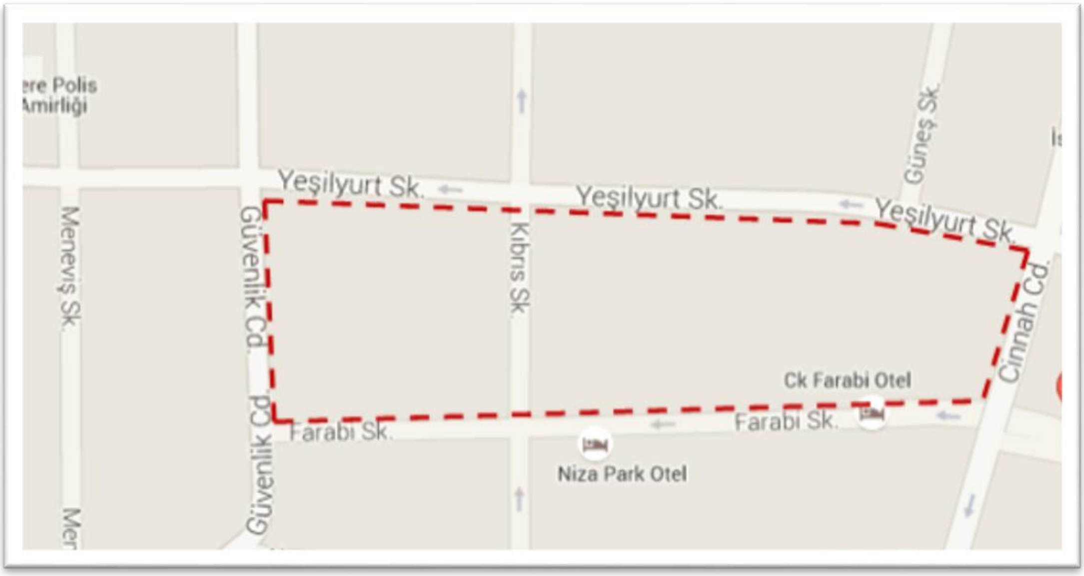


Figure 3.1 Location of the Case Study Area (Source: Google Maps, 2016)

The aim of the case study analysis is not limited to determination of whether the selected area is energy efficient or inefficient. This analysis also aims to specify the particular design dimensions or spatial conditions that strengthen or weaken the energy efficiency and climate friendliness of the area. In addition, the analysis will discuss the potentials of certain design measures and criteria in achieving energy efficiency in different climatic zones. Such discussion can clarify the different patterns in use of urban design to create more energy efficient and climate sensitive urban environments.

Due to some limitations, a single case study area had to be chosen in this research. It is of course plausible to make a comparative study based on selection of two-or-more samples so as to uncover the differences in use of urban design measures and their practical outputs. However, exemplary energy efficient and climate sensitive urban design implementations are almost non-existent in Ankara. In other words, lack of inner city developments, which have been planned and designed with the aim of energy efficiency and climate sensitiveness, compelled the selection of a single case. On the other hand, time constraint was another important factor in selection of the case study. When the number of cases increases, the number of variables for comparison also increases. Such a research that is based on a comprehensive and a wide range of variables require more time. Given the scope and timeframe of a master's research, an empirical research based on a single case study has been conducted.

The case study area is a typical inner city neighborhood in Ankara. The area has been built several decades ago by means of "build-and-sell" type housing provision under the Flat Ownership Law No. 634. Therefore, the case study area consists of typical multi-storey apartment blocks, as in the case of many Turkish cities (Figure 3.2). The case study area, as a typical "build-and-sell" type housing provision, is likely to be subjected to a transformation process in the near future due to the fact that most buildings are at the final stage of their economic and physical lifecycle. One reason for choosing this area as the case study is to derive some lessons and policy implications for transformation of such inner city areas in Turkish cities. This goal is based on the assumption that a rational urban transformation policy in Turkey should not ignore the significance of the concepts of energy efficiency and climate change for future urban development.

Figure 3.2 Apartment Blocks in the Case Study Area (Source: The Author's Archive)

3.2. THE CURRENT SITUATION OF THE CASE STUDY AREA

3.2.1. GENERAL CHARACTERISTICS OF THE AREA AND RESIDENTS

In terms of the building density, the area cannot be specified as a high-density area but rather a medium-density inner area, which provides opportunities to develop and implement energy efficient and climate sensitive solutions. The population of the case study area (the two blocks) is approximately 1500 people. The net residential density is calculated as approximately 400 persons per hectare. As mentioned earlier, the area is located 5km away from the city center, in Güvenevler Neighborhood of Çankaya Municipality.

In terms of the socio-economic profile of the neighborhood, a relatively homogeneous social group resides in the area. Residents are identical in terms of their education and income levels as well as their occupation status. It is mostly middle-income groups who live in the area and the living standards in the neighborhood are above the average.

Figure 3.3 The Satellite Image of the Case Study Area (Source: Google Earth, 2016)

3.2.2. CLIMATIC FEATURES OF THE AREA

The study area which is located in Ankara, Turkey is at 39°53'49.70"N, 32°51'18.75"E. According to Köppen Climate Classification, Ankara is characterized as a hot Mediterranean/dry-summer subtropical climate (Köppen-Geiger classification: Csa) that is mild with moderate seasonality. The summers in Ankara are dry and hot, winters are cold and snowy. According to the data provided by Ankara Central Station of the State Meteorological Agency of Turkey, the average temperature in July, which is the hottest month, is 26.6°C, and the average temperature in January, which is the coldest month, is -3 °C. The annual mean temperature, on the other hand, is 11.7°C. The average annual humidity ratio is 63.7% and the prevailing wind flows from the north in hot periods and flows from the northeast in cold periods. According to Erinc classification, Climatic type of Ankara is semi humid. (Source:www.mgm.gov.tr).

ANKARA	Ocak	Şubat	Mart	Nisan	Mayıs	Haziran	Temmuz	Ağustos	Eylül	Ekim	Kasım	Aralık
Uzun Yıllar İçinde Gerçekleşen Ortalama Değerler (1950 - 2015)												
Ortalama Sıcaklık (°C)	0.4	1.9	6.0	11.3	16.1	20.1	23.6	23.4	18.8	13.0	7.0	2.6
Ortalama En Yüksek Sıcaklık (°C)	4.4	6.6	11.6	17.3	22.2	26.6	30.2	30.3	26.0	19.8	12.9	6.6
Ortalama En Düşük Sıcaklık (°C)	-3.0	-2.2	0.9	5.6	9.7	13.0	15.9	16.0	11.8	7.2	2.4	-0.7
Ortalama Güneşlenme Süresi (saat)	2.5	3.5	5.2	6.4	8.4	10.2	11.3	11.6	9.2	6.5	4.4	2.4
Ortalama Yağışlı Gün Sayısı	12.3	11.0	11.1	11.7	12.6	8.9	3.7	2.8	3.9	6.9	8.4	11.5
Aylık Toplam Yağış Miktarı Ortalaması (kg/m^2)	42.1	36.6	40.3	46.5	52.0	36.7	14.2	10.9	18.7	29.1	32.0	43.1
Uzun Yıllar İçinde Gerçekleşen En Yüksek ve En Düşük Değerler (1950 - 2015)												
En Yüksek Sıcaklık (°C)	16.6	20.4	27.8	31.1	33.0	37.0	41.0	40.4	36.0	33.3	24.4	20.4
En Düşük Sıcaklık (°C)	-24.4	-22.2	-19.2	-6.7	-1.6	3.8	4.5	6.3	2.5	-5.3	-13.4	-18.0

En yüksek ve en düşük sıcaklıkların gerçekleşme tarihini görmek için fare imlecini değerlerin üstüne getiriniz.

Günlük Toplam En Yüksek Yağış Miktarı	11.06.1997	88.9 kg/m^2	Günlük En Hızlı Rüzgar	27.04.1965	122.4 km/sa	En Yüksek Kar	31.01.1950	33.0 cm

Figure 3.4 Climatic Variables of Ankara City (Source: www.mgm.gov.tr)

As it is mentioned previous chapter, Turkey, which is located in the temperate climate zone, is divided into 5 different climatic regions, classified as cold region, temperate-humid region, temperate-arid region, hot-humid region and hot-arid region (Zeren, 1987; Karaman, 1995; Akşit, 2005; Koca, 2006). In the case study analysis, only the two of these climatic regions will be considered and the analyses will be conducted based on these two regions, namely temperate-arid and hot-humid regions. The settlement pattern and the form, volume and orientation of the buildings will be evaluated in the case of both climatic regions so as to create energy efficient and climate sensitive urban design solutions. In what follows, first of all, the case study area and its climatic design principles, as an example of temperate arid climate region will be discussed.

3.3. ANALYSIS OF THE CURRENT SITUATION OF ENERGY EFFICIENCY IN THE CASE STUDY AREA

3.3.1. GENERAL CHARACTERISTICS OF THE TEMPERATE ARID CLIMATE REGION

In Turkey, cities of Afyon, Aksaray, Ankara, Burdur, Çankırı, Çorum, Elazığ, Erzincan, Eskisehir, Iğdır, Isparta, Karaman, Kayseri, Kırıkkale, Kırşehir, Konya, Kütahya, Malatya, Nevşehir, Niğde and Uşak are located in the temperate-arid climate region (Orhon vd, 1988, Akşit, 2005). In this region, differences between day and night temperatures are quite high. Average outside temperature is ranged from +30ºC to -5°C throughout a year. In summer time, the average temperature is around 27-37ºC and the summer nights are cool. In winter time, the average temperature is around 8-15ºC (Göksu, 1999).

The general characteristics of the temperate-arid climate region is similar to that of cold climate region. The conditions which are increasing the heating effect of solar radiation and reducing the effect of cold wind is required in winter, utilizing the cooling effect of wind and providing shaded spaces are required in winter time should be provided in this region. The large range of thermal conditions requires the utilization of radiation and wind effect, as well as protection from them, depending on the time in a year. Hence, a dual role design measures and criteria is required (Olgyay, 1992).

3.3.2. EVALUATION OF ENERGY EFFICIENCY AND CLIMATE SENSITIVITY IN THE CASE STUDY AREA

In terms of land use characteristics, wind sheltered, medium-dense and closed/compact building volume with mixed land uses are preferred in temperate-arid regions. Although the case study area is predominantly a residential area, there are also buildings under commercial uses and also buildings which have small commercial shops on their ground floors. Besides, the case study area is located in the vicinity of the sub-center of the neighborhood. Therefore, in terms of mixed land-use structure, the case study area has some certain merits and advantages. Furthermore, density level in the area is medium and building volumes are closed and compact, as required intemperate-arid regions.

Figure 3.5 Land use features of the area (Source: The Author's Archive)

Energy consumption in indoor heating and cooling is highly influenced by the site of the buildings and building blocks. Therefore, site selection is an important factor that relates urban design measures to energy efficiency. In temperate-arid regions, east of south slopes, wind protected and lower-inclined portions are preferred. Also, east/west street layout and road orientation should be preferred in temperate-arid regions. The case study area is located and oriented south to north inclined site, which should be counted as a disadvantageous situation for energy efficiency in urban design.

Figure 3.6 The dip direction of the area (Source: The Author’s Archive)

Street layout and orientation is another key factor for energy efficient urban design. The reason is that the orientation of streets in an urban setting determines “the amount of shadowing and radiation, light and air movement, intensity of city ventilation and duration of relative humidity in the air" (Golany, 1995: 166). Because of the weak solar access of north-south oriented streets in winter, east-west orientation in street layout should be preferred in temperate-arid regions. As shown in the following figure, the street orientation in the case study area follows an east-west direction, in line with what is suggested for temperate-arid regions that is the climatic region of Ankara.

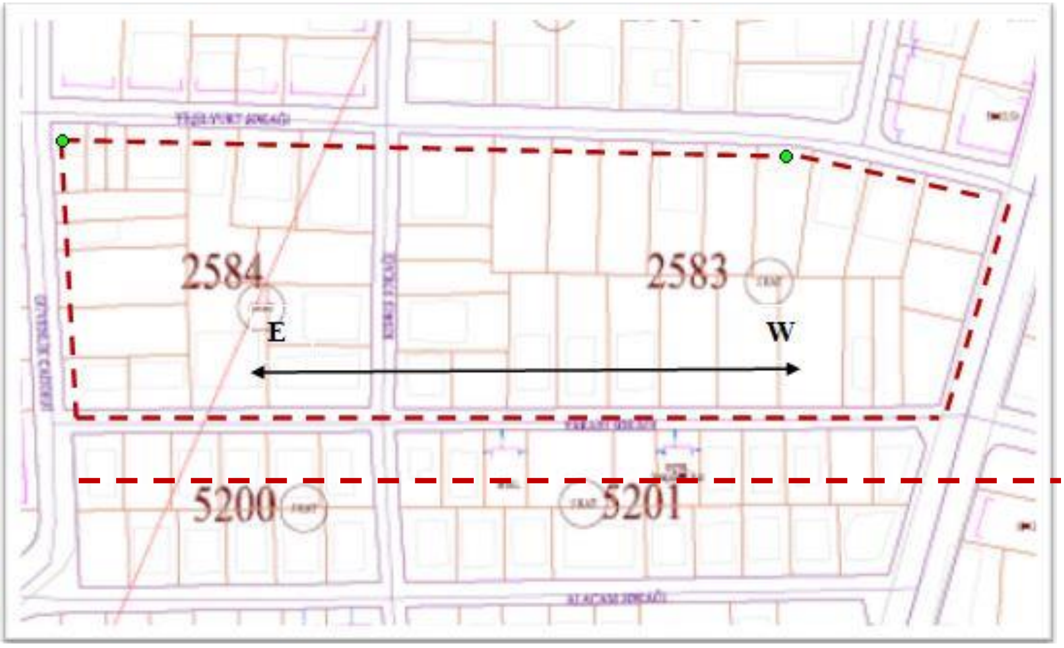


Figure 3.7 The Street Layout of the Study Area is East-West Oriented (Source: The Author's Archive)

As for the housing typology, large-size and simple shapes that have lower surface-to-volume ratio (SlY), wind sheltered, compact and squared housing types are preferable in temperate-arid regions. Most types of housing in case study area are medium-size, simple, compact and detached apartment buildings. However, there are also attached and small-size buildings in the area. So, it could be concluded that housing typology is not uniform and not consistent with the required/ideal housing types for a temperate arid region.

Figure 3.8 Housing types in the area (Source: The Author's Archive)

In terms of form and volume, buildings in the study area differ from each other and the large facades are mostly oriented to north-south direction. This should be considered as a downside of the area for energy efficiency. The reason is that large facades should be oriented east-west direction in terms of benefit from the sun and reducing energy consumption for heating in winter. Furthermore**,** most of the buildings do not have an optimum shape range and the area was not designed in a wind-sheltered manner, except for the existing vegetation. Consequently, the current situation of the study area with regard to building form and volume is not very promising and the area is characterized by several form-related flaws and downsides.

Figure 3.9 The view of building form and volume of the area (Source: The Author's Archive)

Distance between buildings is another key criterion for achieving energy efficiency in urban design because of access to the sun. In temperate-arid regions, the optimum distance between buildings should be determined the range between 2H-3H (H: building height) in the previous chapter. The north-south distance between most of the buildings in study area is larger than 3H, and the other is smaller than 2H, which is an unintended situation from energy efficient urban design perspective **(Figure 3.10)**

Figure 3.10 Distance between buildings in the area (Source: The Author's Archive**)**

In order to obtain the maximum benefit from sun light, solar orientation of buildings has to be different in each climate region. As it is determined in the previous chapter, optimum building orientation should be 27º east of the south to achieve good solar radiation and natural illumination in temperate-arid region. However, most of the buildings in the study area are not appropriately oriented, as shown in the figure below (Figure 3.11).

Figure 3.11 Orientation angle of existing buildings in the area (Source: The Author's Archive**)**

In terms of building roofs, both the form and the direction of the roofs are important. In temperate-arid climate regions, the roofs of the buildings should be well-insulated and inclined. The following figures show sections of the buildings and their roofs in the study area. As seen, most of the buildings have inclined roofs, which is a positive aspect, however, the roofs seem not be very well-insulated, which may end up with lower insulation of heat and cold (Figure 3.12).

Figure 3.12 View of existing buildings' roof in the area (Source: Google Earth, 2016)

Colors of buildings should also be taken into consideration in energy efficient urban design. Medium colors can provide optimum absorbing effect in temperate-arid regions. The building colors in study area are different from each other and it is seen that the colors were not selected with regard to climatic conditions.

Figure 3.13 Colors of buildings in the area (Source: The Author's Archive)

Windows are parts of the buildings, which may or may not bring in excess cold, wind and solar radiation. Therefore, windows and window frames are crucial for a building's energy efficiency. Windows of the south facade can provide maximum benefit from the sun in temperate-arid regions. On the other hand, shading devices should be used for protecting from direct solar heating in summer time. Windows on the east and west facades should be smaller than the windows on the south facade and they should also have a good summer shading.

As shown in the following figures, the buildings in the study area has not appropriate shading devices and vegetation for protecting direct solar heating in summers and windows on each facades are not differentiated for solar radiation. It is obvious that windows of the buildings in the area were not designed accordingly for temperate-arid climatic conditions, which is another downside of the area.

Figure 3.14 Windows of existing buildings in the area (Source: The Author's Archive)

Landscaping and vegetation has an important effect for reducing the heat island effect and thereby energy consumption. Evergreen trees away from the buildings are the best for wind protection in cold seasons. Deciduous shrubs, coniferous trees and non-even green trees near the buildings are preferable in temperate-arid regions. The study area is rich in green and tree cover. There are various trees, shrubs and groundcover plants that help shading the walking streets, pavements and buildings in the study area (Figure 3.15).

Figure 3.15 Vegetation in the study area (Source: The Author's Archive)

Evergreen trees on the open spaces and north-northwest of buildings help reduce wind speed and serve as a windbreaker during winter time

Figure 3.16 Vegetation from backyard of the area (Source: The Author's Archive)

Furthermore, there is an effectively planned landscape that block out the hot summer sun, encourage solar radiation to enter into the house in winter time, deflect cold winter winds, and channel breezes for cooling in summer time in the study area (Figure 3.16). These are all advantages of the existing green landscape and tree cover in the study area for energy efficiency and climate sensitiveness (Figure 3.17).

Figure 3.17 Vegetation from north side of the buildings in the area (Source: The Author's Archive**)**

Following table summarizes the evaluation of current level of energy efficiency and climate sensitiveness in the study area with a particular focus on a) shading and ventilation conditions for cooling requirements, and b) solar access and wind protection conditions.

Table 3.1 Overall Evaluation of the Current Situation in the Study Area

Overall Evaluation of the Current Situation in the Study Area		
Shading and Ventilation Conditions for Cooling Requirements	Merits or Advantages in the Area	Location of buildings provides natural ventilation in summer
		Street layout parallel to the prevailing wind direction encourages good air circulation/movement
		The ratio of open spaces are appropriate for natural ventilation
	Downsides or Disadvantages	Location of buildings prevents shading in summer

Table 3.1 Overall Evaluation of the Current Situation in the Study Area (Continued)

Overall Evaluation of the Current Situation		
Shading and Ventilation Conditions for Cooling Requirements	Downsides or Disadvantages in the Area	Surface area of buildings exposed to solar radiation is low.
		Shading elements like arcades, pergolas, etc. do not exist
		Building heights are uniform, and this may block the prevailing wind
		Landscaping for cooling is not enough
		Surface covering is hard and this situation decreases the albedo
		Openings like windows and doors of buildings face south and let the sun light in
Solar Access And Wind Protection Conditions	Merits or Advantages in the Area	Landscaping provide solar access
		Open spaces between buildings are sunny and wind protected
		Uniform height of buildings does not act as a windbreaker
		In buildings, level of surface area exposed to the wind is high
	Downsides or Disadvantages in the Area	Distance between buildings do not provides solar access
		Landscaping for wind protection is not appropriate
		Location of buildings in relation to each other do not provide solar access

3.4. ENERGY EFFICIENT AND CLIMATE SENSITIVE DESIGN ALTERNATIVES FOR THE STUDY AREA AS PER TEMPERATE ARID CLIMATE REGION

In the previous section, current situation of energy efficiency in the case study area has been evaluated based on design criteria for temperate arid climate region. In this part of the chapter, design alternatives that aim to increase energy efficiency in the study area will be developed and discussed. The design alternatives will also be evaluated based on the benefits they provide as well as the constraints they generate.

First of all, the analysis will focus on the key aspects of the real life situations rather than starting with the ideal design solution. Property ownership, which is usually very fragmented in Turkish cities, is an important challenge of urban design initiatives in Turkey. A realist design solution should consider the property ownership pattern and layout in the area under investigation. With this limitation in mind, development of design alternatives in this section starts with the analysis of the property ownership pattern in the case study area. Then, alternative urban design solutions that aim to increase energy efficiency and create climate friendly urban environment without sacrificing the existing ownership rights and patterns in the two building blocks studies. The analysis will then argue the obstacles, constraints and benefits of the design alternatives developed. The final part of the analysis will focus on the ideal design solutions. In ideal design alternatives, only the total number of property holders will be considered but the land/parcel ownership layout will be subjected to change.

3.4.1. PROPERTY OWNERSHIP PATTERN AND LAYOUT IN THE STUDY AREA

Parcel layout, existing structures and ownership rights have important impacts on new planning and design implementations to be applied to ensure energy efficiency. So, first of all, existing parcel layout and ownership structure should be analyzed in detail and opportunities and constraints brought along should be identified while carrying out the analysis.

The parcel layouts should be appropriate to accommodate climate sensitive building types that enhance energy efficiency in terms of passive heating, cooling lighting and ventilation systems. When existing parcel layout in the study area is analyzed, it is observed that there parcels in different sizes in building blocks no 2584 and 2583, and parcels are usually rectangular and narrow. Building height is limited to 5 floors for both building blocks.

Figure 3.18 Existing Parcel Layout (Prepared by the author)

The parcel layout plays an important role to achieve energy efficiency, as it determines the proximity of buildings, the solar orientation and building form. On the plot level, separation of parcels needs to ensure that the plot layout is flexible enough to accommodate a climate sensitive building types and orientations. The existing buildings or structures in the study area vary depending on the parcel layout, as seen in the following figure.

Figure 3.19 Existing Buildings and Ownership Structure (Prepared by the author)

When all parcels are given numbers and evaluated; for building block no 2584; it is seen that the widths of parcels no 1, 2, 3, 16 and 17 are not sufficient for implementation of criteria identified for temperate arid climatic region to increase energy efficiency. Therefore, "amalgamation of land", which is "tevhid" in Turkish, has to be considered for these parcels. For building block no 2583; it is seen that widths of parcels no 13, 14, 24 and 25 are not sufficient for implementation of criteria identified for temperate arid region to increase energy efficiency. Therefore, "amalgamation of land" is also suggested for these parcels.

There are some opportunities and barriers or limitations arising from the existing property ownership pattern in the study area. As a major benefit, it is observed that the structures are generally located based on the setback distances. On the other hand, several limitations exist. First, it is seen that the distance among many structures is not between "2H-3H" which is the defined range for temperate arid climatic region, Second, building sizes are not also in the identified range of “1:1,1-1:1,3”. Third, it has been observed that the orientation of buildings is not on the optimum angle identified for temperate arid climatic region, which is 27 degrees to the south east. Below is a table containing existing parcel sizes, floor areas of the structures, number of floors and total dwelling units of the blocks no 2583 and 2584.In the tables, it is shown that parcel sizes vary between 202 m2 and 1403 m2 while floor areas vary from 68 m2 to 620 m2.

Table 3.2 Farabi Street City Block No. 2584

PARCEL NO.	PARCEL SIZE	BUILDING FLOOR AREA	NUMBER OF FLOOR	TOTAL BUILDING AREA
1	364 m²	68 m²	4	816 m²
2	202 m²	120 m²	5	1800 m²
3	206,4 m²	0 m²	-	-
4	623,3 m²	361 m²	5	5415 m²
5	1403 m²	280 m²	5	4200 m²

Table 3.2 Farabi Street City Block No. 2584 (Continued)

PARCEL NO.	PARCEL SIZE	BUILDING FLOOR AREA	NUMBER OF FLOOR	TOTAL BUILDING AREA
7	1053,2 m²	620 m²	6	11160 m²
8	814,2 m²	300 m²	5	4500 m²
9	1010,2 m²	400 m²	4	4800 m²
10	1026,7 m²	408 m²	5	6120 m²
11	1507 m²	544 m²	4	6528 m²
12	509,6 m²	210 m²	5	3150 m²
13	530,4 m²	171 m²	4	2052 m²
14	1002 m²	325 m²	4	3900 m²
15	1147 m²	390 m²	4	4680 m²
16	562,4 m²	162 m²	5	2430 m²
17	622,4 m²	165 m²	5	2475 m²
TOTAL	13.559 m²	4950 m²		70416 m²

Table 3.3 Farabi Street City Block No. 2583

PARCEL NO	PARCEL SIZE	BUILDING FLOOR AREA	NUMBER OF FLOOR	TOTAL BUILDING AREA
1	1337 m²	621 m²	4	7452 m²
2	1237 m²	336 m²	5	5040 m²
3	1045 m²	339 m²	5	5055 m²
4	1096 m²	340 m²	6	6120 m²
5	1132,5 m²	338 m²	4	4056 m²
6	1046 m²	335 m²	4	4020 m²
7	1040 m²	341 m²	5	5115 m²
8	1010 m²	333 m²	5	4995 m²
9	1035 m²	400 m²	5	6000 m²
10	805 m²	400 m²	4	4800 m²
11	775 m²	420 m²	4	5040 m²
12	735 m²	360 m²	5	5400 m²
13	576 m²	160 m²	5	2400 m²
14	583,6 m²	165 m²	5	2475 m²

Table 3.3 Farabi Street City Block No. 2583 (Continued)

PARCEL NO.	PARCEL SIZE	BUILDING FLOOR AREA	NUMBER OF FLOOR	TOTAL BUILDING AREA
15	1321 m^2	380 m^2	5	5700 m^2
16	1241 m^2	340 m^2	5	5100 m^2
17	1186 m^2	340 m^2	5	5100 m^2
18	1055 m^2	350 m^2	6	6300 m^2
19	1064 m^2	245 m^2	5	3675 m^2
20	1005 m^2	304 m^2	4	3648 m^2
21	507,8 m^2	240 m^2	4	2880 m^2
22	498 m^2	235 m^2	4	2820 m^2
23	1035 m^2	350 m^2	5	5250 m^2
24	621 m^2	200 m^2	4	2400 m^2
25	518 m^2	200 m^2	4	2400 m^2
TOTAL	22.408,3 m^2	8069 m^2		113241 m^2

3.4.2. THE REALIST SCENARIO THAT PRESERVES OWNERSHIP RIGHTS AND PARCEL LAYOUT FOR TEMPERATE ARID CLIMATE REGION

In the following alternative, design criteria for the structures in temperate arid climatic region are applied while preserving the parcel layout as it is. Each building is redesigned in its own parcel by considering orientation and form according to energy and climate considerations. The alternative shows the suitability of existing ownership pattern for energy efficient design. Maximum floor areas of buildings arranged in this way appear as provided in Table 3.4.

Figure 3.20 Arrangement of buildings based on preserved ownership rights and parcel layout (Prepared by the Author)

Table 3.4 Floor Area of Buildings in Realist Scenario

BLOCK NO 2583				**BLOCK NO 2584**			
Parcel	**Floor Area**	**Parcel**	**Floor Area**	**Parcel**	**Floor Area**	**Parcel**	**Floor Area**
1	470 m^2	**14**	**47 m^2**	**1**	**54 m^2**	**10**	187 m^2
2	165 m^2	**15**	205 m^2	**2**	**15 m^2**	**11**	330 m^2
3	140 m^2	**16**	204 m^2	**3**	**15 m^2**	**12**	140 m^2
4	140 m^2	**17**	176 m^2	**4**	176 m^2	**13**	150 m^2
5	150 m^2	**18**	121 m^2	**5**	115 m^2	**14**	176 m^2
6	165 m^2	**19**	123 m^2	**6**	117 m^2	**15**	216 m^2
7	167 m^2	**20**	140 m^2	**7**	280 m^2	**16**	**63 m^2**
8	176 m^2	**21**	176 m^2	**8**	216 m^2	**17**	**54 m^2**
9	178 m^2	**22**	140 m^2	**9**	218 m^2		
10	260 m^2	**23**	216 m^2				
11	280 m^2	**24**	**96 m^2**				
12	165 m^2	**25**	**88 m^2**				
13	**48 m^2**						
Total	**4776 m^2**			**Total**	**2522 m^2**		

The realist scenario is observed to have some benefits for achieving an energy efficient and climate sensitive urban design while preserving the parcel layout. On the other hand, the adherence to the existing parcel layout brings about several obstacles and constraints that make this alternative difficult to apply. Among the most important benefits of this scenario is the ensuring of the orientation and form related criteria that help increase the efficiency of energy use in buildings. As seen on Figure 3.20, all buildings in the area is oriented 27 degrees to the south-east, and form of all buildings is arranged to be at the maximum size in the rage of 1:1.1-1:1.3 while orienting the longest front to the south.

However, there are various limitations or undeliverable criteria of energy efficient design in this scenario, arising from the preservation of the parcel layout. First of all, the ideal distance between buildings identified for temperate arid climate (2H-3H) cannot be provided for buildings located in parcels on eastern and western fronts. Floor areas of buildings have to be reduced almost by half because of compliance with 27 degrees orientation to south-east without changing the existing parcel layout and direction. Another unintended consequence of this is that property rights cannot be fully met after such reorganization. Thirdly, when buildings are made to meet the suggested "1:1.1-1:1.3" ratio without changing the existing parcel layout, new buildings are then required to have small floor areas, which make them unsuitable for practical use(for instance; floor areas of buildings in 2nd and 3rd parcels of Block No 2584).

Consequently, design criteria, which are suitable for temperate arid regions, have been applied in this alternative or scenario to ensure energy efficiency of buildings without compromising the existing parcel layout. Certain obstacles and constraints have been observed regarding the application of arrangements to be made to increase energy efficiency without changing the parcel layout. These constraints have to be handled and managed for a more fruitful design attempt. Therefore, it seems inevitable to make some changes to parcel layout in order to achieve a better design alternative or scenario. In what follows, a couple of alternatives based on some adjustments to the parcel layout are presented and discussed.

3.4.3. THE REFORMIST SCENARIO I THAT ADJUSTS THE PARCEL LAYOUT FOR TEMPERATE-ARID CLIMATE REGION

For this scenario, first, the parcel layout will be rearranged based on the design criteria for temperate arid regions so as to eliminate the constraints observed in the realist scenario and to increase the feasibility of the design alternative in real life.

To adjust the existing parcel layout, current parcels in study area have been reorganized by orienting them 27 degrees to the south-east based on the design criteria for temperate arid climatic region. The adjusted parcel layout is presented in the following figure.

Figure 3.21 Reorganized Parcel Layout of the study area (Prepared by the Author)

Ownership right of each parcel is primarily aimed to be protected on its own. However, there are some parcels which may not be suitable for construction and for such parcels, amalgamation of land is suggested. This suggestion applies to existing parcels with a side length below 15 meters in order to meet the criteria of ideal climate-sensitive building construction. Therefore, parcels no 1, 2, 3, 16 and 17 have been merged in block no 2584. In block no 2583, parcels no 13, 14, 24 and25 have been merged too. Consequently, the number of parcels in block no 2584 decreased from 17 to14, while the number of parcels in block no 2583 decreased from 25 to 23.

Following the slight adjustments to the parcel layout, energy efficient and climate sensitive design criteria for temperate arid regions have been applied. In the course of this application, structures/buildings with maximum floor area are placed in each parcel by providing the setback distance specified in urban development legislation. Since floor areas of existing structures cannot be provided in some parcels in the adjusted parcel layout, ownership rights have been protected by increasing the floor numbers of buildings.

Figure 3.22 2D View of Proposed Energy Efficient Design Layout for Temperate Arid Climatic Region (Prepared by author)

In order to test solar access and shadowing situation of proposed buildings, a particular software, namely Sketch Up has been utilized. Sketch Up was used to obtain three-dimensional drawing of buildings in this new reformist scenario. Furthermore, coordinates of the study area were defined as inputs to the programme, and the level of sunlight as well as the shadow length of buildings that would be received by noon in December have been analyzed.

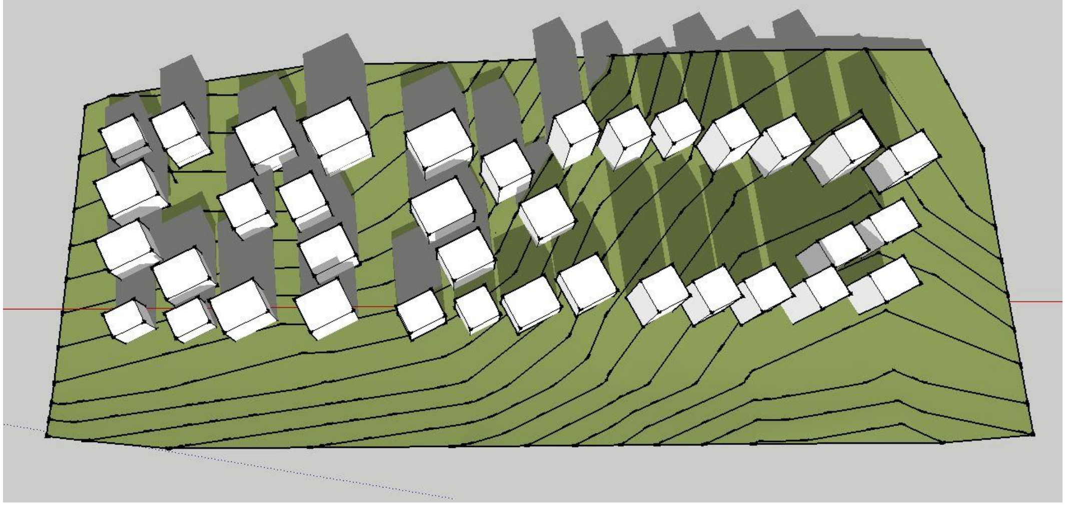


Figure 3.23 Shadowing Situation of Proposed Design by December 12.00 pm -
View from the top of proposed development area (Prepared by the author)

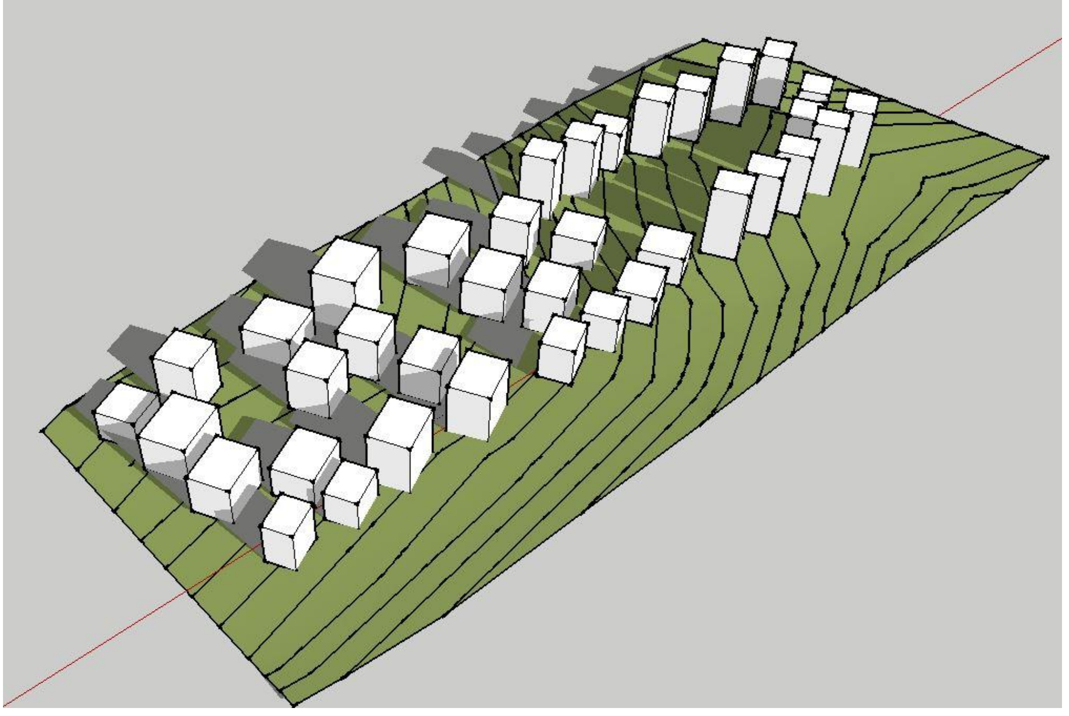


Figure 3.24 Shadowing Situation of Proposed Design by December 12.00 pm -
View from the southwest of proposed development area (Prepared by the author)

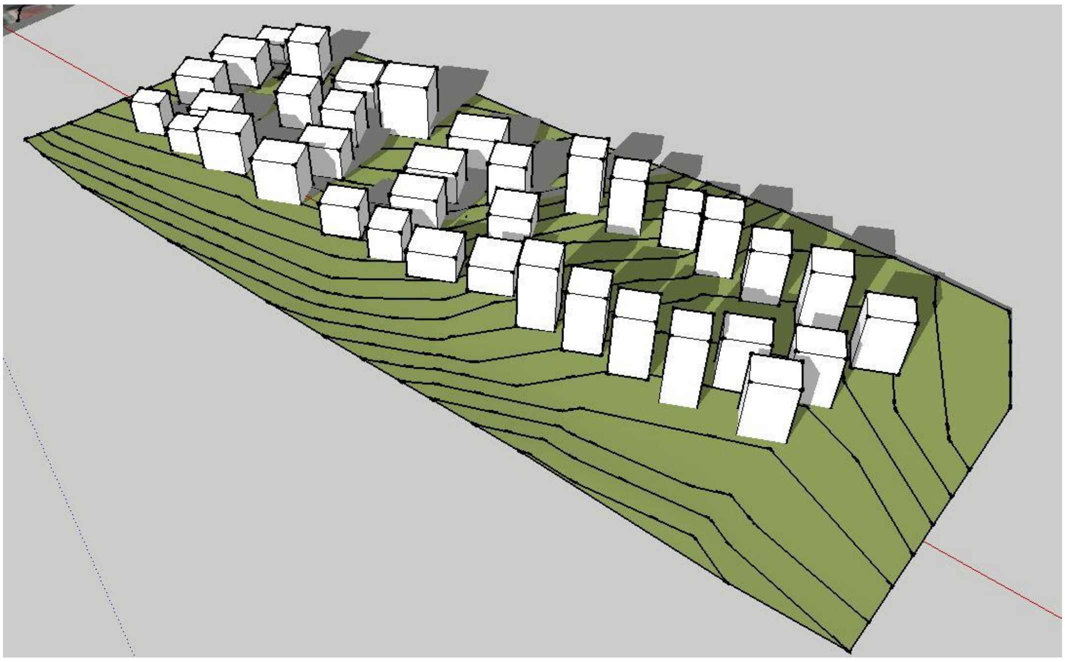


Figure 3.25 Shadowing Situation of Proposed Design by December, 12.00 pm - View from the southeast of proposed development area (Prepared by the Author)

As concluded from images given above, buildings block the sunlight that would otherwise fall onto each other due to the limited distance between them and to the height of structures in the new arrangement. The major benefits delivered by this alternative are that buildings are oriented 27 degrees to south-east, and form of buildings is arranged to be at maximum size in the rage of 1:1.1-1:1.3, while orienting the longest front to the south. Therefore, criteria for orientation and form of buildings to make them more energy efficient could be satisfied here.

There are again various limitations, constraints or shortcomings that come as part of the reformist scenario. First of all, in many parcels (especially the ones located on eastern and western fronts), the distance between structures suggested for temperate arid climatic region (2H-3H) cannot not be provided. Second, there are some buildings where required floor areas cannot be provided due to the structure of the block and parcel widths. Ownership rights have been attempted to be protected by increasing the floor numbers. However, this situation caused blocking of sunlight by structures in some parts of the block.

Thirdly, new layout does not deliver ideal results in terms of common area quality and design. Furthermore, due to the identified criteria and the will to keep ownership rights and statuses as they are, a uniform housing pattern had to be applied. Last but not the least, increase in building density and development rights as a means to finance the required transformation is not recommended. In such cases, substantial compromises have to be made from the goal of achieving and ensuring energy efficiency and climate sensitiveness. On the other hand, concerns over the increase in density and development rights result in the financial problems in realization of the scenario or alternative.

The problematic parts of the new layout, where most of the shortcomings mentioned above are observed, are provided in the following figure. Structures that are located within areas bordered with red lines have to be reconsidered in order to achieve a better design alternative and solutions.

Figure 3.26 Problematic areas in Reformist Scenario I (Prepared by the Author)

3.4.4. THE REFORMIST SCENARIO II

In order to eliminate the constraints observed in the previous alternative, which is the Reformist Scenario I, partial changes have been made to parcel layout, as the first step of development of this new scenario. For parcels, where distance criterion for temperate arid regions to increase energy efficiency cannot be met, amalgamation of land is suggested. Therefore, three parcels and four parcels on both ends of the block have been merged separately in block no 2583, and the number of parcels decreased from 23 to 19. Whereas, in block no 2584, four parcels have been merged and the number of parcels decreased from 14 to 11 (Figure 3.27).

Figure 3.27 2D View of Proposed Energy Efficient Design Layout of Reformist Scenario II (Prepared by the Author)

The problem of distance between buildings has been attempted to be eliminated not only by amalgamation of parcels but also by changing the function of buildings in the merged parcels, in particular from housing to commercial. With the change in function, an opportunity to provide incentives to property owners to bear the cost of a possible transformation emerged.

Again, to test solar access and shadowing situation of proposed buildings, Sketch Up programme has been utilized and several three-dimensional views of proposed structures in the new arrangement have been generated based on real coordinates of study area and on the real life situation of sunlight and shadow length by noon in December.

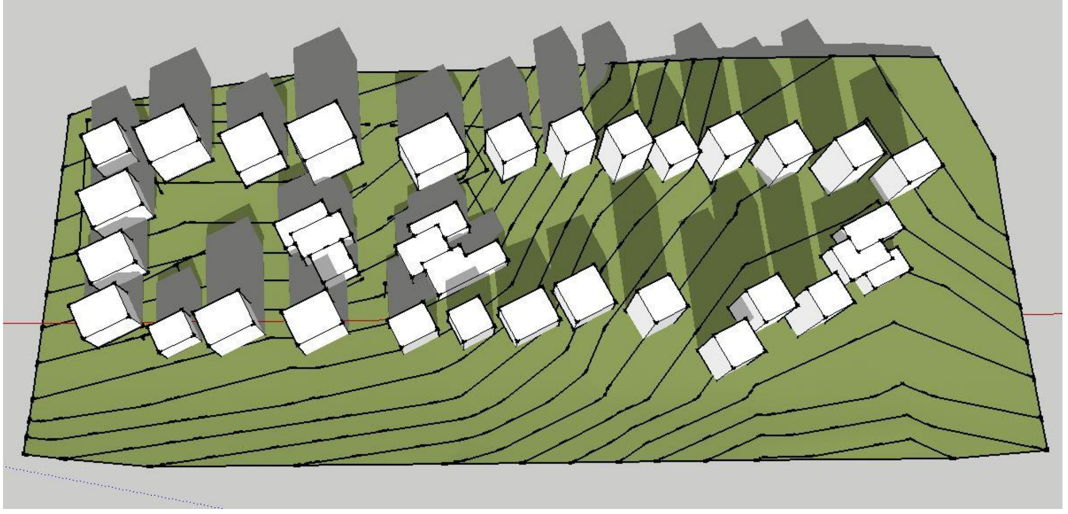


Figure 3.28 Shadowing Situation of Proposed Design by December 12.00 pm- View from top of proposed development (Prepared by the author)

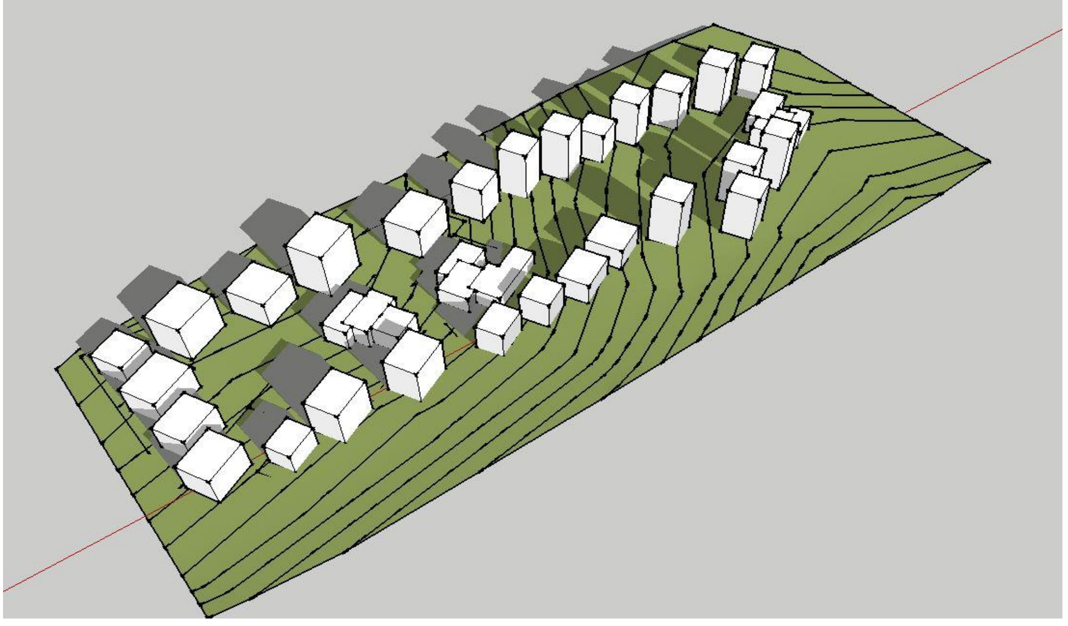


Figure 3.29 Shadowing Situation of Proposed Design by December 12.00 pm - View from the south west side of proposed development area (Prepared by the author)

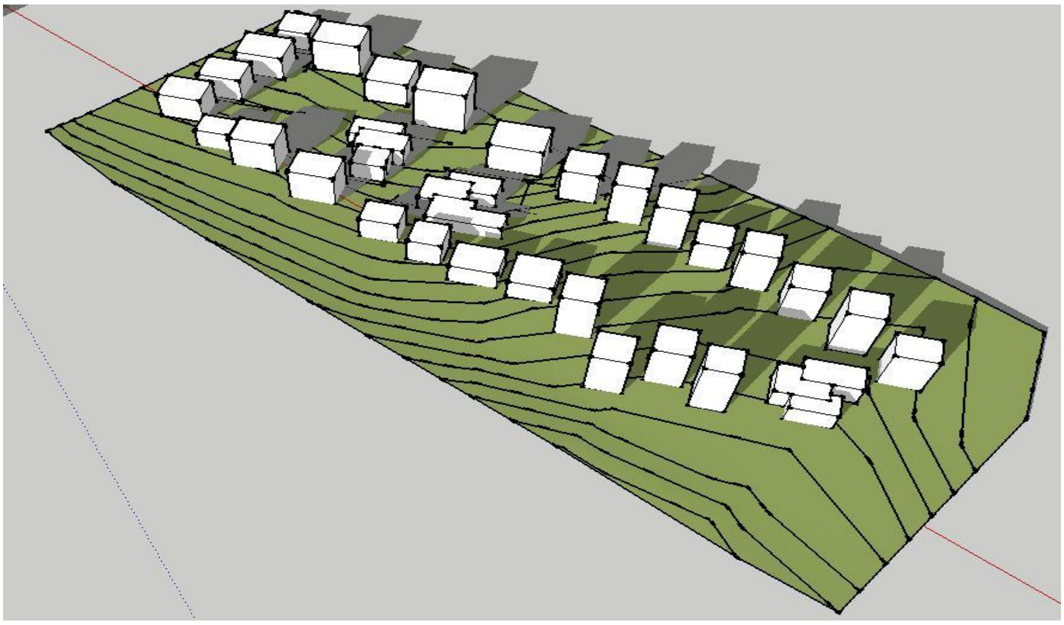


Figure 3.30 Shadowing Situation of Proposed Design by December 12.00 pm - View from the southeast side of proposed development area (Prepared by the Author)

The most obvious benefits delivered by the second reformist scenario are as follows:

- Distance between structures suggested for temperate arid climate to enhance energy efficiency has been ensured in many parcels
- Change in function of some structures located in amalgamated parcels is considered as an incentive for property owners and actors involved
- Increase in energy efficiency has been ensured compared to the previously suggested activity in the study area

On the other hand, there are still some important limitations, constraints and shortcomings of this second reformist scenario. These limitations or shortcomings could be summarized as follows:

- Although amalgamation of new parcels is suggested in order to eliminate the distance problem between structures in the previous scenario, the suggested criterion still cannot be met in all structures due to ownership rights and physical conditions

- There are some structures where required floor areas cannot be provided due to the structure of the block and parcel width. Ownership rights are attempted to be protected with increase in floor numbers. However, this situation caused blocking of sunlight by buildings in some parts of the block.

- The new scenario does not deliver ideal results in terms of common area quality and design to the identified criteria and the will to keep ownership rights and statuses as they are, a uniform housing pattern had to be applied.

- Increase in building density and development rights as a means to finance the required transformation is not recommended. In such cases, substantial compromises have to be made from the goal of achieving and ensuring energy efficiency and climate sensitiveness.

Although the second reformist scenario has been developed to overcome problems of the first reformist scenario, it is obvious that most problems still prevail. The figure given below presents the major problematic areas within the blocks, where most of the shortcoming mentioned above take place. A solution to this issue is to develop an ideal case scenario, where current situation with regard to parcel layout and ownership patterns are not preserved. Next section presents and discusses such an ideal option.

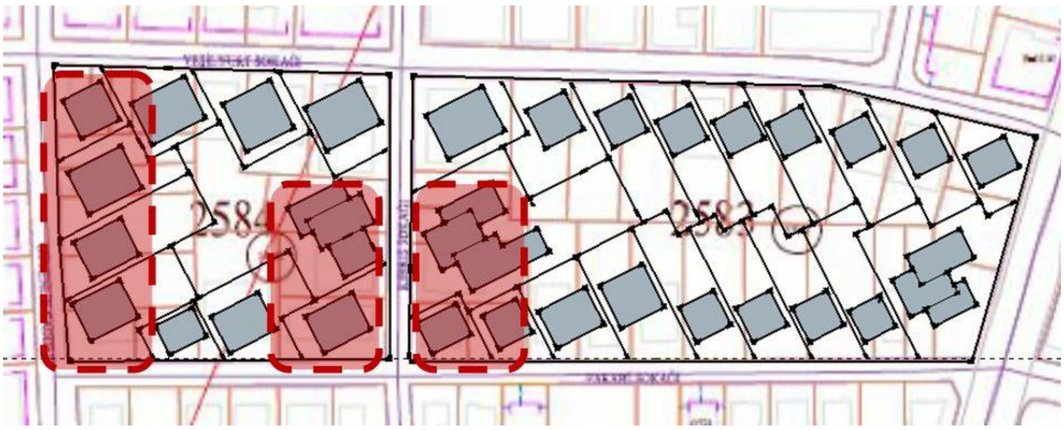


Figure 3.31 The problematic area of reformist scenario II (Prepared by the Author)

3.4.5. THE IDEAL SCENARIO THAT INCREASES ENERGY EFFICIENCY IN TEMPERATE ARID CLIMATE REGION

In the previous section, realist and reformist scenarios have been developed for the study area based on selected design criteria for temperate arid climate region and considering the existing parcel layout and ownership pattern. However, some shortcomings and constraints have been observed. In this section, an ideal scenario will be developed as a solution to eliminate the shortcomings observed and to provide the study area with optimum energy efficient and climate sensitive conditions. In the ideal scenario, existing parcel layout and ownership patterns are not preserved. In what follows, first of all, the ideal plan and general design outputs are presented. Then, each design criteria is discussed in detail on an individual basis. Lastly, shadowing situation by noon in December and June are presented to indicate optimum solar access of buildings for temperate arid climate region. Maximum floor areas of buildings in ideal scenario appear as given in Table 3.5.

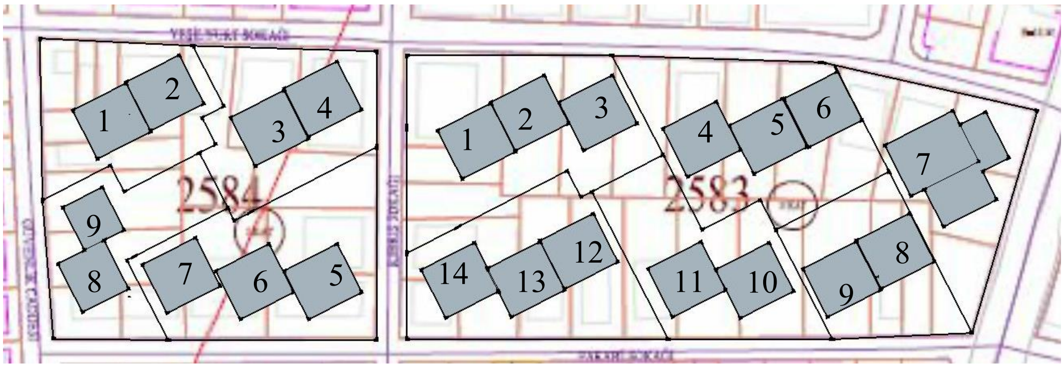


Figure 3.32 2D View of Proposed Energy Efficient and Climate Sensitive Design Layout of the Ideal Scenario (Prepared by the Author)

Table 3.5 Floor Areas of Buildings in Ideal Scenario for Temperate Arid Region

BLOCK NO 2583				BLOCK NO 2584			
Building No	**Floor Area**	**Number of Floors**	**Total Building Area**	**Building No**	**Floor Area**	**Number of Floors**	**Total Building Area**
1	440 m²	6	8360 m²	**1**	440 m²	6	8360 m²
2	440 m²	6	8360 m²	**2**	440 m²	6	8360 m²
3	440 m²	6	8360 m²	**3**	440 m²	6	8360 m²
4	440 m²	6	8360 m²	**4**	440 m²	6	8360 m²
5	440 m²	6	8360 m²	**5**	440 m²	5	7040 m²
6	440 m²	6	8360 m²	**6**	440 m²	5	7040 m²
7	920 m²	4	11960 m²	**7**	440 m²	5	7040 m²
8	440 m²	5	7040 m²	**8**	310 m²	3	3100 m²
9	440 m²	5	7040 m²	**9**	310 m²	3	3100 m²
10	440 m²	5	7040 m²				
11	440 m²	5	7040 m²				
12	440 m²	5	7040 m²				
13	440 m²	5	7040 m²				
14	440 m²	5	7040 m²				
Total	**111.400**			**Total**	**60.760**		

South Side

North Side

East Side

West Side

Figure 3.33 3D Views of Proposed Energy Efficient and Climate Sensitive Design Layout of the Ideal Scenario for Temperate Arid Climate (Prepared by the Author, extended versions of the images are provided in appendix)

Compact, wind protected and approximately squared house type is used in ideal scenario, in line with the defined design criteria of temperate arid climate region (Figure 3.34).

Figure 3.34 Housing type in ideal scenario for temperate arid region (Prepared by the Author)

Structures should be compact with minimum exterior surface. Volume effect is desirable. The shape range is 1:1.1 on the East-West axis which is in the suggested optimum range from 1:1.1 to 1: 1.3 is provided in study area (Figure 3.35).

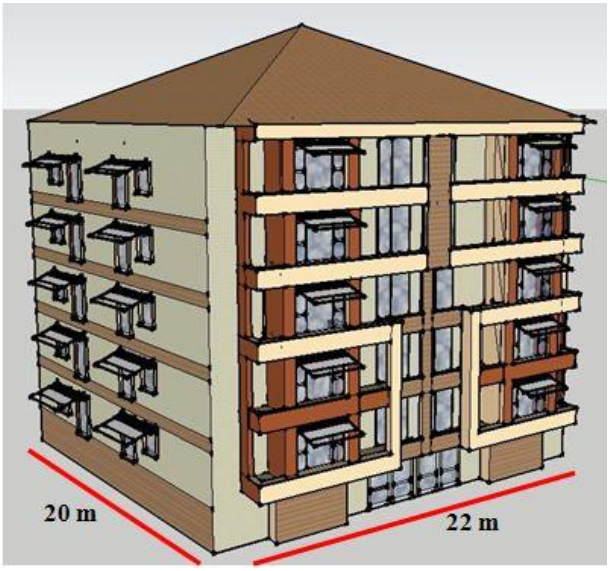


Figure 3.35 Form and volume of a building in ideal scenario for temperate arid region (Prepared by the Author)

All buildings in the study area is oriented 27 degrees to the south-east as proposed in optimum orientation degrees of buildings in temperate arid climate region (Figure 3.36).

Figure 3.36 Building orientation in ideal scenario for temperate arid region (Prepared by the Author)

The ideal distance between buildings identified for temperate arid climate region is 2H-3H (H: Obstacle building height) and this space has been provided for all buildings in the study area while developing the ideal design alternative (Figure3.37).

Figure 3.37 Distance between Buildings in ideal scenario for Temperate Arid Region (Prepared by the Author)

Deciduous trees in the south, east and west sides are used to block summer sun and allow winter sun, as suggested within the design criteria for temperate arid region. Moreover, evergreen trees are also used on north side to prevent and block unintended winder wind (Figure 3.38).

Figure 3.38 Vegetation for temperate arid region (Prepared by the Author)

Insulated and inclined roofs are suggested to be used in buildings in a temperate arid climate region. Besides, medium colors on roof surfaces are also advised so as to provide optimum benefit (Figure 3.39).

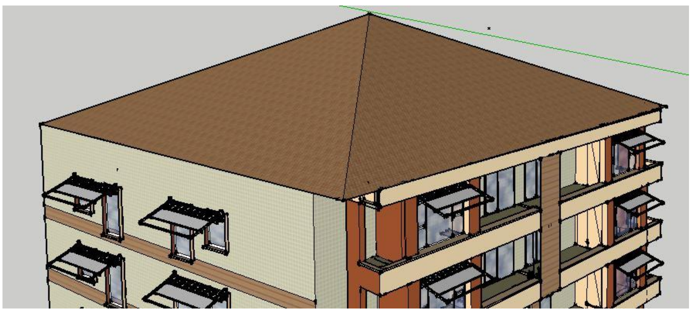


Figure 3.39 Building roof in ideal scenario for temperate arid region (Prepared by the Author)

Windows on the east and west facades should be smaller than the windows on the south facade because of the need to protect east-west side from direct solar gain and provide ventilation on south and north side for breezing. Also reduced openings on north side is desirable. These conditions have also been satisfied in ideal scenario developed for the study area (Figure 3.40).

Figure 3.40 Windows of buildings in ideal scenario for temperate arid region
(Prepared by the Author)

Providing an ideal situation in the study area, shading devices are also used for protecting direct solar heating in south, east and west sides of buildings in summer (Figure 3.41).

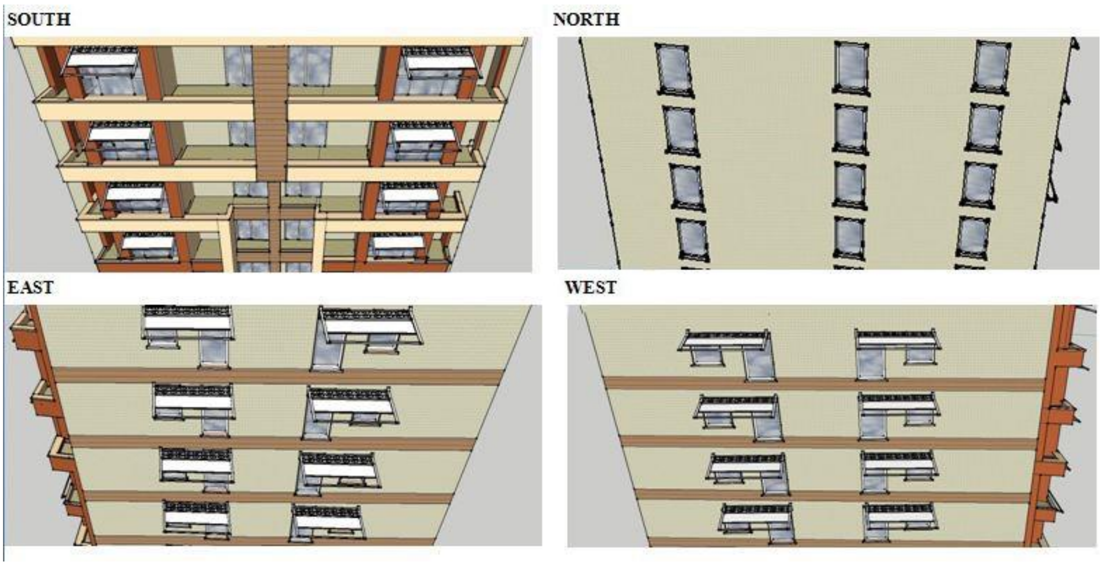


Figure 3.41: Windows in ideal scenario for temperate arid region (Prepared by the Author)

Because of the advantageous provided by medium color, buildings are suggested to be painted in medium colors in the study area. Dark colors are used only in recessed places protected from summer sun (Figure 3.42).

Figure 3.42 Color of a building in ideal scenario for temperate arid region (Prepared by the Author)

In ideal scenario for temperate arid region, solar access of buildings are ensured by providing an ideal distance between structures. To present solar access and shadowing situation of proposed buildings, Sketch Up programme has been utilized again and several three-dimensional views of proposed structures in the new arrangement have been generated based on real coordinates of the study area and on a real life situation of sunlight and shadow length by noon in December and noon in June.

Figure 3.43 Shadowing Situation by December 12.00 pm - View from top

(Prepared by the author)

Figure 3.44 Shadowing Situation by December 12.00 pm - View from southwest

(Prepared by the author)

Figure 3.45 Shadowing Situation by December 12.00 pm - View from southeast (Prepared by the Author

Figure 3.46 Shadowing Situation by June 12.00 pm - View from southeast (Prepared by the Author)

Figure 3.47 Shadowing Situation of by June 12.00 pm - View from southwest (Prepared by the author)

Figure 3.48: Shadowing Situation by June 12.00 pm - View from southeast (Prepared by the Author)

As it is seen from images given above, none of the building in the study area blocks the sunlight of other buildings thanks to the ideal distance between them.

To conclude, all of the climate sensitive and energy efficient design criteria for temperate arid region have been implemented in this scenario to make the study area more energy efficient compared to other scenarios. However, increase in building density has not provided in this scenario. Therefore, the financial problems in realization of the scenario is the most important shortcoming of the ideal solution.

3.5. ENERGY EFFICIENT AND CLIMATE SENSITIVE DESIGN ALTERNATIVES FOR THE STUDY AREA AS PER HOT HUMID CLIMATE REGION

3.5.1. THE REALIST SCENARIO THAT PRESERVES OWNERSHIP RIGHTS AND PARCEL LAYOUT

In this section, climate sensitive design criteria are applied for structures in a hot humid climatic region. The parcel layout is preserved and each building is redesigned in its own parcel by considering orientation and form according to energy and climate considerations. The alternative shows the suitability of existing ownership pattern for energy efficient design. Maximum floor areas of buildings arranged in this way appear as provided in Table 3.6.

Figure 3.49 The realist buildings that preserves ownership rights and parcel layout (Prepared by the Author)

Table 3.6 Floor Areas of Buildings in Ideal Scenario for Temperate Arid Region

Parcel	**Floor Area**	**Parcel**	**Floor Area**	**Parcel**	**Floor Area**	**Parcel**	**Floor Area**
1	475 m²	**14**	**33 m²**	**1**	**26 m²**	**10**	338 m²
2	149 m²	**15**	166 m²	**2**	**12m²**	**11**	343 m²
3	125 m²	**16**	172 m²	**3**	**12 m²**	**12**	156,5 m²
4	137 m²	**17**	168 m²	**4**	163 m²	**13**	150 m²
5	128 m²	**18**	119 m²	**5**	111 m²	**14**	255 m²
6	125 m²	**19**	119 m²	**6**	170 m²	**15**	262 m²
7	127,5 m²	**20**	118,5 m²	**7**	260 m²	**16**	**32,25 m²**
8	119 m²	**21**	147m²	**8**	258 m²	**17**	**32,25 m²**
9	122 m²	**22**	145 m²	**9**	318,5 m²		
10	245 m²	**23**	314,5 m²				
11	230 m²	**24**	**32,25 m²**				
12	155 m²	**25**	**34 m²**				
13	**32,25 m²**						
Total	**2580 m²**			**Total**	**2422 m²**		

When the table and the suggested climate-sensitive plan given above are analyzed, it is observed that the floor areas of some buildings are unsuitable for construction and use. Although there are some benefits of climate-sensitive arrangement preserving the parcel layout, there are also various obstacles and constraints that make this alternative difficult to apply.

Providing the orientation, form and distance related criteria that help increase the efficiency of energy use in buildings is the most important benefits of this scenario. As seen on Figure 3.4.6.1, all buildings in the area is oriented 3 degrees to the south-east, and form of all buildings is redesigned to be at the maximum size in the rage of 1:1.7 - 1:3 while orienting the longest facade to the south.

However, the preservation of the parcel layout causes various limitations or undeliverable criteria of energy efficient design. First of all, the ideal distance between buildings identified for hot humid climate (1 ½ - 2 ½ H) cannot be ensured for buildings located in parcels on eastern and western fronts. Secondly, floor areas of buildings have to be reduced because of compliance with 3 degrees orientation to south-east without changing the existing parcel layout and direction. Therefore, unintended consequence of this is that property rights cannot be fully met after such rearrangement.

Lastly, when buildings are made to meet the suggested "1:1.7-1:3" ratio without changing the existing parcel layout, new buildings are then required to have small floor areas, which make them unsuitable for practical use (for instance; floor areas of buildings in 13th and 14th parcels of Block No 2583 and floor areas of buildings in 2nd and 3rd parcels of Block No 2584).

Consequently, design criteria which are suitable for hot humid climate have been applied in this realist scenario to provide climate sensitive structures and to reduce energy consumption while preserving the number of parcels and ownership right. However, unsuitable outcomes have been observed regarding the arrangements to be made to increase energy efficiency in real life without changing the parcel layout. These constraints have to be handled and managed for a more fruitful design attempt. Therefore, it seems inevitable to make some changes to parcel layout in order to achieve a better design alternative or scenario. In new scenario, some alternatives based on some adjustments to the parcel layout are presented and discussed.

3.5.2 THE REFORMIST SCENARIO I THAT ADJUSTS THE PARCEL LAYOUT FOR HOT-HUMID CLIMATE REGION

For this scenario, first, the parcel layout will be rearranged based on the design criteria for hot humid regions so as to eliminate the constraints observed in the realist scenario and to increase the feasibility of the design alternative in real life. Because of adapting the existing parcel layout for hot humid climatic region, current parcels in study area have been rearranged by orienting them 3 degrees to the south-east based on the design criteria. The adapted parcel layout is presented in the following figure.

Figure 3.50 Reorganized Parcel Layout of the study area for hot humid region.
(Prepared by the Author)

Ownership right of each parcel is primarily aimed to be protected on its own. However, there are some parcels which may not be suitable for construction and for such parcels, amalgamation of land is suggested. This suggestion applies to existing parcels with a side length below 15 meters in order to meet the criteria of ideal climate-sensitive building construction. Therefore, parcels no 1, 2, 3, 16 and 17 have been merged in block no 2584. And block no 2583, parcels no 13, 14, 24 and 25 have been merged too. Consequently, the number of parcels in block no 2584 decreased from 17 to14, while the number of parcels in block no 2583 decreased from 25 to 23.

Following the slight adjustments to the parcel layout, energy efficient and climate sensitive design criteria for hot humid regions have been applied. In the course of this application, structures/buildings with maximum floor area are placed in each parcel by providing the setback distance specified in urban development legislation. Since floor areas of existing structures cannot be provided in some parcels in the adjusted parcel layout, ownership rights have been protected by increasing the floor numbers of buildings.

Figure 3.51 2D View of Proposed Energy Efficient Design Layout for Hot Humid Climatic Region (Prepared by Author)

Again, to test solar access and shadowing situation of proposed buildings, Sketch Up programme has been used and several three-dimensional views of proposed structures in the new layout have been generated based on real coordinates of study area and on the real life situation of sunlight and shadow length by noon in December.

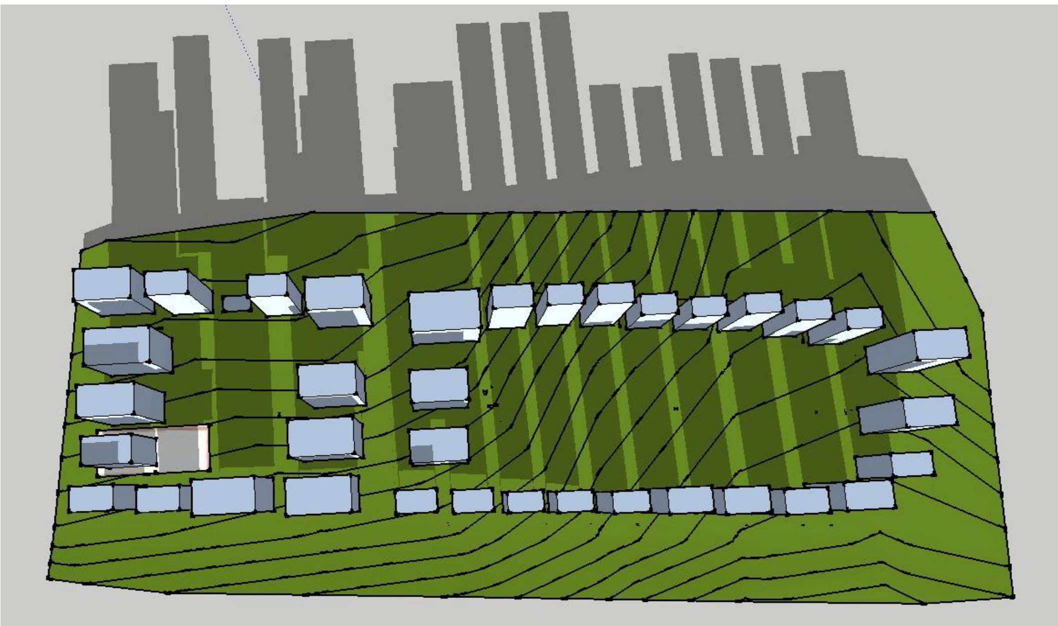


Figure 3.52 Shadowing Situations of Proposed Design by December 12.00 pm -
View from the top of proposed development area (Prepared by the Author)

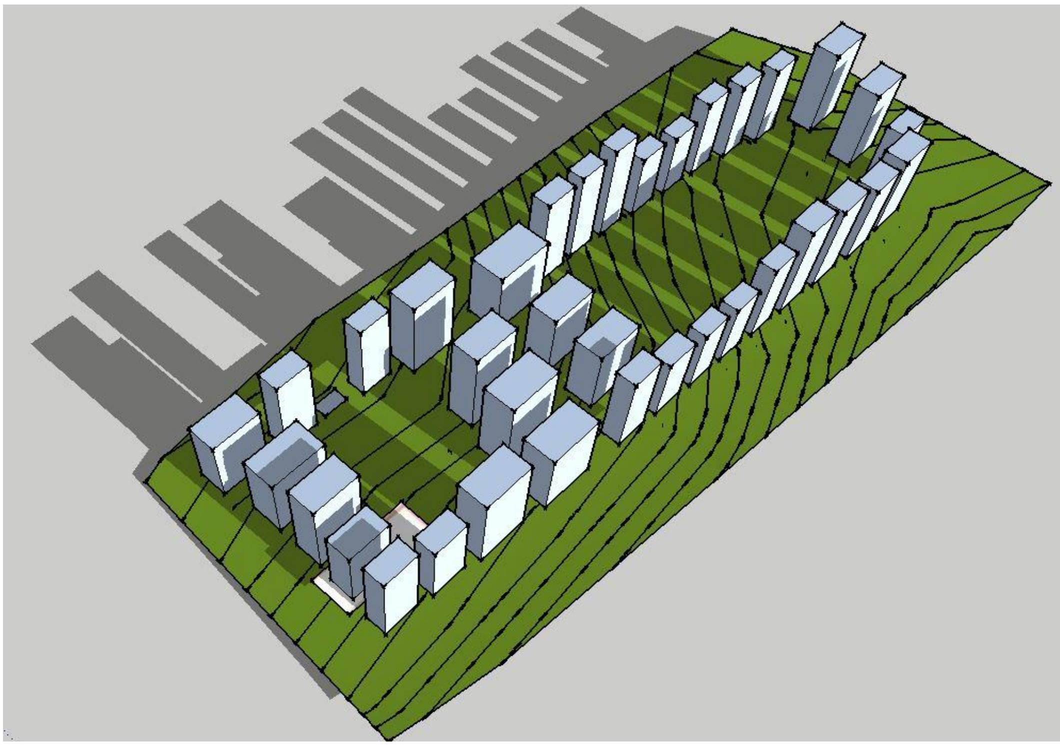


Figure 3.53 Shadowing Situations of Proposed Design by December12.00 pm -
View from the southwest of proposed development area (Prepared by the author)

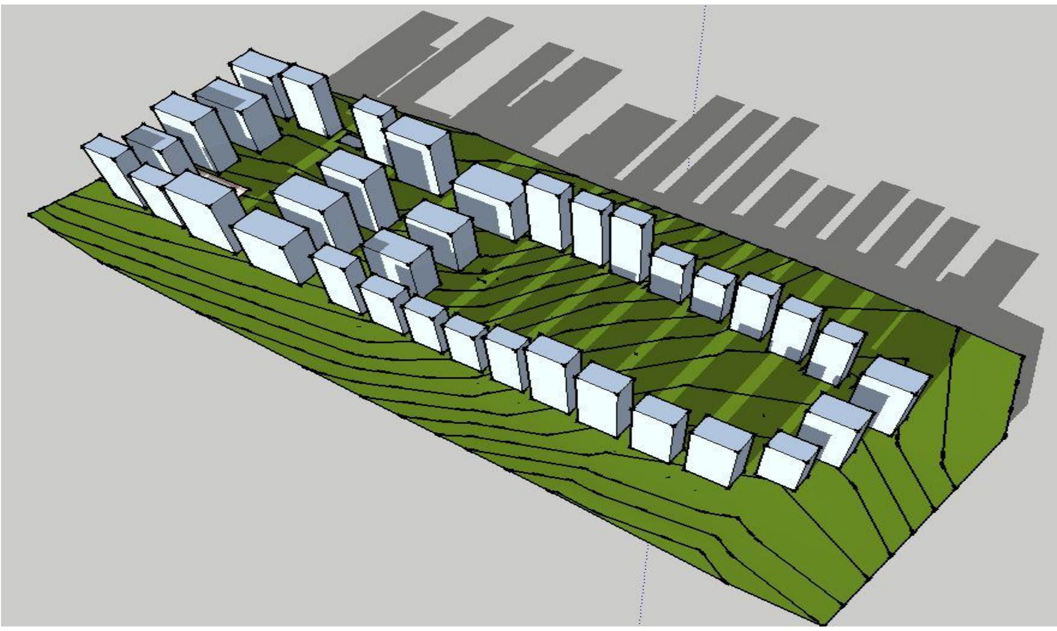


Figure 3.54 Shadowing Situations of Proposed Design by December, 12.00 pm–

View from the southeast of proposed development area (Prepared by the Author)

As concluded from images given above, buildings block the sunlight that would otherwise fall onto each other due to the limited distance between them and to the height of structures in the new arrangement. The major benefits delivered by this alternative are that buildings are oriented 3 degrees to south-east, and form of buildings is arranged to be at maximum size in the rage of 1:1.7-1:3, while orienting the longest front to the south. Therefore, criteria for orientation and form of buildings to make them more energy efficient could be satisfied here. However, various limitations, constraints or shortcomings as part of the realist scenario are not eliminated in reformist scenario I. The problems of providing the distance between structures suggested for hot humid climatic region (1 ½ - 2 ½ H) is not overcome in many parcels (especially the ones located on eastern and western fronts). Moreover, there are some buildings where required floor areas cannot be provided due to the structure of the block and parcel widths. Although the ownership rights have been attempted to be protected by increasing the floor numbers, this situation caused blocking of sunlight by structures in some parts of the block. Thirdly, new layout does not deliver ideal

results in terms of common area quality and design.
Last but not the least, increase in building density and development rights as a means to finance the required transformation is not recommended as is realist scenario.

The problematic section of the new layout, where most of the constraints mentioned above are observed, are presented in the following figure. Structures that are located within areas bordered with red lines have to be reconsidered in order to achieve a better design alternative and solutions.

Figure 3.55 The problematic area of Realist Scenario I (Prepared by the Author)

3.5.3 THE REFORMIST SCENARIO II THAT ADJUSTS THE PARCEL LAYOUT FOR HOT-HUMID CLIMATE REGION

In order to eliminate the shortcomings observed in the Reformist Scenario I, some partial changes have been made to parcel layout, as the first step of development of this new scenario. While distance criterion for hot humid regions to increase energy efficiency cannot be met, amalgamation of land is suggested for parcels. Therefore, all of the parcels have been merged differently in two blocks. The number of parcels decreased to 10 in block no 2583 and decreased to 6 in block no 2584 (Figure 3.56).

Also, existing parcels in the work area have been rearranged by being oriented 3 degrees to the south-east based on the design criteria for hot humid climatic region with the aim of increasing energy efficiency.

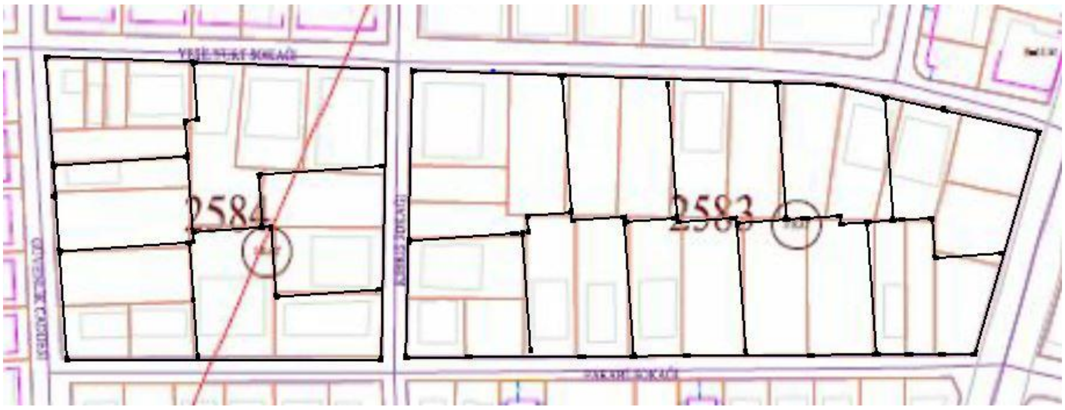


Figure 3.56 2D View of Proposed Energy Efficient Design Layout of the Reformist Scenario II (Prepared by the Author)

Figure 3.57 2D View of Proposed Energy Efficient Design Layout of the Reformist Scenario II (Prepared by the Author)

Table 3.7 Floor Area of Buildings in Realist Scenario

BLOCK NO 2583						BLOCK NO 2584		
Parcel	**Floor Area**	**Floor Number**	**Parcel**	**Floor Area**	**Floor Number**	**Parcel**	**Floor Area**	**Floor Number**
1	1125m²	5	**6**	680 m²	5	**1**	750m²	5
2	627 m²	6	**7**	734 m²	5	**2**	1210 m²	6
3	680 m²	4	**8**	738 m²	5	**3**	680 m²	5
4	666 m²	5	**9**	550 m²	4	**4**	360 m²	**10**
5	956 m²	5	**10**	808 m²	5	**5**	693 m²	5
						6	564 m²	5

Sketch Up programme has been used to test solar access and shadowing situation of proposed buildings, for three-dimensional drawing of structures in the new arrangement. Furthermore, coordinates of the work area have been entered to the programme, and the level of sunlight received and shadow length of the structures have been analyzed at noon in December.

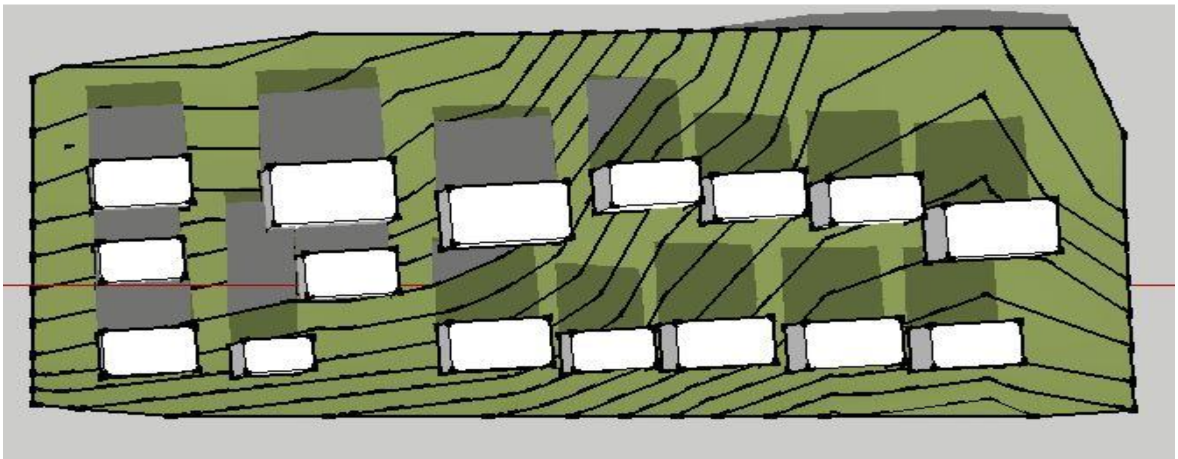


Figure 3.58 Shadowing Situations of Proposed Design by December 12.00 pm-
View from top of proposed development (Prepared by the Author)

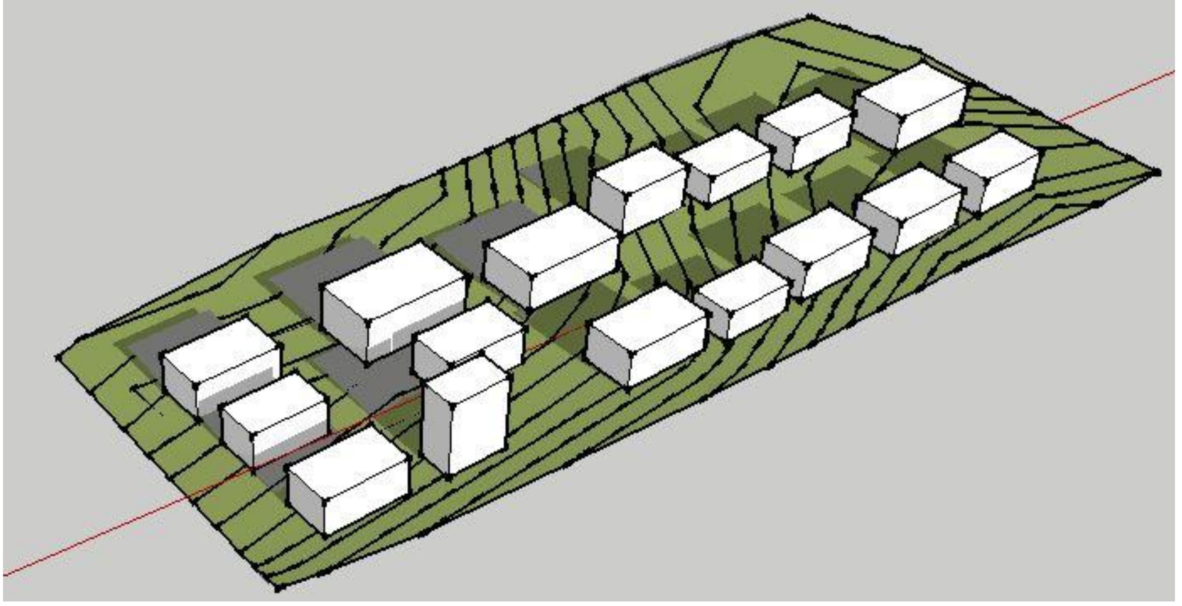


Figure 3.59 Shadowing Situations of Proposed Design by December 12.00 pm - View from the south west side of proposed development area (Prepared by the Author)

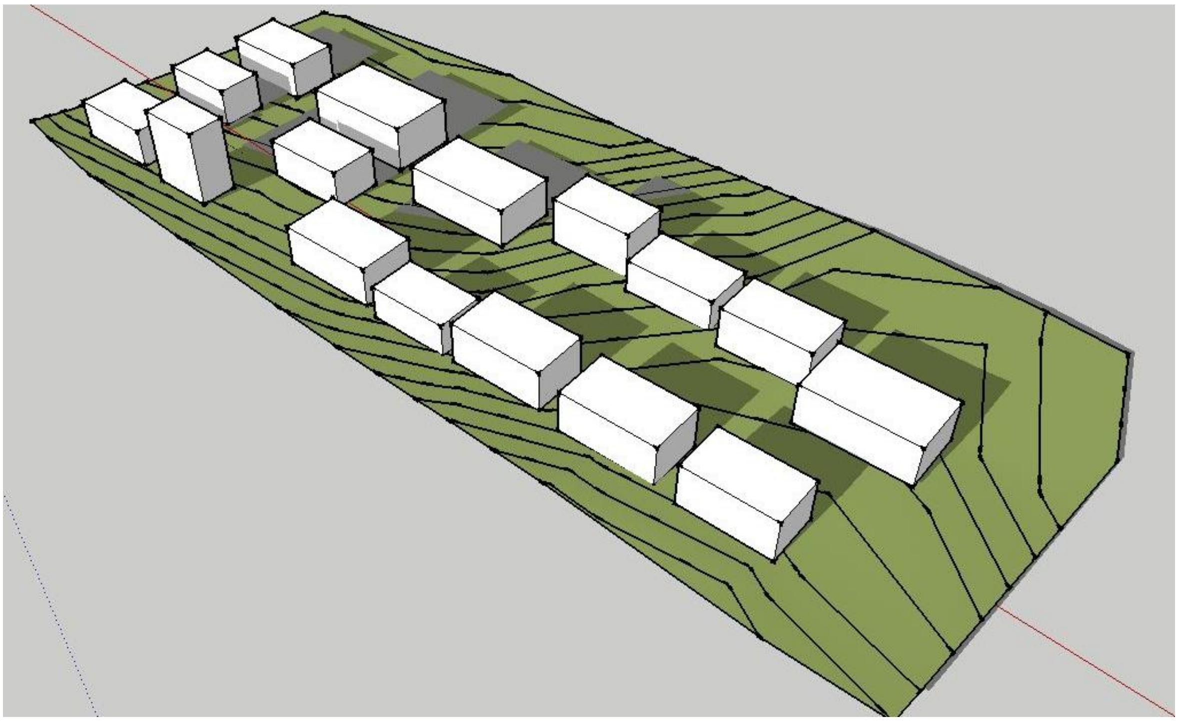


Figure 3.60 Shadowing Situations of Proposed Design by December 12.00 pm - View from the southeast side of proposed development area (Prepared by the Author)

The most obvious benefits delivered by the second reformist scenario are as follows:

- Distance between buildings suggested for hot humid climate to enhance energy efficiency has been ensured all parcels in block no 2583.

- Increase in energy efficiency has been ensured compared to the previously suggested activity in the study area.

On the other hand, there are still some important limitations, constraints and shortcomings of this second reformist scenario. These limitations or shortcomings could be determined as follows:

- While amalgamation of new parcels is suggested in order to eliminate the distance problem between structures in the previous scenario, the suggested criterion still cannot be met in all structures in block no 2584 because of physical conditions and ownership rights.
- Ownership rights are attempted to be protected with increase in floor numbers. Nevertheless, this situation caused blocking of sunlight by buildings in some parts of the block
- The new scenario does not deliver ideal results in terms of common area quality and design to the identified criteria and the will to keep ownership rights and statuses as they are. Increase in building density and development rights as a means to finance the required transformation is not recommended. In such cases, substantial compromises have to be made from the goal of achieving and ensuring energy efficiency and climate sensitiveness.

As it seen the reformist scenario has not been overcome all problems of the first reformist scenario, some problems still prevail. The figure given below presents the major problematic areas within the blocks, where most of the shortcoming mentioned above take place. Because of overcoming problems and shortcomings, an ideal case scenario will be developed, where current situation with regard to parcel layout and ownership patterns are not preserved. An ideal option will be presented and discussed in next part.

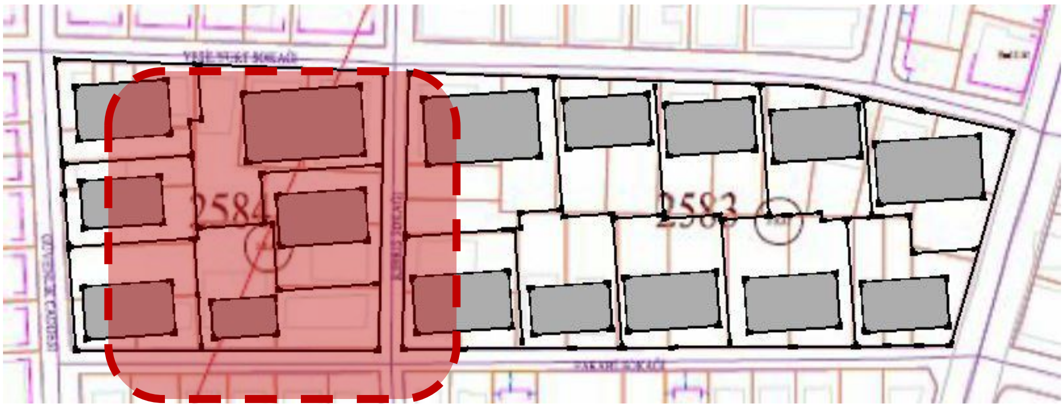


Figure 3.61 The problematic area of reformist scenario II (Prepared by the Author)

3.4.5. THE IDEAL SCENARIO TO INCREASE ENERGY EFFICIENCY IN TEMPERATE ARID CLIMATE REGION

The realist and reformist scenarios in the study area have been developed and outcomes of them have been discussed in the previous section based on climate sensitive design criteria for hot humid region and considering the existing parcel layout and ownership patterns. However, some important shortcomings and constraints were observed and these shortcomings make it difficult to fully provide the climate sensitive and energy efficient design conditions. In this section, an ideal scenario will be developed as a solution to eliminate the shortcomings observed and to provide optimum energy efficient and climate sensitive conditions for a hot humid region. The parcel layout and ownership patterns are not paid much attention in the ideal design alternative. Only the total building area is preserved.

The ideal design alternative will be developed based on the determined climate sensitive and energy efficient design criteria. In the following parts, first of all, the ideal plan and general design outputs will be presented. Then, it is aimed to show and discuss the implemented design criteria one by one on an individual basis. Lastly, shadowing situations by noon in December and June are presented to indicate the optimum solar access of buildings in ideal scenario for hot humid climate region. Maximum floor areas in ideal scenario are as in Table 3.8.

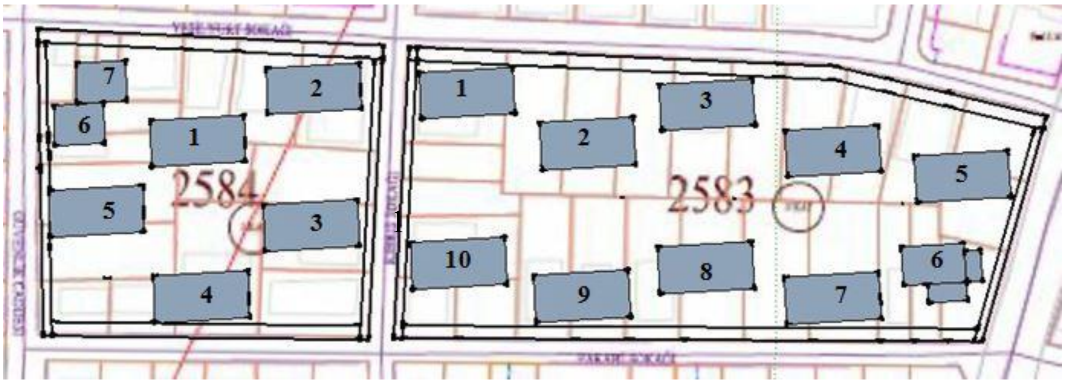


Figure 3.62 2D View of Proposed Energy Efficient and Climate Sensitive Design Layout of the Ideal Scenario (Source: Prepared by the Author)

Table 3.8 Floor Area of Buildings in Ideal Scenario for Hot Humid Region

BLOCK NO 2583				BLOCK NO 2584			
Building No	**Floor Area**	**Number of Floor**	**Total Building Area**	**Building No**	**Floor Area**	**Number of Floor**	**Total Building Area**
1	680 m^2	7	14.960 m^2	**1**	680 m^2	7	14.960 m^2
2	680 m^2	7	14.960 m^2	**2**	680 m^{22}	7	14.960 m^2
3	680 m^2	7	14.960 m^2	**3**	680 m^{22}	6	12.920 m^2
4	680 m^2	7	14.960 m^2	**4**	440 m^2	6	12.920 m^2
5	680 m^2	7	14.960 m^2	**5**	440 m^2	6	12.920 m^2
6	920 m^2	4	11.960m^2	**6**	310 m^2	3	3100 m^2
7	680 m^2	4	12.920 m^2	**7**	310 m^2	3	3100 m^2
8	680 m^2	6	12.920 m^2				
9	680 m^2	6	12.920 m^2				
10	680 m^2	6	12.920 m^2				
Total	**138.440**			**Total**	**74.880**		

South Side

North Side

East Side

West Side

Figure 3.63 3D Views of Proposed Energy Efficient and Climate Sensitive Design Layout of the Ideal Scenario for Hot Humid Climate (Prepared by the Author, extended versions of the images are provided in appendix)

Individual, freely elongated and high building types are used in the ideal scenario as one of the major design criteria for hot humid climate region (Figure 3.64).

Figure 3.64 Housing types in ideal scenario for Hot Humid Region (Prepared by the Author)

Strong radiation effect on the E and W sides should dictate the form of buildings to a slender elongation. The shape range of an ideal form is 1:1.7 on the East-West axis, which is in the suggested optimum range from 1:1.7 to 1:3 for hot humid region (Figure 3.65).

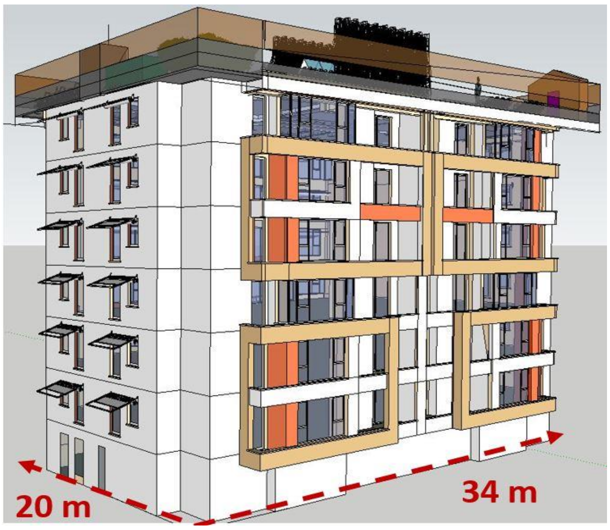


Figure 3.65 Form and Volume in ideal scenario for Hot Humid Region (Prepared by the Author)

All buildings in the area is oriented 3 degrees to the south-east as proposed in term of optimum orientation degrees for hot-humid region (Figure 3.66).

Figure 3.66 Orientation in ideal scenario for Hot Humid Region (Prepared by the Author)

The ideal distance between the structures identified for hot humid climate region which is 1 ½H - 2 ½ H (H: Obstacle building height) is provided for the all buildings in the study area (Figure 3.67).

Figure 3.67 Distance between Buildings in ideal scenario for Hot Humid Region (Prepared by the Author)

Deciduous trees are used in the south, east and west sides to block summer sun and allow winter sun as suggested criteria for hot humid region. Moreover, evergreen trees are used on north side to prevent and block unintended winder wind.

Figure 3.68 Vegetation in ideal scenario for Hot Humid Region (Prepared by the Author)

Insulated and ventilated roof are preferable for hot humid climate region. Therefore, Green roof is used in ideal scenario for hot humid region because vegetation is a good radiation absorbent (Figure 3.69).

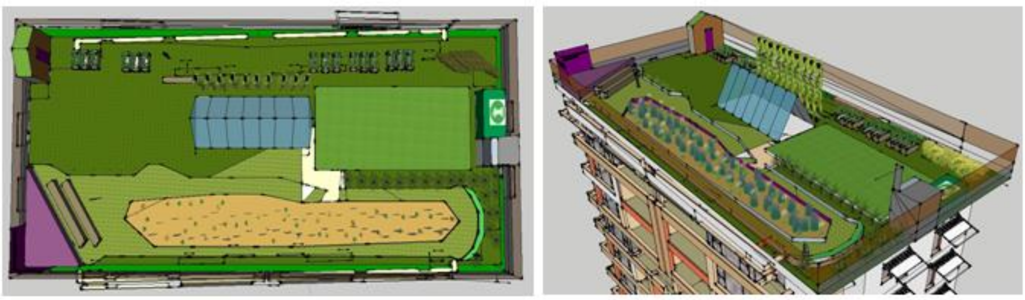


Figure 3.69 Roof types in ideal scenario for Hot Humid Region (Prepared by the Author)

Windows on the east and west facades are smaller than the windows on the south facade because of protecting east-west side from the direct solar gain and provide ventilation on south and north side for breezing. These conditions have also been satisfied in ideal scenario developed for the study area (Figure 3.70).

Figure 3.70 Windows in ideal scenario for Hot Humid Region (Prepared by the Author)

Blocking solar access and preventing undesirable solar gain are the most important shading aims in summer for hot humid region. Therefore, shading devices are used for protecting direct solar heating in south, east and west sides of buildings in summer (Figure 3.71).

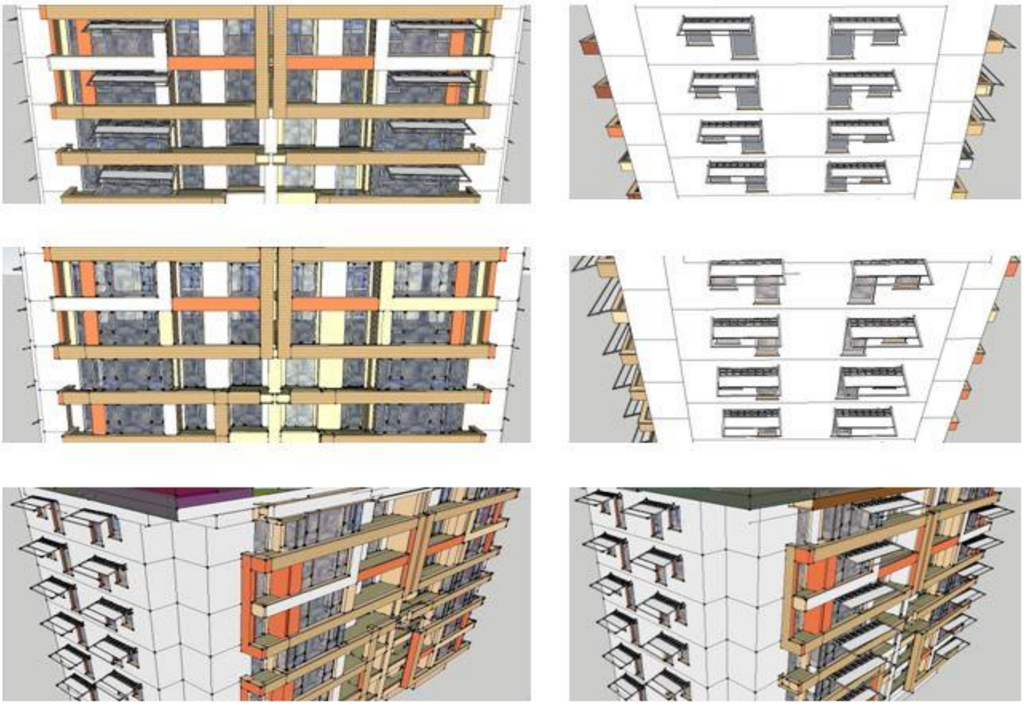


Figure 3.71 Shadowing Devices in ideal scenario for Hot Humid Region (Prepared by the Author)

Reflective light colors in the pastel range are used in order to reduce solar gain and avoid glare for hot humid region (Figure 3.72).

Figure 3.72 Colors in ideal scenario for Temperate Arid Region (Prepared by the Author)

In ideal scenario for temperate arid region, solar access of the buildings are ensured by the providing an ideal distance between the structures. To present solar access and shadowing situation of proposed buildings in ideal scenario, Sketch Up programme has been utilized and several three-dimensional views of proposed structures in the new arrangement have been generated based on real coordinates of study area and on the real life situation of sunlight and shadow length by noon in December and noon in June.

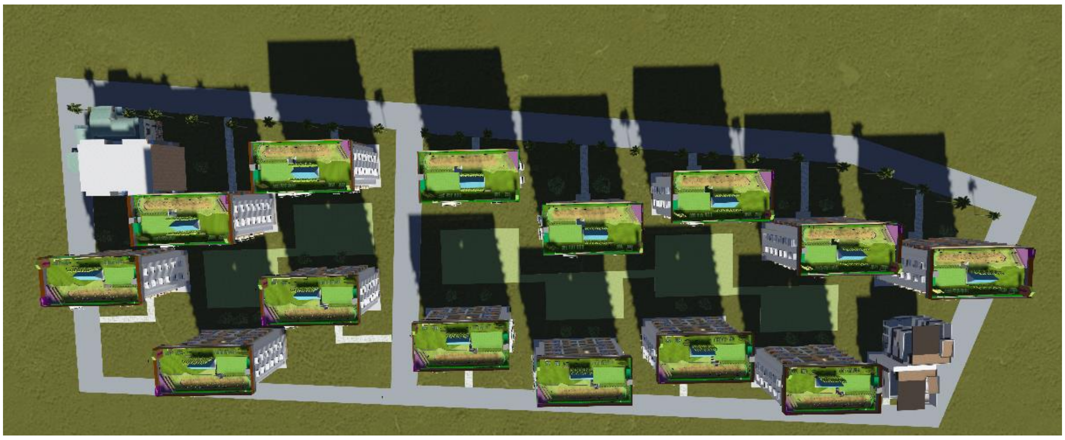


Figure 3.73 Shadowing Situations by December 12.00 pm- View from top of proposed development (Prepared by the Author)

Figure 3.74 Shadowing Situations by December 12.00 pm- View from southeast of proposed development (Prepared by the author)

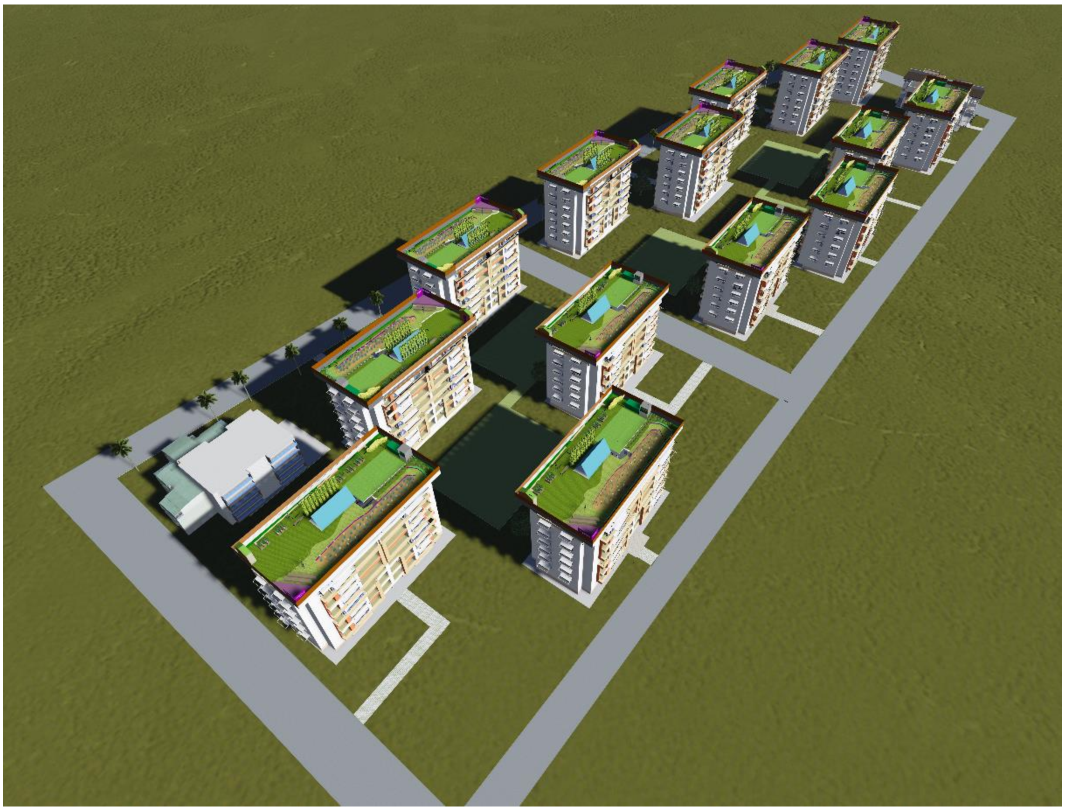


Figure 3.75 Shadowing Situations by December12.00 pm - View from the south west side of proposed development area (Prepared by the author)

Figure 3.76 Shadowing Situations by June 12.00 pm - View from the top of proposed development area (Prepared by the Author)

Figure 3.77 Shadowing Situations by June 12.00 pm - View from the south west side of proposed development area (Prepared by the author)

Figure 3.78 Shadowing Situations by June 12.00 pm - View from the southeast side of proposed development area (Prepared by the Author)

As it is seen from images given above, none of the buildings in the study area has not block the sunlight of others in the ideal scenario because of realizing the ideal climate responsive criteria such as ideal distance between them.

As a result, because of the realizing all of the climate sensitive design criteria that is provided for hot humid region, the study area is more energy efficient in this scenario than other scenarios. However, increase in building density has not provided. Therefore, the financial problems in realization of the scenario is the most important shortcoming of proposal.

CHAPTER 4

CONCLUSION

4.1 A BRIEF SUMMARY OF FINDINGS

Climate change and global warming are among the most important environmental and social problems of our age. Environmental problems which are caused by rapidly developing urbanization and industrialization processes following the industrial revolution have almost irreversibly damaged the ecological balance in the nature. In the traditional planning and architecture initiatives climatic impacts and factors have been taken into consideration with the aim of developing measures and solutions against the impacts of external environment. Methods of creating spaces that are protected against or benefiting from the solar radiation or wind depending on local needs have always been primarily concern. However, due to rapidly growing population and its pressing requirements, climatic and environmental factors in urbanization started to be disregarded. This situation has led to emergence of urban layouts that are weak in terms of benefiting from sunlight and wind, incompatible with climatic factors and consuming ever increasing energy.

Reducing the pressure and damage of urban areas on the natural environment and ecology is one of the most important environmental and social concerns of our age. Urban settlements and buildings play a significant role in energy consumption, and this situation proves the need for developing practices that increase energy efficiency. In this study, climate-sensitive design parameters that increase energy efficiency have been investigated in order to reduce the impacts of urban areas and buildings on the natural environment, to reduce the amount of energy consumed, and to help converse the natural ecosystem. It is known that urban and architectural design parameters that compliant with climatic factors play a crucial role in increasing energy efficiency.

As a result of the literature review, energy efficient and climate-sensitive design parameters that are used to increase energy efficiency and the relationships between these two sets of parameters are summarised in the table below.

Energy Efficient Design Parameters **Climate Sensitive Design Parameters**

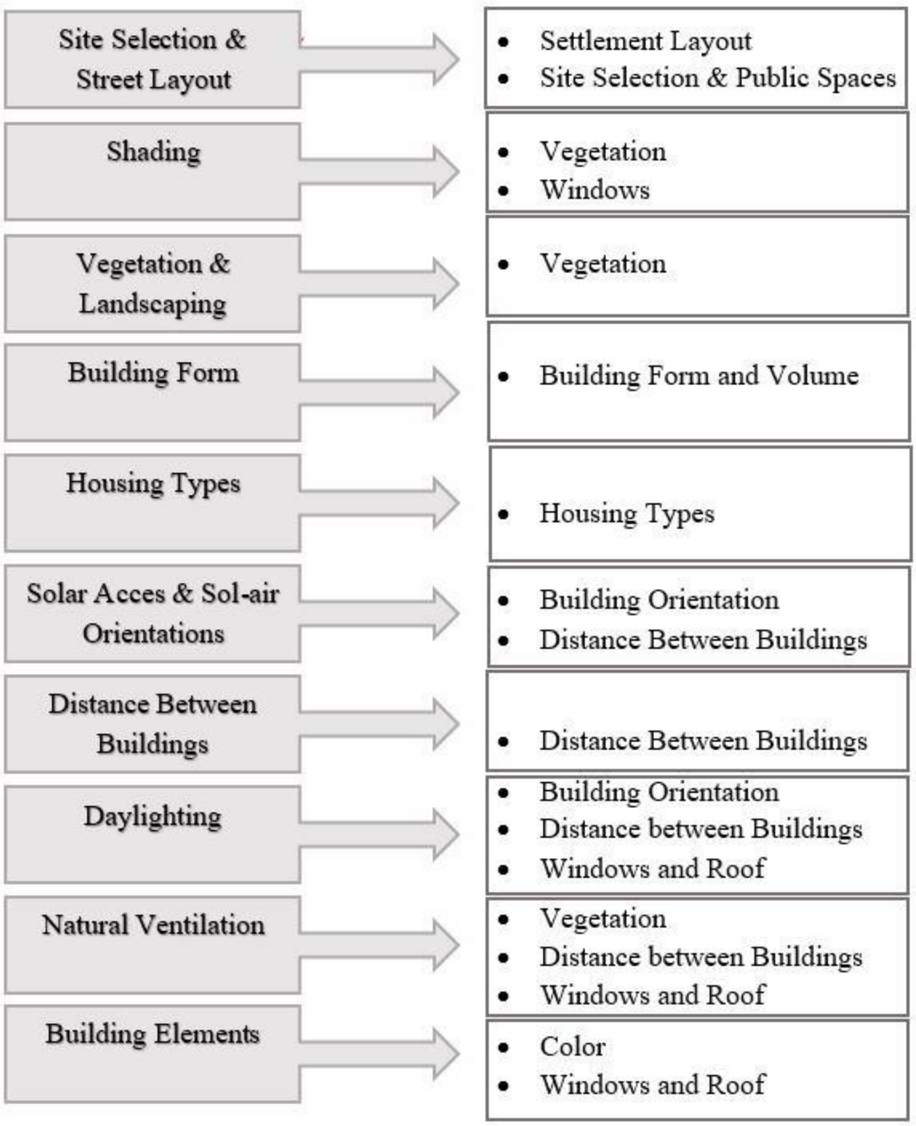


Figure 4.1 Energy efficient and Climate Sensitive Design Parameters (Prepared by Author)

As seen in Figure 4.1, there is a close relationship between energy efficient and climate-sensitive design parameters/sets. However, it is obvious that climate-sensitive design parameters include more detailed and specific criteria which helped and guide planners and designers in developing design alternatives.

The empirical research of the thesis focused on two city blocks located on Farabi Street in Çankaya District of Ankara Province are selected as the case study area. The area is characterised by an apartment layout with fragmental property ownership pattern which is the most common selected inner-city residential layout in Turkish cities. Since the case study area is selected within Ankara city, energy efficiency and climate-sensitivity of the existing situation are analysed according to the design parameters identified for temperate arid climatic zone. In temperate arid climatic zones, urban design attempts should aim to obtain the maximum benefit from sunlight and to be protected from wind in order to conserve the internal energy of buildings and prevent heat loss in cold seasons while targeting for benefitting from the wind and protecting from sunlight to reduce the energy consumption for indoor cooling during hot seasons. The results of the analysis of the current situation in the case study area obtained are presented in the table below.

Table 4.1 Assessment of the Current Situation of Case Study Area in Energy Efficient and Climate Sensitive Design Parameters

Climate Sensitive Design Parameters	**Recommended Design Parameters for Temperate Arid Climatic Region**	**Current Situation of Case Study Area**	**Suitability Assessment**
Settlement Layout	Compact layouts, Medium-intensive closed bulks	Medium density level Closed and compact layout	Applicable
Site Selection and Public Spaces	South-eastern sides of slope	Located and oriented south to north inclined site	Not applicable
Housing Types	Compact buildings, Close relation between buildings and nature	Various housing types (Medium and small size Attached and Detached)	Not applicable

Table 4.1 Assesment of the Current Situation of Case Study Area in Energy Efficient and Climate Sensitive Design Parameters (Continued)

Climate Sensitive Design Parameters	Recommended Design Parameters for Temperate Arid Climatic Region	Current Situation of Case Study Area	Suitability Assessment
Building Form and Volume	Buildings with 1:1,1 or 1:1,3 proportions elongated on east-west axis	Mostly oriented to north-south direction.	Not applicable
Building Orientation	Optimum sun orientation lies 27º East of South.	Orientation lies between 0 º -10 º West of South	Not applicable
Distance Between Buildings	2H - 3 H in the direction of North-South	Larger or smaller than recommended distance	Not applicable
Color	Medium colours	Different building colors from each other	Not applicable
Windows and Roof	Small size on east, west side southern facade. Minimum size on northern facade An inclined-insulated roof	Similar (not differentiated) size on each facade	Not applicable
Vegetation	Shrubs in the south, Evergreen in the north. Tree species in the east west	Various trees, shrubs and groundcover plants	Applicable

As seen in the table above, it has been identified that the case study area does not fully meet almost any of the required energy efficient design parameters at present.

Three design scenarios, namely realistic, reformist and ideal situation have been developed for temperate arid climatic zone and hot humid climatic zone, which is the opposite of the temperate arid zone, with the aim of identifying possible arrangements and practices that can be realized through energy efficient and climate-sensitive design parameters in case of transformation of the selected area. Results of the three scenarios developed are summarized in the table below.

Table 4.2 An Assessment of Recommended Design Scenarios

	Recommended Scenario	Design Properties	Benefits	Constraints & Shortcomings
Temperate-Arid Climatic Region	**The Realist Scenario**	Preserving Ownership Rights and Parcel Layout Strictly	Ensuring of the orientation and form-related criteria	Fail to distance between buildings Unsuitable floor areas for construction. Blocking of sunlight by buildings Low quality of common area and design
	The Reformist Scenario I	Slight adjustments to Parcel Layout, while Preserving the Ownership Rights	Ensuring of the orientation and form-related criteria	Fail to distance between buildings Unsuitable floor areas of building Blocking of sunlight by structures Low quality of common area and design
	The Reformist Scenario II	Partial changes to parcel layout while preserving the Ownership Rights Change of the functions of some buildings	Ensuring of the orientation and form related criteria Increase in energy efficiency compared to the previous scenario	Fail to distance between buildings Blocking of sunlight by structures Low quality of common area and design
	The İdeal Scenario	Changes to parcel layout and ownership patterns Consolidation of land	Ensuring all of the design criteria High energy efficiency and climate sensitivity	Quality of common area and design

Table 4.2 An Assessment of Recommended Design Scenarios (Continued)

	Recommended Scenario	Design Properties	Benefits	Constraints & Shortcomings
Hot-Humid Climatic Region	The Realist Scenario for	Preserving Ownership Rights and Parcel Layout	Ensuring of the orientation and form related criteria	Fail to distance between buildings Unsuitable floor areas of building Blocking of sunlight by structures Low quality of common area and design
	The Reformist Scenario I	Adjust the Parcel Layout Preserving Ownership Rights	Ensuring of the orientation and form related criteria	Fail to distance between buildings Unsuitable floor areas of building Blocking of sunlight by structures Low quality of common area and design
	The Reformist Scenario II	Partial changing to parcel layout Preserving Ownership Rights	Ensuring of the orientation and form related criteria Increase in energy efficiency compared to the previous scenario	Fail to distance between buildings Blocking of sunlight by structures Low quality of common area and design
	The İdeal Scenario	Changing parcel layout and ownership patterns Amalgamation of land	Ensuring all of the design criteria High Energy efficiency and climate sensitivity	Quality of common area and design

The alternative design scenarios that were developed with the aim of implementing climate-sensitive and energy efficient design parameters brought about significant results for possible urban transformation of the study area. The results are presented as follows:

In realist scenarios, criterias that are related to solar orientation and optimum building form have been ensured. Therefore, it is possible to say that energy efficiency of areas was increased in realist scenarios compared to the current situation. However, due to protection of existing parcel layout and ownership rights, even though this situation ensures easy implementation, the problem related to blocking of sunlight by buildings is faced, since optimum distance criterion between buildings cannot be met. As this is an undesired situation in terms of energy efficiency, it also constitutes an obstacle for realization of energy efficient and climate-sensitive transformation in the study area. Furthermore, when buildings are designed according to orientation angles and floor distances without implementing a new parcel layout, undesired outcomes such as buildings with quite small impractical floor areas are obtained due to the unconformity of existing parcel layout. Considering all these shortcomings, desired outcomes in terms of energy efficient and climate-sensitive design layout cannot be obtained during the redevelopment study of the area by means of realistic scenarios.

Since targeted energy efficient and climate-sensitive redevelopment cannot be achieved in realistic scenarios, parcel layout is rearranged and consolidation of certain parcels is suggested in the reformist scenarios. However, new arrangements are found insufficient to remedy the shortcomings of the previous scenario. Even though solar orientation and optimum building form criteria are met in this scenario, optimum distance criterion between buildings cannot be met in the study area; increase in floor numbers is suggested with smaller floor areas than the existing situation in order to protect the ownership rights; but this time the problem of blocking of sunlight by buildings cannot be solved in the city block. Consequently, suggested criteria for energy efficient and climate-sensitive design in both realistic and reformist scenarios cannot be wholly met, and ideal and analytical results in terms of common space design cannot be obtained.

The ideal scenarios are developed in order to eliminate the shortcomings and undesired results observed in realistic and reformist scenarios that adhered to the existing parcel layout and ownership patterns. In the ideal scenario, parcel layout and ownership patterns have been changed but ownership rights and number of properties have been protected. The identified design parameters are demonstrated in practice step by step. These scenarios are presented as a model showing how a transformation model, where energy efficient and climate-sensitive design parameters are implemented as a whole, should be in order to reflect the real aim of the study.

However, there are certain challenges which are common in all scenarios for redevelopment of existing city blocks and buildings with energy efficient and climate sensitive design criterias. And this challenges can not be solved with current urban redevelopment systems and practices.

Since it was identified in the primarily suggested realistic and reformist scenarios that the energy efficient and climate-sensitive design criteria cannot be met without changing the existing parcel layout, ownership patterns and ownership rights, how to realize changes in ownership rights and parcel layout, how to bring owners together and how to arrange the legal framework appear to be serious problems. Since the real aim of the study is to realize transformation with climate-sensitive design parameters to increase energy efficiency, these criteria are met by protecting the current density level. Increase in density level is not suggested as it would cause compromises in many design criteria and undesired outcomes in terms of energy efficiency. In this case, the problem on how to cover the financial and economic requirements of urban redevelopment appears to be an important concern for local and central governments in Turkey.

When existing housing practices and urban transformation policies in Turkey are considered, it could be maintained that policies taking climate factors into account, aiming to increase energy efficiency and having a high level of sanction power in urban design are not adequately involved in the legal framework and legislation. Lack of policies encouraging or guiding actors for an energy efficient transformation and low level of awareness have been identified as important obstacles and shortcomings regarding the realization of such a transformation.

In this study, the design aspect of urban redevelopment is discussed in terms of energy efficiency and climate sensitivity and several design proposals have been developed and recommended. The climatic conditions of the study area were prioritized as the key element to lead the design proposals. However, each city or even inner city area have their unique and specific characteristics and situation in terms of cultural, environmental and socio-spatial patterns as well as associated spatial problems. In the design and development processes of urban space, social, cultural, economic, historical and spatial values of the localities should be considered as a whole. Urban identity, local, traditional and architectural patterns should be conserved to the extent possible. The design implementations should bring the local features into the forefront. Environmental and climatic conditions and local spatial patterns should be evaluated together. According to settlement pattern and local values of the urban areas, specific, original and effective solutions should be developed not only to solve urban problems but also to meet the particular needs of residents, rather than proposing similar or even uniform solutions for many places.

4.2 RECOMMENDED POLICIES

As a result of this research, some policy implications are suggested so as to eliminate the obstacles on the way of energy efficient and climate-sensitive urban design practices in Turkey. These policy implications will also help plan and design energy efficient and climate-sensitive urban quarters and buildings through urban transformation projects. The policy implications are listed as follows:

- Legal frameworks and legislations related to urbanization and housing should be rearranged in a way to make energy efficiency and climate sensitivity one of the basic aims of urban redevelopment.
- Energy efficiency should be one of the main aims in the preparation of master plans, and climate factors and climatic needs of the area to be planned should certainly be taken into consideration.

- A strong relation should be established with urban transformation and energy efficiency, and these two concepts should be evaluated together. Authorities responsible for urban transformation should update and amend the transformation policy and practices by taking energy efficient and climate-sensitive planning and design approaches as the basis.
- During transformation of inner city settlement areas, mechanism and means to protect and rearrange ownership rights should be developed. Ownership rights should be handled and arranged as a whole such as consolidation decision within city blocks.
- Financial incentives should be developed for stakeholders and actors (users, designers, implementing bodies) planning to realize energy-efficient and climate sensitive transformation with governmental support such as exemption from tax or credit supply with low interest rates.
- Buildings designed in line with energy efficient and climate-sensitive design criteria should be properly audited by authorized institutions with a power of sanction during the project, implementation and post-implementation periods.
- In order to improve the studies conducted on energy efficient and climate-sensitive planning and design, public sector, private sector, universities and non-governmental organizations should be encouraged to produce joint projects in cooperation; and also, cooperation with international institutions should be ensured and exemplary international projects should be analysed.
- In Turkey, various regulations and standards related to energy efficiency have been developed such as the regulation on energy performance of the buildings. However, most of these are limited with decisions on insulation of buildings, and they do not have an adequate compliance power and mechanism. These arrangements should be revised and their scope should be expanded in terms of energy efficiency in urban planning and design.

- Activities should be carried out to raise awareness of decision-makers in public institutions and organizations, local governments, private sector, owners and public on the importance and requirement of energy efficient and climate-sensitive design and related benefits to be obtained. The cost of energy efficient housing and urbanization, their contribution to the health and budget of the users and their impacts on elimination of environmental problems such as global warming and climate change should be explained in detail.

Consequently, energy efficient and climate-sensitive design should be considered as a solution to reduce energy consumption emerging with industrialization and urbanization processes, gradually increasing with irregular and unplanned urbanization and housing and causing many environmental and social problems, and it should be handled as a primary aim in urban policy-making and planning processes. In Turkey, where transformation of 6.5 million houses is planned in the near future, as suggested by certain relevant experts, urban transformation projects can be seen as an opportunity. However, in order not to waste this opportunity, energy efficient and climate sensitive design concepts should be integrated into policy and legal frameworks that shape urban transformation projects.

REFERENCES

Akkar, M. (2006) Kentsel Dönüşüm Üzerine Batıdaki Kavramlar, Tanımlar, Süreçler ve Türkiye, TMMOB Şehir Plancıları Odası Yayını, ISSN: 1300-7319, No: 36, 2006/2, pp. 29-39

Akşit, F. (2005). Türkiye'nin Farklı İklim Bölgelerinde Enerji Etkin Bina veYerleşme Birimi Tasarımı. *Tasarım Dergisi*, 157, 124-127.

Ashford, P. (1999) The Cost Implications of Energy Efficiency Measures in the Reduction of Carbon Dioxide Emissions from European Building Stock, EuroACE, Brussels.

Awano, H. (2005) Towards Sustainable Use of Buildings Stock: Final Synthesis Report, OECD, Paris.

Ayan, M. (1985). Konut Alanları Tasarım İlkeleri. *Batıkent Konut Üretim Kooperatifleri Birliği*, 52 (6), 51-70.

Balaban, O., & Puppim de Oliveira, J. A. (2014) Understanding the links between urban regeneration and climate-friendly urban development: lessons from two case studies in Japan, Local Environment, 19:8, 868-890, DOI: 10.1080/13549839.2013.798634. Retrieved June 25, 2016, from http://dx.doi.org/10.1080/13549839.2013.798634

Barry, G. R., & Hall-McKim, E. A. (2014) *Essentials of the Earth's Climate System.* United Kingdom: Cambridge University Press

Berköz, E., Aygün, Y. Z., Kocaaslan, G., Yıldız, E., Ak, F., Küçükdoğu, M., Enarun, D., Ünver, R., Yener, K.A. ve Yıldız, D., (1995). *Enerji Etkin Konut ve Yerleşme Tasarımı,* (Tübitak Proje No: İntag 201). İstanbul.

Bölük, G., Mert, M., (2015), The Renewable Energy, Growth and Environmental Kuznets Curve in Turkey: An ARDL Approach, Renewable and Sustainable Energy Reviews, 52, 587595. (SSCI-A).

Central Public Works Department. (2013). *Integrated Green Design for Urban & Rural Buildings in Hot-Dry Climate Zone*. Retrived in 16 July 2016, http://cpwd.gov.in/Publication/IGDBooklet.PDF.

Cook, J. (1991). Searching for the Bioclimatic City. S. Alvarez et al. (Eds.), *In Architecture and Urban Space*, (7-16). Dordrecht: Kluwer Academic Publishers.

Colombo, R., Landabaso, A., & Sevilla, A. (1994). *Passive Solar Architecture for Mediterranean Area Design Handbook*. Commission of the Europen Communities: Joint Research Centre.

Critchfield, H. J. (1974). *General Climatology*. New Jersey: Prentice-Ha

DARA (2012) Climate Vulnerability Monitor: A guide to the cold calculus of a hot planet, 2nd ed.

Demirbilek, N.F. (2001). *Güneş Mimarlığı*. Ankara: Temiz Enerji Vakfı Yayınları.

Diesendorf, M. (2014). *Sustainable Energy Solutions for climate chance*: Routledge

Djukic, A., Vukmirovic, M. and Stankovic. S. (2015). Principles of climate sensitive urban design analysis in identification of suitable urban design proposals. Case study: Central zone of Leskovac competition. *Elsevier, 115,* 23-35. Retrieved July 20, 2016, from http://www.sciencedirect.com/ science/article /pii /S0378778815002753.

Düzgün, B., & Kömürgöz, G. (2014). Turkey's energy efficiency assessment: White Certificates Systems and their applicability in Turkey", Energy Policy 65, 465-474, Turkey

Elsland, R., Schlomann, B., & Eichhammer,W. (2014). Is Enough Electricity Being Saved? Impact of Energy Efficiency Policies Addressing Electrical Household Appliances in Germany Until 2030, ECEEE 2013 Summer Study on Energy Efficiency. Hyères.

Elsland, R., Divrak, C., Fleiter, t., & Wietschel, M. (2014). Turkey's Strategic Energy Efficiency Plan – An ex ante impact assessment of the residential sector, Energy Policy 70, 14-29, Germany.

Errel, E., Pearlmutter, D., & Williamson, T. (2011) *Urban Microclimate: Design the Spaces Between Buildings*. London: Earthscan Ltd

EUROSTAT. (2013). Statistical Office of the European Union European Commission Statistics ⟨http://epp.eurostat.e c. europa.eu/portal/page/portal /eurostat/home⟩ (1-3-2013).

Gauzin-Müller, D. (2002). *Sustainable Architecture and Urbanism*. Basel; Berlin; Bostan: Birkhäuser Publishers for Architecture.

Girginer, S. (2006). *Kentsel Tasarım İle Ekolojik Sürdürülebilirliğin İlişkilendirilmesi Ve Toplu Konut Gelişme Bölgelerinde Örneklenmesi*. (Yayımlanmamış doktora tezi). Dokuz Eylül Üniversitesi/Fen Bilimleri Enstitüsü, İzmir.

Givoni, B. (1976). *Man, Climate and Architechture*. London: Aplied Science Publishers Ltd.

Givoni, B. (1991). Urban Design For Hot Humid and Hot Dry Regions, S. Alvarez et al. (Eds.), *In Architecture and Urban Space*, (19-31). Dordrecht: Kluwer Academic Publishers.

Golany, G.S. (1995). *Ethics and Urban Design*. New York : John Wiley & Sons.

Goulding, J. R., Lewis, O.J., & Steemers, T.C. (Eds) (1993). *Energy Conscious Design*: *A Primer for Architects.* Batsford for the commission of the European Communities. London: B T Batsford Ltd.

Göksu, Ç. (1999). *Güneş Kent.* Ankara: Göksu Yayınları.

Hausladen, G., Liedl, P., & De Saldanha, M. (2012). *Building to Suit the Climate A Handbook.* Basel: Birkhäuser Publishers for Architecture.

Hinrichs, R., Kleinbach, M. (2006). Energy : Its Use and the Environment
Karaman, A. (1995). *Urban Design Aspects of Turkish Towns.* University of Maryland, School of Architecture, Studio Lectures, 25-33.

Knowles, R. (1974). *Energy and Form*. United States of America: The Massachusetts Institute of Technology.

Knowles, R. (1981). *Sun Rhythm Form*. United States of America: The Massachusetts Institute of Technology.

Ko, Y. (2013). Urban Form and Residential Energy Use: A Review of Design Principles and Research Findings. *Journal of Planning Literature*, 28(4), 327-351.

Koca, Ö. (2006). *Sıcak-Kuru ve Sıcak-Nemli İklim Bölgelerinde Eneri Etkin Yerleşme ve Bina Tasarım İlkelerinin Belirlenmesine Yönelik Yaklaşım*. (Yayınlanmamış yüksek lisans tezi). İstanbul Teknik Üniversitesi/Fen Bilimleri Enstitüsü, İstanbul.

Kohler, N. and Hassler, U. (2002) The building stock as a research object. Building Research & Information, 30(4), 226–236.

Lechner, N. (2014). *Heating, Cooling, Lighting*: *Sustainable Design Methods For Architects.* United States of America: Wiley.

Lowe, R. (2000) Defining and meeting the carbon constraints of the 21st century. Building Research & Information, 28(3), 159–175.

Lyle, J.T. (1994). *Regenerative Design for Sustainable Development*. New York: John Wiley&Sons.

MENR (2012). Republic of Turkey Ministry of Energy and Natural Resources Statistics Retrived in 20.12.2015 from http://www.enerji.gov.tr/index.php?dil=tr&sf=webpages&b=y_istatistik&bn=244&hn=244&id=398

Mega, V. (2005) Sustainable Development, Energy and the City: a Civilization of Visions and Actions, Springer, USA

Mendler, S. Odell, W. (2000) The HOK Guidebook to Sustainable Design, John Wiley & Sons, USA.

Newman, P.W.G., & Kenworthy, J. R. (1989). Gasoline Consumption in Cities. *Journal of the American Planning Association 55 (1), 24-37.*

Olgyay, V. (1992*). Design with Climate: Bioclimatic Approach To Architectural Regionalism*. Princeton: Princeton University Press.

Ok, V. (2007). Sağlıklı Kentler için Pasif İklimlendirme ve Bina Aerodinamiği. *VIII. Ulusal Tesisat Müh. Sempozyumu (213-227). İzmir.*

Orhon, İ., Küçükdoğu, M., & Ok, V. (1988). *Doğal İklimlendirme. Toplu Konut İşletmesi Proje Planlama Tasarım El Kitabı*, Ankara: TUBİTAK YAE.

Ovalı, P. (2007). *Türkiye İklim Bölgeleri Bağlamında Ekolojik Tasarım Ölçütleri Sistematiğinin Oluşturulması: Karaköy Yerleşmesinde Örneklenmesi*. (Yayımlanmamış doktora tezi). Trakya Üniversitesi/ Fen bilimleri Enstitüsü, Edirne.

Owens, S. (1987). *Energy, Planning and Urban Form*. London: Pion Limited.

Özdeniz, M.B. (1984). *Yapı Tasarımı için Türkiye İklim Verileri.* Trabzon.

Peker, Z. (1998). *Energy Efficient Urban Design.* (Yayımlanmamış yüksek lisans tezi). İzmir Yüksek Teknoloji Enstitüsü, İzmir.Roaf, S., (2003). *Ecohouse 2: A Design Guide.* London: Architectural Press.

Priemus, H. (1999) Sustainable cities: how to realize an ecological breakthrough: A Dutch approach. International Planning Studies, 4(2), 213–236.

Santamouris, M., Asimakopoulos, D.N., Assimakopoulos, V.D., Chrisomallidou, N., Klitsikas, N., Mangold, D., Michel, P., & Tsangrassoulis, A. (2011). *Energy and Climate ın the Urban Built Environment*. London: James & James.

SEEP. (2013). Strategic Energy Efficiency Plan of Turkey of 25.02.2012, Official Journal 28215 Retrived in 01.03.2016 from http://www.resmigazete.gov.tr /eskiler/2012/02/20120225-7.html

Sensoy, S., Demircan, M., Ulupınar, U., Balta, İ. (2008) Türkiye İklimi, Retrived in June 9, 2016 from www.mgm.gov.tr/FILES/iklim/turkiye_ iklimi.pdf

Sunikka, M. (2006). Energy efficiency and low-carbontechnologies in urban renewal, Building Research & Information, 34:6, 521-533, DOI:10.1080/09613210600660976

TMMOB. (2013). Union of Chambers of Turkish Engineers and Architects. Dünyada ve Turkiye'de enerji verimliliği oda raporu Retrived from http://www.mmo.or g.tr/resimler/dosya_ekl er/21e255f89e 0f258_ek.pdf in 1 June 2016.

Tönük, S. (2001). *Bina Tasarımında Ekoloji*. İstanbul: YTÜ Basım Yayın Merkezi.

Trewartha, G.T. (1954) *An Introduction to Climate.* The United States of America: Mc Graw-Hill Book Company.

United Nations Environmental Programme. 1972. *Declaration of the United Nations Conference on the Human Environment.* Retrived in 18.09.2016 from http://www.unep.org/documents.multilingual/default.asp?documentid=97&article id=1503

United Nations General Assembly. 1987. *Our Common Future. Report of the World Commission on Sustainable Development* Retrived in 18.09.2016 from http://www.unep.org/sgb/prev_docs/87_06_GC14_report_N8723250.pdf

United Nations General Assembly. 1992. *Rio Decleration On Environment and Develoment.* Retrived in 17.09.2016 from http://www.un.org/documents/ga/ conf151/aconf15126-1annex1.html

United Nations. 2012 *United Nations Conference on Sustainable Development. RIO+20.* Retrived in 17.09.2016 from https://sustainabledevelopment.un.org /rio20

Watson, D. (1989). Bioclimatic Design Research. K.W. Boer. (Eds.), *Advances in Solar Energy*, (402-438). American Solar Energy Society NewYork: Plenum Press.

Watson, D., & Labs, K. (1992). *Climatic Building Design: Energy-Efficient Building Principles and Practices*. The United States of America: Mc Graw-Hill Book Company.

Van der Waals, J.F.M. (2001) CO2 Reduction in Housing. Experiences in Building and Urban Renewal Projects in the Netherlands, Rozenberg, Amsterdam.

WP (2010) The Oil & Gas Year Turkey 2010. Wildcat Publishing Yeltekin, S., 2013. Insaat sektör raporu 2010 (Construction sector report 2010), MUSIAD sector report 72 Retrived in 12 March 2016 from http://www.musiad.org.tr/img/arastirmalaryayin/pdf/Insaatsektorraporu.pdf in

Yüceer, N.S., & Çerçi, S. (2002). Evaluation of Climatic Effects on Building Design. *Creating the Future 2. FAE International Sympossium in European University of Lefke*, Lefke.

Yüceer, N.S. (2015). *Yapıda Çevre ve Enerji*. Ankara: Nobel Akademik Yayıncılık.

Yüksel, N. (2005). Günümüz Kamu Kurumlarında Yapısal Konfor Koşullarının Tespit Edilmesine Yönelik Bir Çalışma. *Uludağ Üniversitesi Mühendislik-Mimarlık Fakültesi Dergisi*, 10 (2), 21-30.

Yiğit, A., & Atmaca, Đ. (2007). Dünya'da ve Türkiye'de Isıl Konfor Çalışmaları. VIII. Ulusal Tesisat Mühendisliği Kongresi (305–315). İzmir.

Zeren, L. (1978). Mimarlıkta Yapma Çevre Tasarımı ve Güneş Enerjisi. *Güneş Enerjisi ve Çevre Dizaynı Ulusal Sempozyum., İTÜ Mimarlık Fakültesi, İstanbul.*

Zeren, L. (1987). *"Türkiye'de Yeni Yerleşmeler ve Binalarda Enerji Tasarrufu Amacıyla Bir Mevzuat Modeli'ne İlişkin Çalışma",* Arşt. Projesi, İTÜ Uyg-Ar Merkezi, İstanbul.

Zuhairy A. A., Sayigh, A. A. (1993). The Development Of The Bioclimatic

Concept in Building Design. *Journal of Renewable Energy*, 3(4), 521-533.

Climatic Variables of Ankara., Retrived in June 12, 2016 from www.mgm.gov.tr

The Satellite Image of the Case Study Area, Retrived in March 16,2016 from Google earth

APPENDICES

APPENDIX A

South Side of Ideal Scenario for Temperate Arid Region

North Side of Ideal Scenario for Temperate Arid Region

East Side of Ideal Scenario for Temperate Arid Region

West Side of Ideal Scenario for Temperate Arid Region

APPENDIX B

South Side of Ideal Scenario for Hot Humid Region

North Side of Ideal Scenario for Hot Humid Region

East Side of Ideal Scenario for Hot Humid Region

West Side of Ideal Scenario for Hot Humid Region