Urban Strategies for Green Kadiköy Istanbul

International Design Studio 2013

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University of Twente *Yldiz Technical University* *University of Sarajevo*

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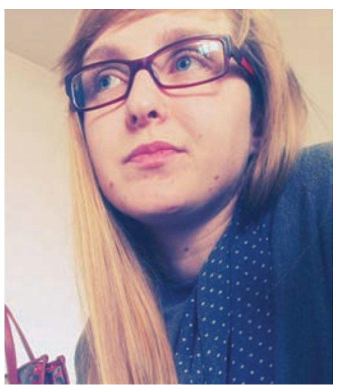

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Editorial

Editorial

Written by Adnan Pašić and Elma Durmisevic

The project presented in this publication is a result of an international cooperation between University of Sarajevo, University of Twente from Enschede and Yildiz Technical University from Istanbul, started in 2008.

This international cooperation has been structured around the theme of integrated sustainable and transformable design concepts and solutions for the built environment.

In last four years joint International Design Studios (organized by, Yldiz Technical University, University of Sarajevo and University of Twente) were dealing with design of green and transformable architecture as showcases of the new challenges in design in 21st century, integrating promptly Design for Disassembly concepts into design of sustainable buildings. The starting point of each studio was establishment of collaboration with the construction industry and design schools as this meager is a key factor of successful transition towards sustainable design and construction of the built environment.

During the last four years of the International Design Studios were focused on experimenting, researching and designing of multipurpose green and transformable pavilion structures. And another goal of design studios was to introduce collaboration among educational, research and industrial capacities in design process and further development of multidisciplinary design methodology and integration of advanced design principles. The ambition of each studio was to investigate a possibility for the implementation of design solution together with the construction industry on the real location.

During International design studios from 2008 until 2012 the design concepts have been developed for the construction of the polyvalent green transformable buildings on different locations of three participating countries.

The host of the first International Design Studio in 2008 was Faculty of Architecture at the Sarajevo University. The participant schools were Faculties of Architecture from Technical University of Delft and Yldiz Technical University. The pavilion site has been in Campus of Faculty of Architecture and Faculty of Civil Engineering University of Sarajevo. Beside intense experimentation and congested design process conducted by teachers and students from participant schools, design process included experts from industry and research institutions from Bosnia and Herzegovina, Nederland

and Turkey. The whole process was done in 15 weeks. Despite construction and equipment costs that were covered by the construction industry legal procedures have slowed the implementation process and brought it to a hold.

In 2009 the host was Faculty of Architecture at Yldiz Technical University from Istanbul and the program dealt with polyvalent demountable pavilions on Sultan Ahmet square, in collaboration with Istanbul Municipality of Eminonu. The prominent location on Historical Peninsula, former Hippodrome area from Roman ancient times, beside pavilions, included design of surrounding open public areas. Design process was completed according to planed schedule and in accordance with guidelines conducted with Municipality representatives. Although some part of urban solutions have been integrated into the urban reconstruction of the square the realization of presented pavilion designs missed because of lack of final support of Municipality.

In 2010 and 2011 the host was Faculty of Engineering Technologies of Twente University. Design Studio was part of broader initiative established by Prof. Durmisevic, named Green Transformable Building Lab. The studio program was dealing with design of demonstration laboratory where green and transformable building concepts and technologies will be realized tested and improved. Broad variety of Building Industries and Construction Companies from the Nederland were working with student during the studios and we directly involved into the design and decision making process. The pavilion site was at the Campus of University of Twente, and design of Green Transformable Pavilion explored potentials of applying green design and DfD principles and technologies of pavilion structure which would change its basic configuration every year as a part of ongoing open-air permanent exhibition. Pavilion would combine three different programs/ apartments, offices and exhibition spaces. As a part of this International Design Studios, first built structure from this project is under construction as an experimental Module, which will be assembled in the Factory and later moved to the Campus.

In 2012 the task and site was again in Istanbul, but this time there was a shift in scope. For the first time the task was not pavilion, but Children Science Centre in YTU Davut Pasha Campus. Previous Design Studios offered substantial experience that provided opportunity for more demanding and creative approach, that could widen previous knowledge developed from experimentation, research and designing of green, transformable and flexible spaces and structures. Program was developed from basic needs of any technical university today, to promote and introduce technical and engineering disciplines to children and youngsters through scientific wonders and affirmative approach towards engineering sciences.

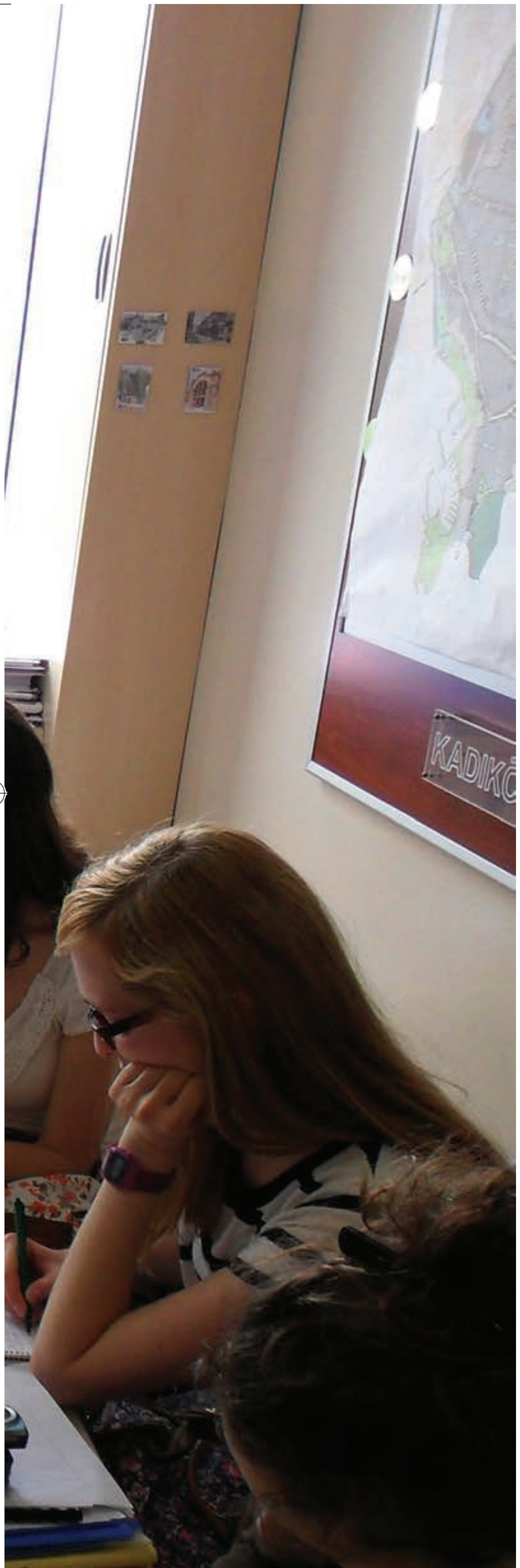
Previously mentioned collaborative Design Studios cope with wide ranges of design issues on building scale. The design issues are related to understanding, integrating and applying spatial relations, structural components and material aspects into an environmental context that urge for implementation of sustainable principles in architecture and design.

However comprehensive approach to architecture doesn't have relevance without wider context of cities and landscapes. This widening context has capacity to include social, economic and cultural issues as a constituent part of sustainable design in its primary role of human endeavor in pursuit and creating proper human habitat and environment.

This year's scope of international design studio is expending to the urban level and makes an effort to integrating green design aspects in design of sustainable cities. The idea of this year's IDS is to implement the principles of Green Design used in precious years into a roadmap for the development of a sustainable Kadikoy waterfront area providing in the end requirements for the design of buildings within this area which will be a part of the next stage of students work.

The ongoing Design Studio Project "Kadikoy Waterfront Transformation" is challenge in many important aspects of design. The location in a natural bay on Asian side of Istanbul emerged as a cradle of contemporary Istanbul, being one of the most prominent cities in the history of human civilization. The site that took advantage of beginning of industrialization in Turkey in 19th century and got Haydar Pasha Rail Station building as a first station on Asian continent. A spot of legendary Orient Express railway. Today Kadikoy Waterfront area is one of the most frequent transportation hub in Istanbul, mixture of commercial, public, infrastructural activities, mixture of different historical urban and architectural layers, mixture of different cultural influences and modes of living and architecture...the very same constituents that is challenging the contemporary human society today at all...the challenge that any planner, architect, thinker would like to deal with, to comprehend and to design on...

Figure 1 - Project location. Kadiköy in yellow, The waterfront of Kadiköy in red.



Introduction

Introduction to Green Planning in Istanbul

Written by Elma Durmisevic

Cities are at the epicentre of a global shift of population from rural to urban settings. They are the powerhouses of the global economy, innovation and creativity. Sustainability of cities goes hand in hand with its physical capacities and socio-cultural strength. Therefore issues as, adaptability, health conditions, reuse and recycling of resources but also social integration and cultural continuity expressed through the factor of lovability are critical to the quality and continuity of cities in the future.

Cities are responsible for around 65 percent of all energy used, 60 percent of all water consumed and 70 percent of all greenhouse gases produced worldwide. The future of cities will therefore be a defining element of the global future.

The massive processes of urbanization under way today are inevitably at the centre of the environmental future. It is through cities and vast urban agglomerations that mankind is increasingly present at the planet through which it mediates its relationship to the various stocks and flows of environmental capital. It is critical to understand the capabilities and complex systemic and multi-scale capacities of cities to support sustainable urban living conditions.

The main question for a city planner today is: “What is the optimum size of the population that the city can bear based on the resources needed to enhance the good quality of life of the population?” Planners of Istanbul mapped all the physical conditions and resources of Istanbul including: water reserves, micro climate, safety risks, deforestation that would bring up mayor disruption of the irrigation system and ecological system of Istanbul. All data has been integrated into the chart illustrating recourse capacity of Istanbul. (see Figure 3) Based on this, it has been calculated that the maximum number of people that can be supported by the cities resources providing livable conditions is 16 million. (Figure 2) Nevertheless the political aspirations on the state level are somewhat bigger than the physical capacity of the space. The ambition set up by Turkish politics is to let Istanbul grow to 24 million by 2023.

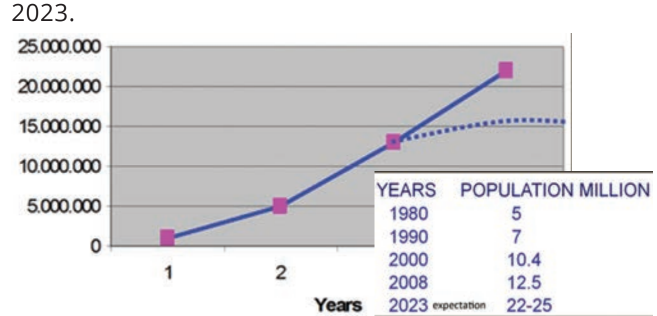


Figure 2 - Istanbul population growth

This growth will destroy the last strip of the northern forest. Besides the degradations of microclimate that will be caused by these actions, the reserves of drinking water will be in danger as well.

The question is how and who will be setting the limits of growth of megacities, and based on which premises? Second question is didn't we reach the time of reveres planning of city's that will deal with design of shrinking of mega cities to the level of their physical, social and cultural sustainability in place of plans for growth which are still very appealing political promises. We have faced these questions during the international design studio that coincided with the protests of inhabitants of city of Istanbul against the plans of government to continue with the construction and extension of the city by transforming the last parts of natural reserves being a part of life support system (providing, oxygen, clean water, water absorber, biodiversity, livable micro-climate) into an urbanized area which does opposite and possibly puts living conditions at stake. The aim of this International design studio was to open a platform for strategic green integral planning that local authority can use to frame its needs and responsibilities towards local community, improve institutional responses and local decision making.

Generally, the responsibilities of local governments are limited to land use and excluding integrated urban development strategies including infrastructure provision. The advantages of green urban strategic planning include an increase in governance that aides local governments in establishing performance based management, clearly identify the challenges facing local community and more effectively responding on a local level rather than national government.

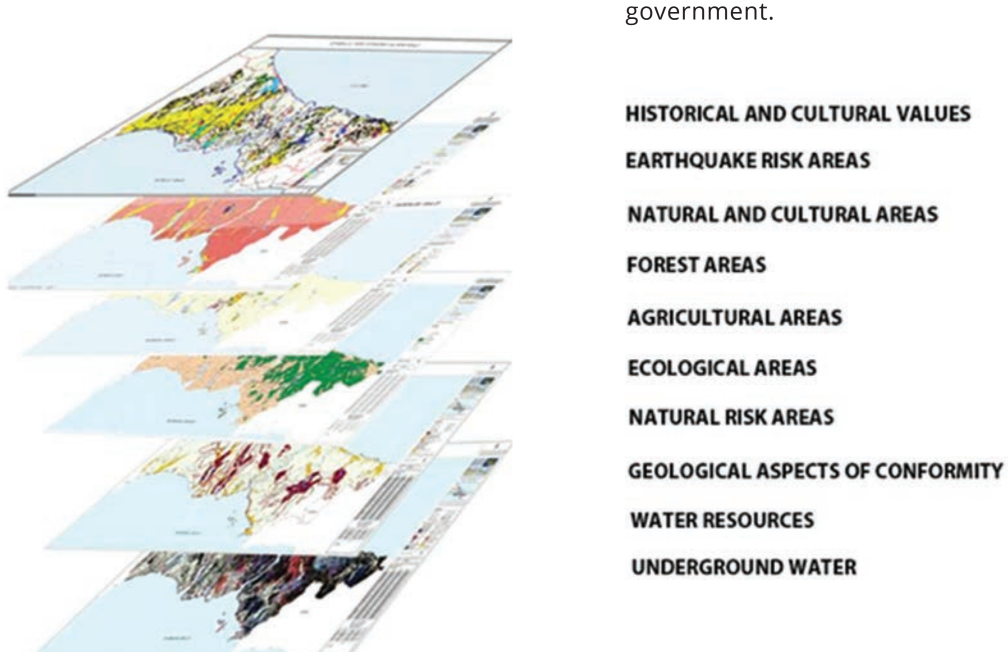


Figure 3 - Istanbul urban development limits

Green Cities Strategies

Background

The exponential increase in population and contemporaneous increase in standard of living for many will mean that the demand for essential goods & services (transportation, cars, planes, but also housing, materials, water, food) will increase by at least a factor 2 in the next few decades. If the need to support an additional 3 billion people and effect of increase per capita consumption is added it is clear that the linear material flow (from excavation to disposal) present in the existing industrial systems is not sustainable. Many scientists speculate that if 9 billion people have a western life style in 2050 we would need 6 Earth's to provide the necessary resources to sustain a population. A point has been reached when search for sustainable solutions for the resource feedback loops has become unavoidable.

At the times of global climate crises and when natural materials supplies are gradually depleting and becoming increasingly expensive the durability of buildings and cities is becoming a major issue. Issues as lovability, adaptability, reuse and recycling will be critical to the quality of buildings and cities in the future.

In an ideal case one can adopt as a goal that the materials and components in every product and building should be used to create other useful products at the end of its life, that the main structure of every building can accommodate different use patterns during its total life and that each city will produce its own electricity reuse its heat, water and waste, and use existing structures as a resource bank for a new construction.

Green cities

The future of cities will therefore be a defining element of the global future. The challenges presented by sustainable urban development are immense. It is estimated that over 50 percent of the world's population now lives in cities and urban areas. According to the UN Habitat, that is set to rise to 60 percent in a couple of decades. These large communities provide both challenges and opportunities for environmentally conscious developments. Cities are responsible for around 65 percent of all energy used, 60 percent of all water consumed and 70 percent of all greenhouse gases produced worldwide.
These massive processes of urbanization under way

today are inevitably at the center of the environmental future. It is through cities and vast urban agglomerations that mankind is increasingly present at the planet through which it mediates its relationship to the various stocks and flows of environmental capital. It is critical to understand the capabilities of cities to transform what is today a negative environmental impact to a positive one. The complex systemic and multi-scale capacities of cities provide massive potential for a broad range of positive correlation with nature's ecological systems.

Green Design Aspects

To achieve transition towards green society and circular economy number of levels of tangible and intangible systems need to be redesigned.
The key aspects of societal, economic and technological transformations are related to the following themes:

1. Green Materials and Technologies for effective material recovery
2. Mobility and Infrastructure
3. Energy solutions
4. Urban Landscaping and farming
5. Green Buildings and archicture
6. Green Cities
7. Economy, Policy and regulatory standards that can stimulate development and implementation of green concepts and techniques
8. Social Cohesion and Cultural Continuity

1. Green Materials and Technologies for effective material recovery

Figure 4 - Villa Welpeloo in which as much as possible surplus materials are used (2012 Architects)

The composition of materials used in everyday products is a major factor in its life-cycle environmental impact. The transition into a green design stream sets stage to designing and using environmentally preferable products and processes that do not pollute or unnecessarily contribute to the waste stream, do not adversely affect health, and do not deplete limited natural resources. As the growing global economy expands the demand for raw materials, it is no longer sensible to throw away much of what we consider construction waste. Using a "Cradle-to-Cradle" approach, the "waste" from one generation can become the "raw material" of the next.

When developing specifications, product descriptions and standards, designers should be taught to consider a broad range of environmental factors including: waste prevention, recyclability, the use of recycled content, environmentally preferable, and bio-based products, life-cycle cost, and ultimate disposal.

The green design strategies should focus on design and development projects, with an accent on design methodology, which must have a comprehensive, integrated perspective that seeks to teach students how to:

- Renovate existing facilities, products, and equipment whenever possible, such as old furniture, interior spaces etc;
- Evaluate the environmental preferability of existing products using the cradle-to-cradle, life-cycle assessment (LCA) approach; the teaching staff should be sufficiently trained to be able to offer such a course and relevant equipment and software has to be acquired.
- Maximize the recycled content of all new materials, especially from a post-consumer perspective;
- Specify materials harvested on a sustained yield basis such as lumber from certified forests;
- Encourage the use of recyclable assemblies and products that can be easily "de-constructed" at the end of their useful lives; design for disassembly course
- Limit waste, encourage the separation of waste streams, and encourage recycling during the manufacturing process;
- Eliminate the use of materials that pollute or are toxic during their Give preference to locally produced products and other products with low embodied energy content. Students should be taught to understand the concept of Appropriate Technologies which support local workforce, local knowledge hence supporting social and cultural
- continuity as well.

2. Mobility and Infrastructure

Figure 5 - Example of mobility and infrastructure

Movement and communication in contemporary society has become increasingly complex. Demand is more diverse and the infrastructure, both hardware and software is also in a state of hectic development. Integration, privatization, deregulation and pricing are all affecting our understanding of and our capacity to plan the cities for these dynamic transport and mobility markets. However, transportation also comes with significant undesirable side effects, particularly in terms of air pollution in urban areas and emissions of greenhouse gases, which can impact global climate change. The health consequences of urban air pollution are high; each year, suspended particulate matter (for which car exhaust is a major source) account for premature deaths of many among urban population. Evidence is also growing of transport's negative impact on local populations, particularly on the poor in developing world cities. There, pollution and congestion often hinder local, national, and regional economic growth. The key questions are how to: improve customer service, improve fuel efficiency, reduce emissions of greenhouse gases, reduce noise pollutions, reduce congestions, reduce environmental impact , improvedefficiency, enhance vehicle and infrastructure utilization, reduceddriver stress, minimize driver distraction, improve safety.

- Alternative means of transport
- Cars and renewable energy sources
- Smart greed
- Fossil fuel free cars and transport
- Virtualized intersection intelligence (traffic control in the cloud)
- Adaptive traffic signalling based on changing priorities determined from environmental and situational sensors (supported by Internet of things, e.g. future sensor networks within Internet)
- Area-wide optimization strategies
- Cooperative traffic signal control
- Traffic-adaptive demand management for congestion pricing
- Demand-responsive parking management

3. Energy solutions

Figure 6 - Examples of renewable energy resources

In the near future, all new buildings will be built to the CO_2 neutral level and existing buildings will be renovated to meet the low-energy building standard. The new approaches to energy efficient design are not only moving in the direction of lower and lower U-values to achieve lower energy consumption, but also the development and use of natural and local building materials.
In recent years, the field of thermal protection in buildings is focusing more upon ecological properties. Environmental awareness is now not only limited to energy savings, but also contained within ecologically sound construction, i.e. minimum energy input, resource consumption, and pollution production should be a part of the production, installation, and use of insulation materials.
In general, the principles of sustainable development are closely adhered to within the trends of existing development. Fears of raw material and energy

resource depletion, and concerns about excessive air pollution are rising to a far greater extent now than in the past. Far more emphasis is placed upon non-toxic materials and recyclability. The indicated trends are also evident within innovation of buildings. Consideration is shifted away from energy demanding technologies towards organic materials, i.e. the natural raw materials that meet the majority of requirements for sustainable development.

The risks of worldwide climate change are forcing new challenges upon our society, arguably the most important being to reconceive the way we consume and produce the energy that we need. These challenges can only be met by radical innovations in the field of research and technology. In the context of the ongoing urbanization of our population, the integration of renewable energy sources into urban energy networks and the increase in energy efficiency in cities are the core topics to be addressed in the near future. The following trends can be recognized in the transition towards green energy concepts:

- Renewable energy sources
- Sustainable energy and the city
- Intelligent environments and emerging technologies
- Smart grids
- Self-provision of energy
- Green energy concepts

4. Urban Landscaping and Farming

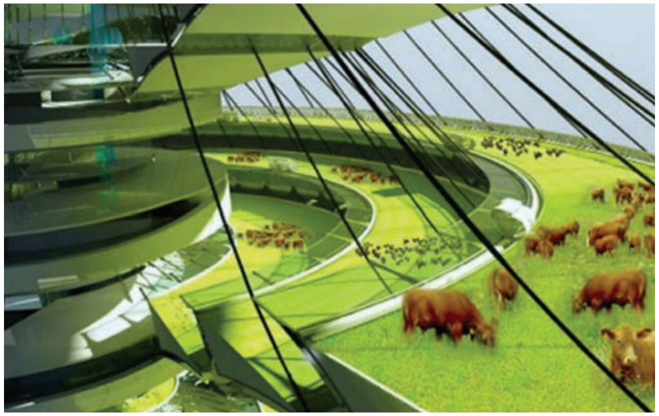


Figure 7 - Example of vertical/urban farming

Urban landscaping will play a key role towards reintegration of human settlements within a logical framework of natural eco systems. It will deal with issues as reducing heat island effects, quick water absorption during heavy rain showers to prevent streets form immediate flooding, more localized food production on building tops, and absorption of CO_2 emissions. And cleaning of wastewater within the urban parks, small-scale food production on green roofs and façades and improvement of the micro climate and air quality within cities.

- Urban Landscape planning and design
- Urban farming
- Microclimate design in the cities

5. Green Buildings and Architecture

Figure 8 - Green technologies implemented in a house

Building sector is accounted for 50 percent of global greenhouse gas emission (UNEP-IETC, 2002) that makes it the largest single contributor to greenhouse gas emissions globally. In many countries the construction industry accounts for up to 40% of materials entering the global economy (CIWMB 2000), 50 percent of waste production, and 40 percent of energy consumption.
Materials used for buildings (with their heat transition properties) but also materials in other goods will have impact on energy concepts but also reuse and recycling potential of materials can make cites independent of row material exploitation and eliminate problems related to the waste disposal plants.

On the other hand a symbiotic relationship between buildings and the urban fabric they form and occupy is an essential condition for a green architecture. By getting in the way of pre-existing energy flows, buildings alter the energy balance of their surroundings, fostering immediate microclimatic changes that affect them as well as impinging on their buildings and pedestrian activities in the vicinity. Equally importantly buildings also engage in a continuous disposal of waste heat that they release to the urban environment outside by conduction, by air exchange. Whether in free-running mode or mechanically heated, ventilated or cooled, buildings will relentlessly warm the air around them, inducing complex long-term effects that fragments the urban environment into a random assemblage of accidental microclimates which in turn subject the surrounding buildings to different conditions. (Simmos Yannas). Besides the direct relation between the building design, and zoning with the energy concepts of the city, a similar symbiotic relationship exists between the urban transportation and mobility concepts with the level of pollution, quality of climate and urban fabric. Materials used for buildings (with their heat transition properties) but also materials in other goods will have impact on energy concepts and micro climate on one hand but also reuse and recycling potential of materials can make cites independent of row material exploitation and eliminate problems related to the waste disposal plants.

- CO2-balanced building
- Transformable and flexible buildings
- Bioclimatic architecture
- C2C building strategy
- Open Building
- Life Cycle Design of Building
- Industrial, Sustainable and Flexible Buildings

6. Green Cities

Figure 9 - Two concepts of a green city

Cities are the powerhouses of the global economy and contribute to knowledge production and innovation. The future of cities will therefore be a defining element of the global future. The ideal model of a green city will require a balanced relationship between socio-cultural dimensions of the city design (including architectural design as a cultural product considering delicacy of cultural heritage, fragility of public participation procedures) and physical factors as energy, waste disposal, urban transport, use of green materials.

Reducing greenhouse gas emissions has become increasingly important along with finding ways to enhance regional economies while reducing their impact on the planet. Urban areas, as hubs of human activity and resource consumption, offer the best opportunity for innovation. Governments, developers and designers must collaborate to decrease energy demand, switch to green power and offset any remaining carbon.

- Centralized versus decentralized energy solutions
- Decentralized concepts for water and sanitation
- Urban Agriculture
- Waste management in the built environment
- Green Urban strategies
- Planning, development and management
- Transformation of cities
- Urban metabolism
- Planning for risk

7. Economy, Policy and Regulatory for Green Concepts and Techniques

Figure 10 - Policy, Regulations and Laws

The emphasis in both policy and regulations is on the dynamic nature of a sustainable development where goals and means are moving constantly. This requires a dynamic and multi-player environment that can timely react on the latest developments and provide prompt stimulating economic and regulatory models for the implementation of green solutions technologies.

- Politics and sustainability
- Real estate management and sustainability
- Planning, development and management
- Green growth
- Case studies green business models
- Impact assessment of green benchmark

**The green gesign aspects mentioned above (1-7) are based on the Green Design Manifest by writte Elma Durmisevic which illustrates a framework for the development of a strategy for green cities.*

8. Social Cohesion and Cultural Continuity

Figure 11 - Multiculurism

The social cohesion and cultural continuity are important part of contemporary architecture and engineering and in a broader sense deepen the issues related to the Green Design going back to and involving the final user, a human. These are important concepts in order to carry over the knowledge and promote and inclusive thinking, design, and society.

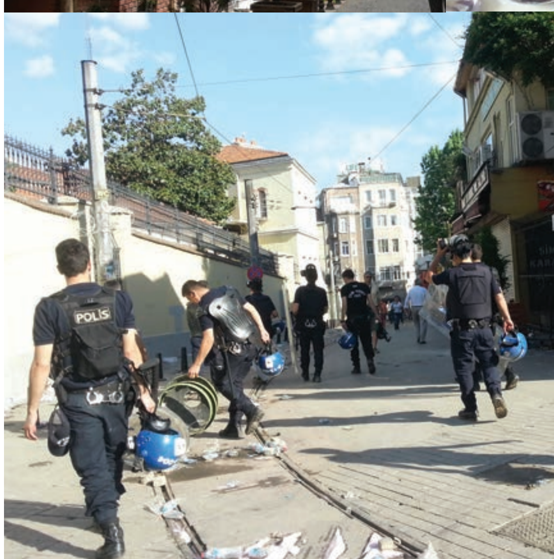
Today, cities and societies as a whole have gone through dramatic socio-physical changes, suggesting now presence of multiple diversities at every level. This social and cultural awareness needs to be recognized and incorporated on all levels of creativity and drive a truly multidisciplinary approach with a human, the consumer, the occupant, in the centre always. Since 1960s growing awareness of insufficiency and un-sustainability of western-centric cultural model as a predominant one has lead consequently to the rise of consciousness about importance of other cultural tradition as well as entanglement of cultural influences in general (Adnan Pasic).

In the western societies today, «Green» means cities, cultural diversity, and a new and different design pedagogy that enhances people-environments connections. With these changes, demands for new types of knowledge and their application in design pedagogy are clearly needed. We now do understand the deep relationship between the environment and human behavior and the principles of behavior that guide societies. Introduction of the People-Environment paradigm, also termed Environment-Behavior Studies, to young architects, urban engineers and designers should then be done through regular higher education courses, from the start of their studies. This new pedagogy should be useful, not only in defining design problems, understanding existing phenomena, formulating design objectives, and preparing architectural curricula, but also in applied work, the actual design, by integrating these concepts and research into teaching and design/creative thinking.

The question is, how and by what means can planning of the city and architecture (that form the envelop for human activities in urban area) incorporate challenges regarding social cohesion and cultural continuity that modern multicultural and multilayered societies meet. To answer these questions the following aspects need to be addressed.

- Cultural heritage issues
- Cultural and social traditions and context
- Community involvement
- Environment-behavior interaction
- Quality of life
- Infrastructures and social services
- The community and the city
- Sustainable urban tourism

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Chapter one

Istanbul

Istanbul Planning Strategies

Istanbul is the largest city in Turkey, constituting the country's economic, cultural, and historical heart. With a population of 13.9 million, the city forms one of the largest urban agglomerations in Europe and is the second-largest city in the world by population within city limits. Istanbul's vast area of 5,343 square kilometres is coterminous with Istanbul Province, of which the city is the administrative capital. Istanbul is a transcontinental city, straddling the Bosphorus — one of the world's busiest waterways — in north-western Turkey, between the Sea of Marmara and the Black Sea. Its commercial and historical center lies in Europe, while a third of its population lives in Asia The location of Turkey, Istanbul and the project area are shown in the figure below.

Istanbul's strategic position along the historic Silk Road, rail networks to Europe and the Middle East, and the only sea route between the Black Sea and the Mediterranean have helped foster an eclectic populace, although less so since the establishment of the Republic in 1923. Overlooked for the new capital during the interwar period, the city has since regained much of its prominence. The population of the city has increased tenfold since the 1950s, as migrants from across Anatolia have flocked to the metropolis and city limits have expanded to accommodate them. Arts festivals were established at the end of the 20th century, while infrastructure improvements have produced a complex transportation network (Wikipedia, 2013). The growth of the city over the last 40 years (1950-1980) are illustrated on the next page.

Figure 12 - Location of Turkey, Istanbul and Kadiköy

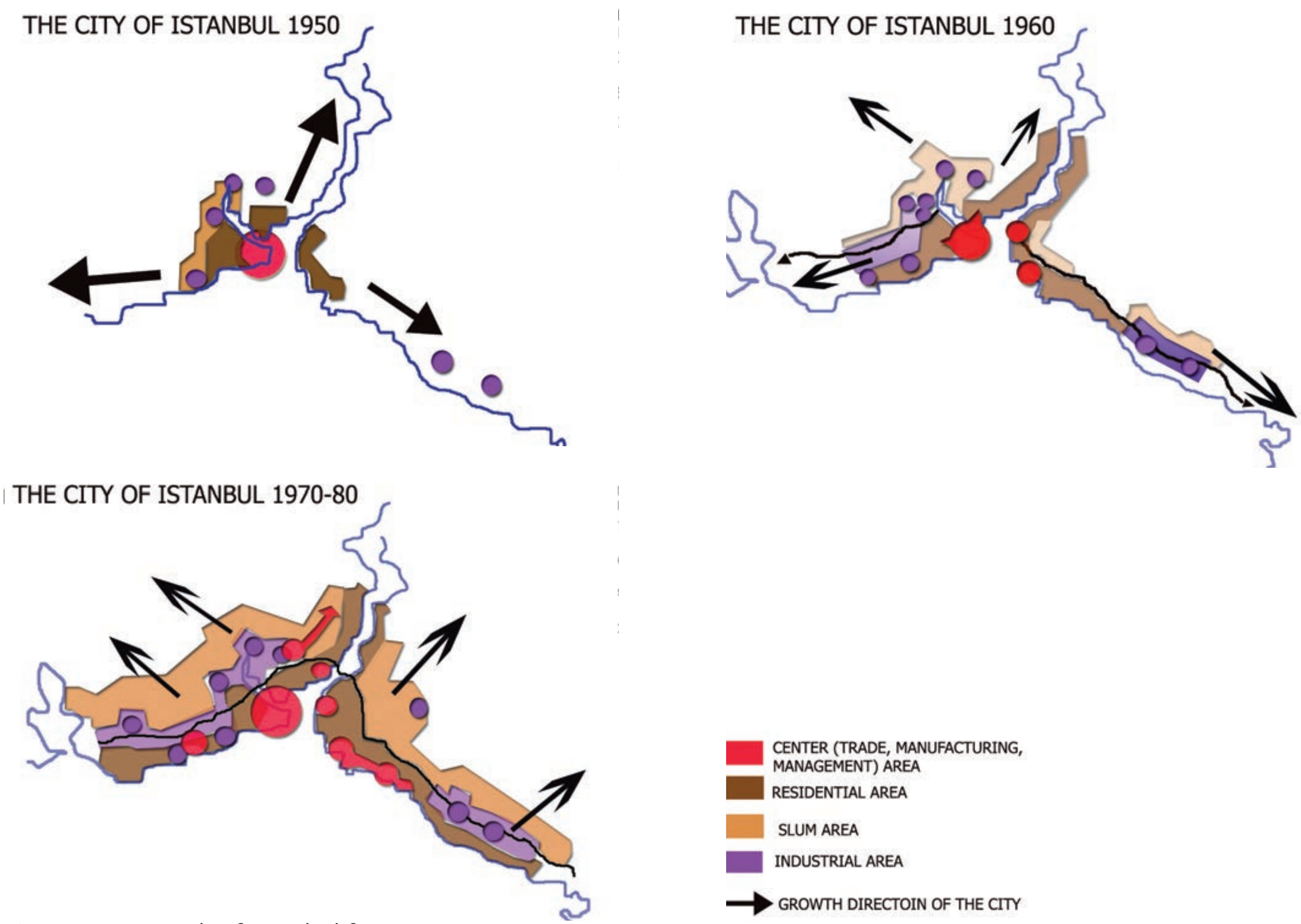


Figure 13 - Growth of Istanbul from 1950 to 1980

Limits of growth

As said in the intertroduction there are some limits to the growth of Istanbul. The main question for a city planner of Istanbul is: "What is the optimum size of the population that the city can bear based on the resources needed to enhance the good quality of life of the population?". Planners mapped all the resources Istanbul has. Based on that, it has been calculated that the maximum number of people that can be supported by the resources is 16 million. (See Figures 2 and 3)

Nevertheless the political spirations on state level are somewhat bigger than the physical capacity of this space. The ambition set up by Turkish politics is to let Istanbul grow to 24 million by 2023. This growth has severe consequences. Besides the degradations of microclimate that will be caused by these actions, the reserves of drinking water will be in danger.
On the next pages figures show growth of metropolitan centres, shopping centres and housing areas over time.

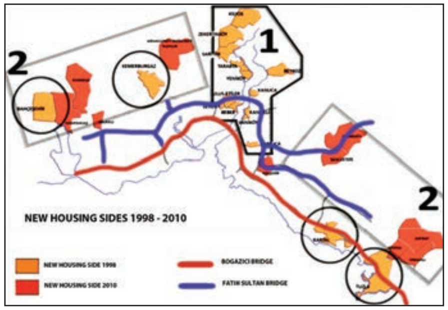


Figure 14 - Istanbul metropolitan area and new housing sides 1998-2010

Figure 15 - Istanbul metropolitan area centres 1980

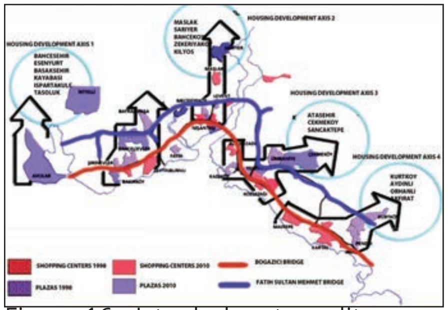


Figure 16 - Istanbul metropolitan area shopping centres and plazas 1998-2010

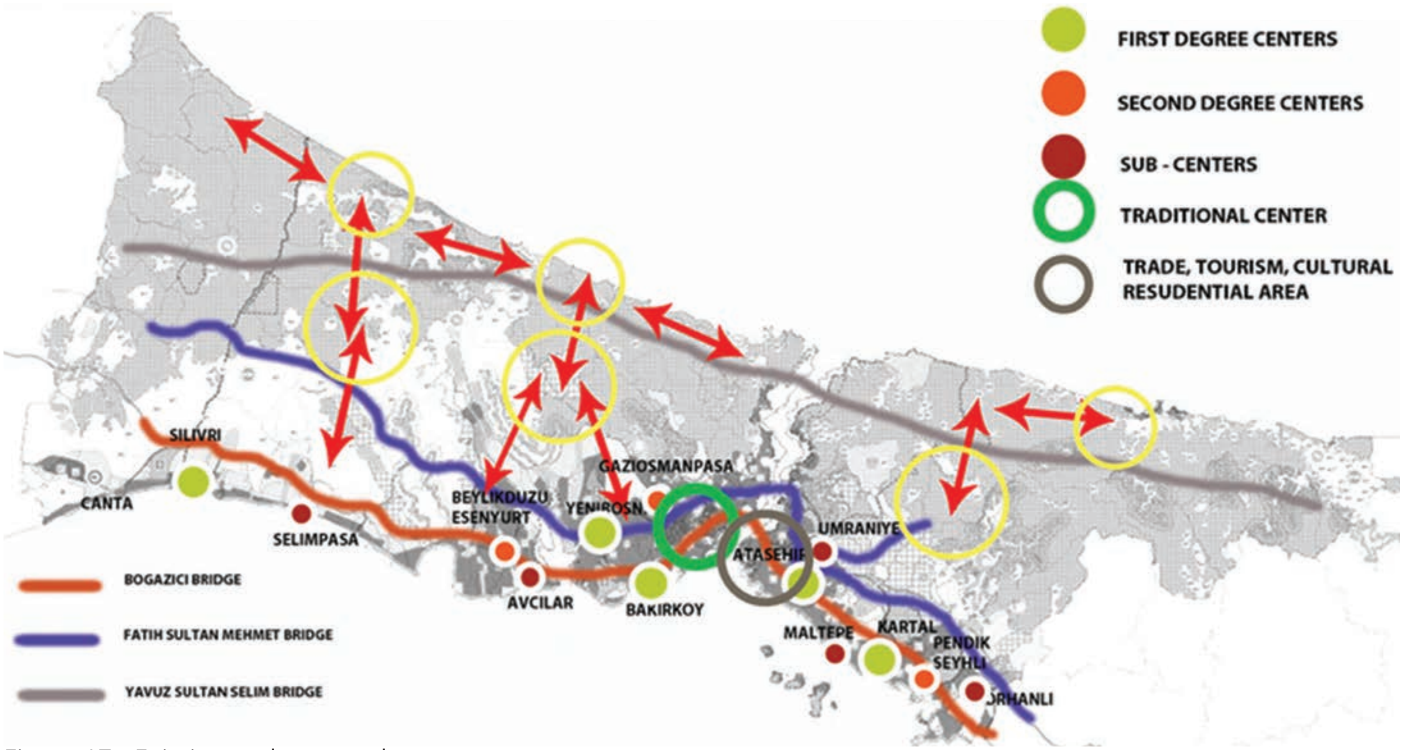


Figure 17 - Existing and proposal centers

Connectivity, City Mobility and Transport

The city of Istanbul is unique in many different ways. But one aspect gave it the very special place through the entire history of Humankind and that is being a bridge of civilizations. Istanbul is the only city in the World that connects two continents, Asia and Europe. This unique position brought Istanbul importance as a strategic point that provide control of trade, military and cultural routes and connections between East and West, as well as North and South. Bosphorus Channel which is the only naval gate from Black See to Marmara See and consequently Mediterranean See, in the same time connects and divides two Continents and two Sees. This unique position represents affirmation of principle by which cities generate their meaning and importance in accordance with their capacity to be places for good living based on qualities of natural preconditions and capacity to become focal point for people, goods and power. The foundations of these capacities one can recognize in potential that could be found in production of extra values inevitable for genesis and development of any proved phenomenon by whom urban potential of the cities is in direct and unchained relation with their capacity to fulfil human needs for existential security and social communication end expression, in both senses, material as well as in spiritual ones. (ova cijela recenica mi nije nikako jasna sta zelis sa njime reci)

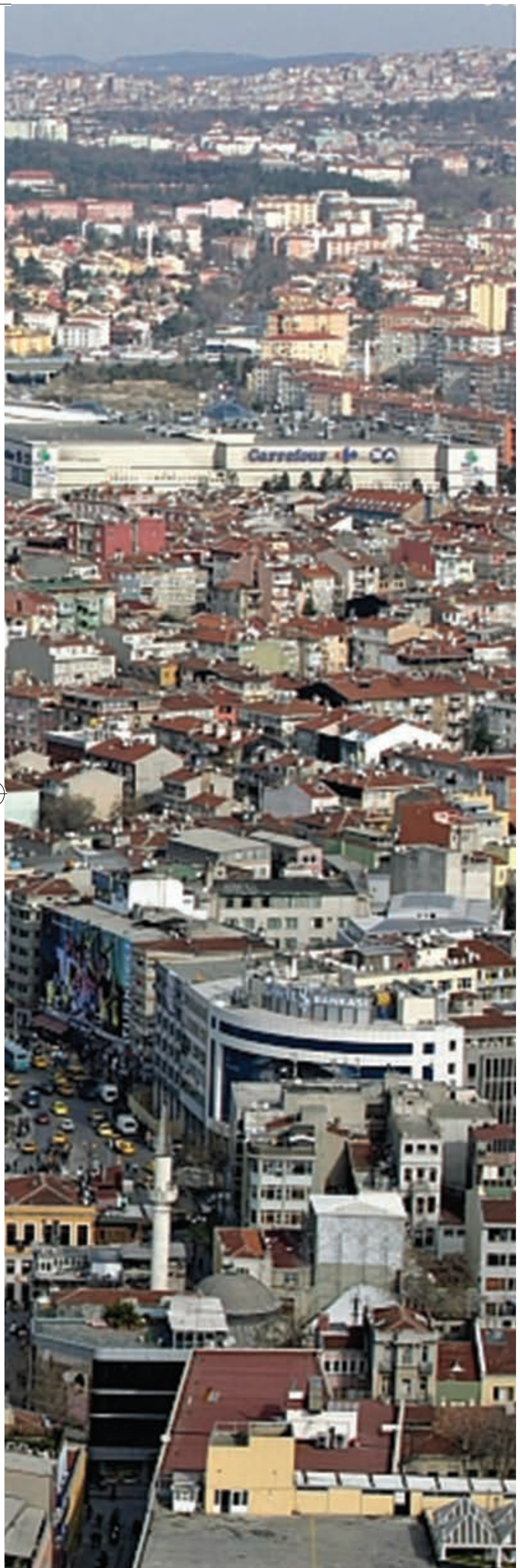
Contemporary urban development in Istanbul was deeply bounded with its transportation system. Daily commuting of the people in Istanbul is incredibly complex network of different routes and subsequent means of transport, generally divided in transportation systems on ground and on See. The second one has shaped historical urban development of Constantinople and later early Istanbul. Through historical era Constantinople was erected on historical Peninsula and it had on one the hand natural borders made of Bosphorus, Golden Horn Bay and Marmara See, and on the other hand Theodosius Wall an later Justinian ones on North Western side of the historical city. After conquest of Costantinopole in 1453 by Ottomans, the city got its contemporary name Istanbul. An urban development during these times followed by the rise and the fall of Ottoman Empire, extended beyond the city borders and historical walls. But major contemporary development of Istanbul started in 19th century and especially in the second half of 20th century with a construction of a first high-way with a first bridge over Bosphorus, and later a second one with second Bosporus bridge. These new transportation facilities along with permanent industrial development of Istanbul area become a magnet for migration and consequently urban spread, mostly along new high-ways. The current planning of a construction of a third northern high-way and Bosphorus bridge with prediction for expanding of population rates bare negative effects on natural resources by the existing borders of Istanbul toward Black See.

All these projections have short and long term impacts and consequences on Kadiköy municipality and Kadiköy waterfront area which will be surveyed and analyzed during the next phases of this research project.

Figure 18 - Main Transportation systems of Istanbul metropolitan area


Figure 19 - Rainway and Subway system of Istanbul

Figure 20 - Main transformation points of Istanbul



Chapter Two

Kadiköy

Background Information on the Location for IDS 2013

Kadiköy is one of the 32 districts in Istanbul, on the Asian side of the city, consists of 28 neighbourhoods. Kadiköy, being a residential and commercial district with its theatres, cinemas, business areas, educational and health institutions is ranked first as the cultural centre of Anatolia. It is the biggest centre in Asian side of Istanbul with regard to the transportation through Harem Harbour, Haydarpasa Railway Station and Harem Bus Terminal. With the Bosphorus from the west, Kadiköy is one of the most important districts to be used to connect Europe and Asia. As it has a shore through Bosphorus which extends on the Europe and Asia, Kadiköy has the most important aspects rather than any other districts in Istanbul

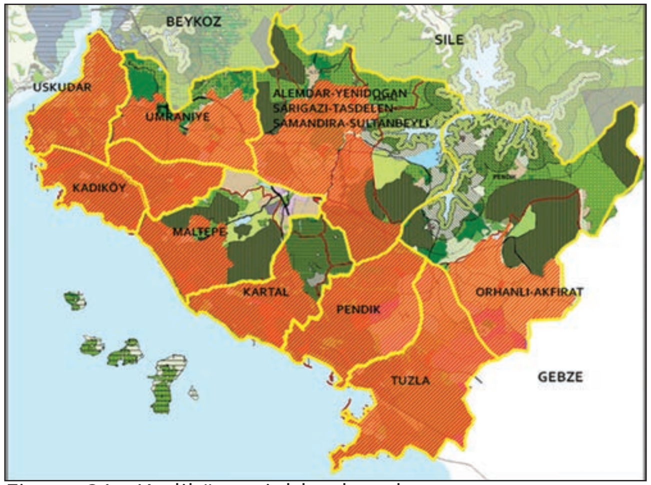


Figure 21 - Kadiköy neighborhood

Figure 22 - Kadiköy district and Kadiköy project area

Urban development and cultural background

Kadiköy (in Turkish - *Village of the Judges*) is one of the oldest Istanbul's settlements on Asian side. The area was continuously inhabited since the prehistoric times as numerous settlements were found since that time. The oldest port has been founded by Phoenicians. The most famous ancient settlement was Chalcedon established in 685 BC by ancient Greeks from Megara. This was before the most famous ancient Greek settlement Byzantium was founded in 667 BC on the opposite side of Bosphorus in the Golden Horn area. The second one later became ancient Roman Nova Roma, later Byzantium Constantinople and since 1953 Istanbul. Since its establishment Chalcedon was part of different historical entities throughout time, such as: Persians, Bithynian's, Romans, Byzantines, Arabs, Crusaders and Turks. It was damaged during Fourth Crusade and conquered by Ottomans in 1353, one hundred years before the fall of Constantinople in 1453. In that time, Chalcedon was rural settlement, and under Ottoman conquest it got its contemporary name Kadiköy. Since Ottoman conquest, Kadiköy became a popular market place for agricultural goods and throughout time it was developing into vibrant and mixed residential area, settled and shaped by typical Ottoman cultural mixture of Armenians, Greeks, Jews and Turks. In 19th century, with a construction of railways in Anatolia and Near East, there were a number of communities of Europeans who were engaged on its construction. Since then, Kadiköy was developed inland and became a mixture of different public, market and residential areas, a mixture of different usages, the urban and the architectural typologies and cultural patterns, recognizable until today.

The figures (23-26) illustrates distribution of different public functions and their integration into the housing zones in Kadikoy

Figure 23 - Kadiköy waterfront centre points

Figure 23 - Kadiköy build and unbuild area

Figure 24 - Kadiköy functional plan

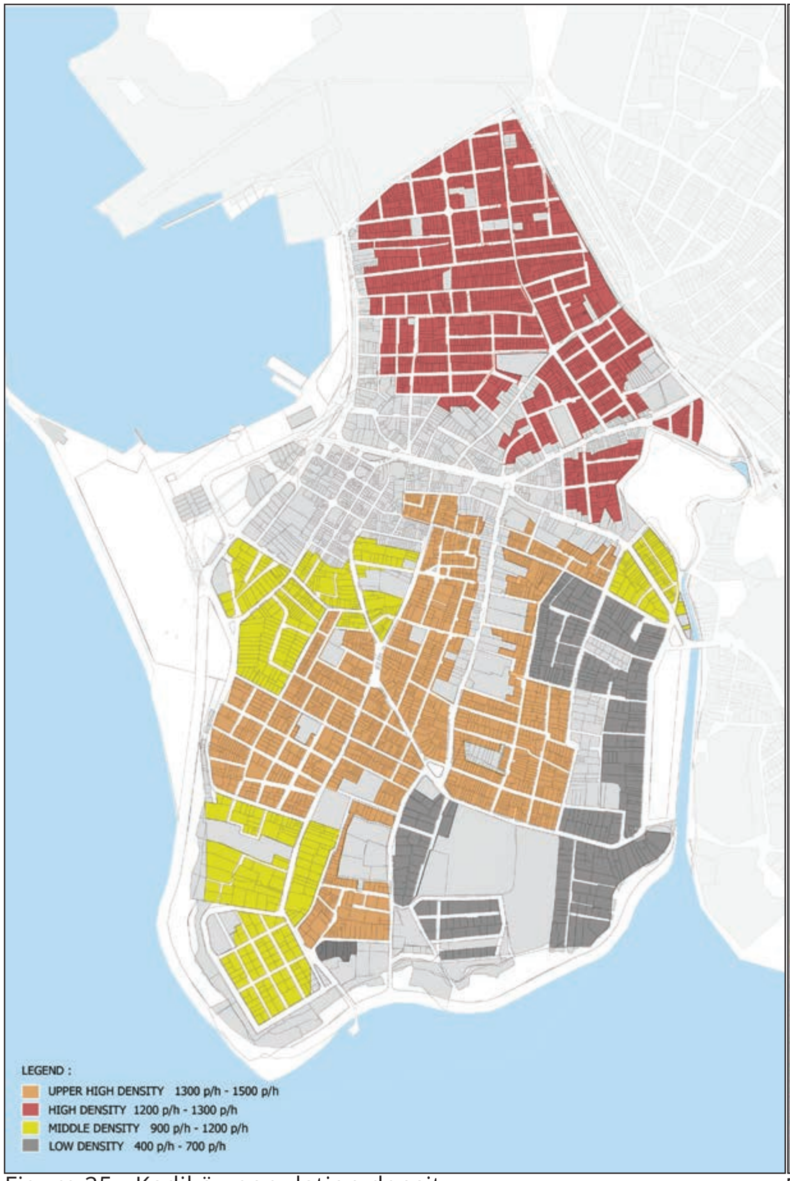


Figure 25 - Kadiköy population density

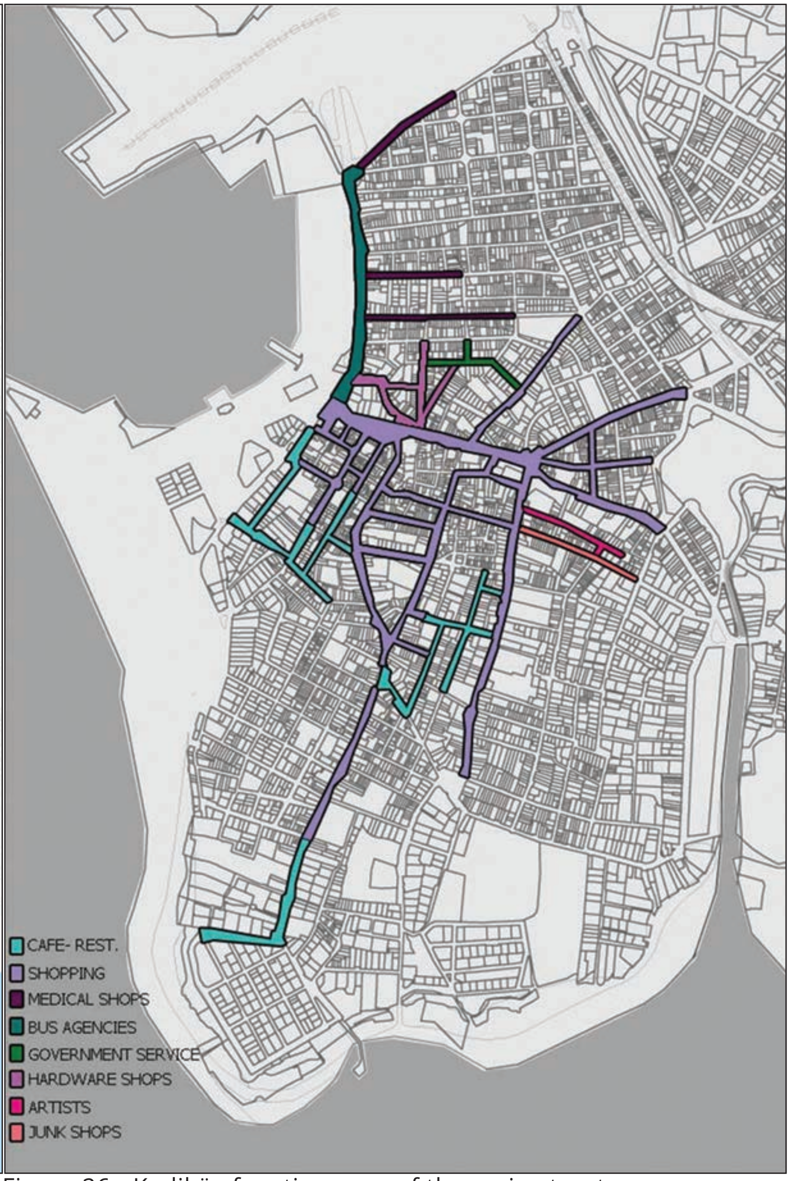


Figure 26 - Kadiköy function map of the main streets

Kadiköy Zoning, Connectivity and Mobility

The prominent point of Kadiköy bay is Haydarpasha Railway Terminal opened in 1908 as the starting railway station on Asian side that connects Istanbul and Bagdad with Famous Orient Express train as well as with Damascus and Medina on other famous railway that brought pilgrimages to Mecca. Today Kadiköy central waterfront area is the main transportation hub for people that commute on daily bases through Bosphorus between Asian and European side of Istanbul. The peers for ferry and boat transport are connected with the bus and the minibus terminal next to docks, and the transportation network is developing from this starting point deep in the inner areas of Kadiköy Municipality as well as the other inland areas.

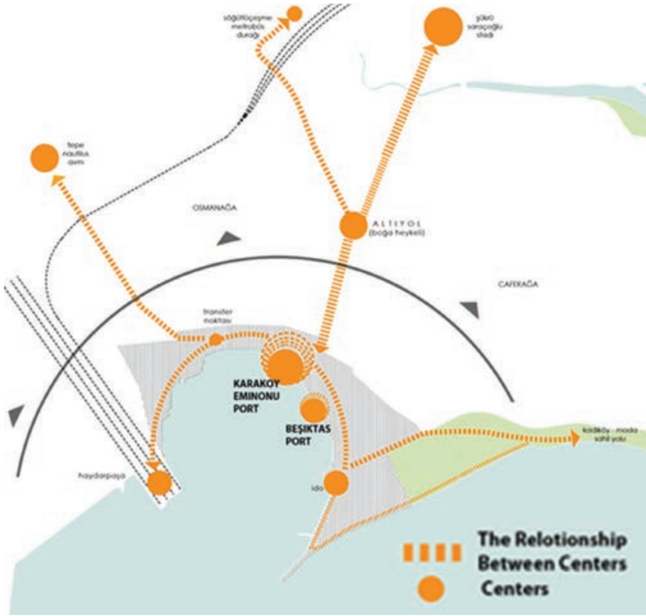


Figure 27 - Connections between centres in Kadiköy

Figure 28 - Pedestrian movement waterfront

Figure 29 - Kadiköy transportation

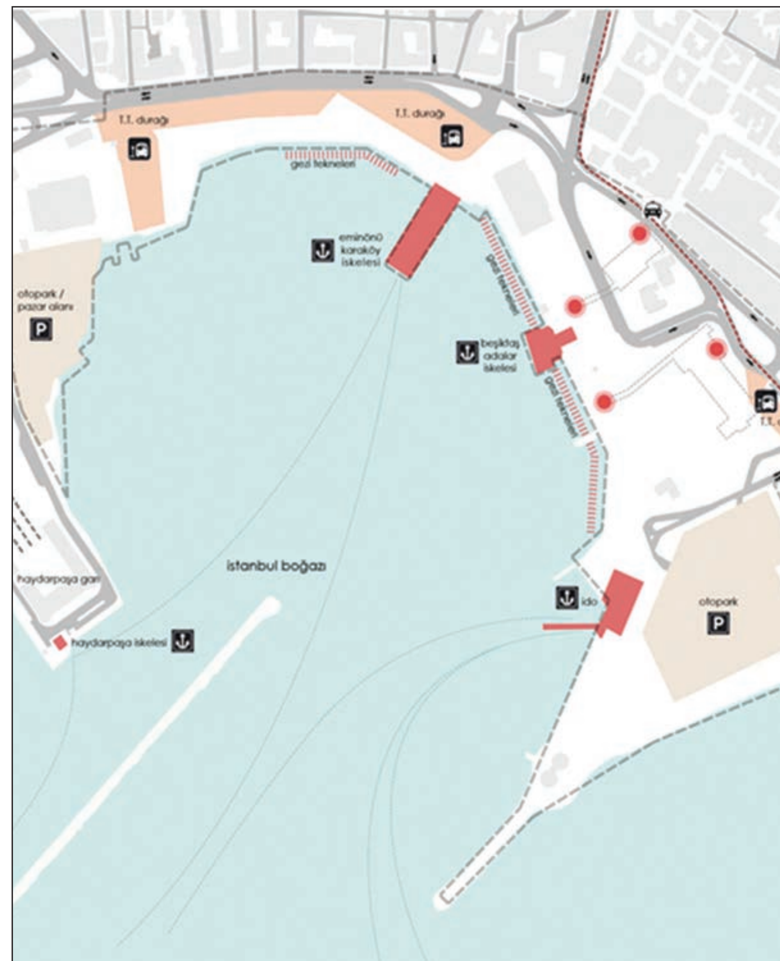


Figure 30 - Kadiköy transportation spots



Chapter three

Green Design Potential

Introduction

Cities are at the epicenter of a global shift of population from rural to urban settings. They are the powerhouses of the global economy and contribute centrally to knowledge production and innovation. The future of cities will therefore be a defining element of the global future.
The ideal model of a green city will require a balanced relationship between socio-cultural dimensions of the city design (including architectural design as a cultural product considering delicacy of cultural heritage, fragility of public participation procedures) and physical factors as energy, waste disposal, urban transport, use of green materials.
Reducing greenhouse gas emissions has become increasingly important along with finding ways to enhance regional economies while reducing their impact on the planet.
Urban areas, as hubs of human activity and resource consumption, offer the best opportunity for innovation. Governments, developers and designers must collaborate to decrease energy demand, switch to green power and offset any remaining carbon.

That is why it is so important for Kadiköy, but also for Istanbul in general to implement green design aspects. In the next chapter the green design aspects will be discussed for the project in Kadiköy. First an overview of green design aspects will be given, followed by the green potentional in Kadiköy based on an analysis of wind, solar and water.
Before that there will be a introduction about different sustainable measures for the built environment. First a short history of how sustainable models emerged over time ending with the finally the new five triads of H.J.H. Brouwers and A.G. Entrop.

History

The first sustainable step or ranking-based model in the Netherlands was proposed as a motion by Member of Parliament Lansink in the late 1970s. The so-called 'Lansink's Ladder' – contains seven steps to cope with waste disposal. Later a three-step scheme was made by Duijvestein in 1993. These steps rank sustainable measures for the building industry with each step in order of sustainability preference. Duijvenstein made a distinction between incoming flows and outgoing flows and not only mentioned the flow of materials, like Lansink, but also other building-related flows such as water and energy. That was new because many building projects sustainability only focuses on a low energy use, even nowadays. Three years later, Lysen introduced in 1996 his three-way strategy for sustainable energy, the so-called 'Trias Energetica'.

The next following years many others described the 'Trias Energetica' and it turned into a more clear and hierarchical approach of sustainability.

1. Prevention: Prevent the use of energy by reconsidering the energy use
2. Renewable/Reuse: Use sustainable energy sources as widely as possible
3. Efficiency: When there still remains an energy demand, then use fossil fuels as efficiently as possible.

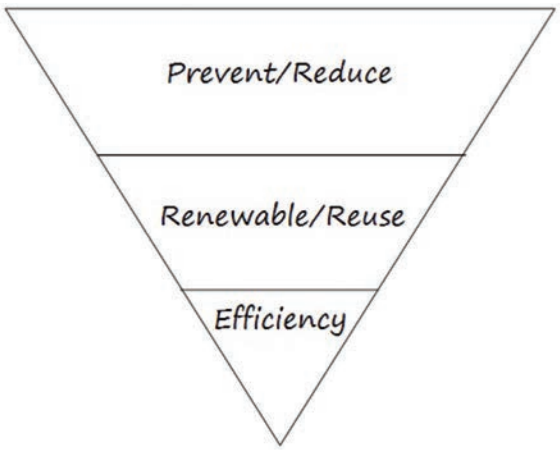


Figure 31 - Hierarchical approach of sustainability

Five trias

The 'Trias Energetica' is not the only trias that is mentioned by H.J.H. Brouwers and A.G. Entrop. Because energy use is not the only aspect that influence the environmental impact, other building-related aspects are also pointed out. These are: 'Trias Toponoma' for land-use, 'Trias Poreutica' for transport, 'Trias Hydrica' for water and 'Trias Hylica' for materials and they all have the same strategy of avoiding, sustaining and rendering efficient.

Overview of Green Design Aspects for Kadiköy

According to the World Bank Data, the urban population counted 52,5 million inhabitants in 2011, which represented 71 % of the population in Turkey. In 2012, there was 13,5 million inhabitants in Istanbul and the population could reach 22 to 25 million by 2030. Cities are responsible for over 70 % of global CO_2 emissions. More and more people are living in urban areas, that is why it is urgent to start rethinking the way we develop cities. Above all else, a green city is a city which provides a high quality living and working environment to its inhabitants with the lowest possible ecological footprint.

About City orientation and buildings' performance

It is well known that the biggest environmental gains come from the most passive and least expensive tools. That is why the planning process is very important. Right from the start, factors such as the city's and building's orientation and form have to be studied in depth. After that, the buildings' performance has to be optimized with efficient envelope (insulation, percentage of glazing, natural light) and systems (natural ventilation, LED-lighting) and smart building materials.
After an analysis of orientation and forms, green design features that make cities greener are presented below:

Greenery

Besides providing a green and healthy image for the city, greenery helps filtering pollutants and dust in the air and reducing the green house effect by absorbing CO_2. It creates opportunities for relaxation, social contact and recreation and therefore enhances well-being. It is well know that greenery enhance physical and mental health. It reduces stress and increase employee productivity.

Of course, it is way to attract species since it provides habitats for fauna in the city. If implemented in the right way, it provides water retention possibilities and it can even reduce the need for heating in winter and airconditionning in summer. Planting trees and shifting from paved surfaces to green surfaces is an effective way to deal with microclimate and urban heat island effect.. Greenery and city parks can be implemented all over the city: even parking areas need shade. Trees in parking areas keep cars cooler and reduce the amount oh hydrocarbon vapour emissions from parked cars.

Green Network

The priority is given to pedestrians and bicycles. The routes are safe for soft mobility and bring people to the city's parks and recreational spaces. Besides, by integrating greenery in the city, the pedestrian routes are attractive and people might wish to walk or to cycle instead of using the car for daily routine short trips, leading to a reduction of CO2 emissions.

Local food production and urban farming

Urban farming provides opportunities for inhabitant to grow their own food within the limits of the city. It reduces CO2 emissions due to the food transporta tion since the products go directly from the producer to the consumer. Besides, it is a way to bring peoplefrom different backgrounds and cultures together.

Air circulation and ventilation

Air quality is an important aspect in green design. Once again greenery in forms of continuous, closed and linear barrier of trees can be used to drive the polluted air upwards. Once again the location of the trees has to be studied before. It is not always good to place trees everywhere. For instance, trees which form a tunnel along narrow streets have a negative effet on the flow of fresh air into the street and the flow of polluted air away from the street. In this case it is desirable to use green facades.

Once again, appropriate implementation of trees can help improving the microclimate and urbanheat island effect by ventilating the city in a natural way and driving away the polluted air.

Energy production

The city is fully powered by renewable energy and renewable energy for electricity, cooling and heating purposes is generated in the area. As the city grows, the remaining power will be sourced from offsite renewable sources. Photovoltaic panels are used to provide electricity to inhabitants but the solar energy is also used to provide domestic hot water via hot water solar collectors. Electricity can also be produced using wind energy. Biogas is an effective alternative to produce electricity and heat using food and green waste.

Local Materials & Waste Management

Local materials are used for building materials and urban furniture (bus stop, benches, fences…) as much as possible in order to reduce CO2 emissions due to transportation. They preferably come from renewable sources or recycled materials. They are safe for the environment and for human health. All waste is recycled, composted or used for energy production (biogas).

Water Management

The water evolves in a closed loop within the city. Grey water is filtered and can therefore be reused for irrigation purposes within the city. No drinking water is used when not necessary. That is why, rainwater is collected and used to irrigate the parks, flush the toilet and for the appliances that don't need drinking water (dishwasher, washing machine...)

In short a green city can be seen as a self sufficient organism in terms of energy procution. Greenery plays an important role in improving air quality and ventilation within the city, but it also has a positive impact on human health. It is important to understand that not only very complex and expensive systems (for water management, smart grid...) are necessary to make a city greener. It can also be developped with simple and less expensive tools: building's orientation and envelop, location of trees and city parks, redesign of routes to give priority to pedestrian...

Water Potential

Water potential is analyzed for the Kadiköy district. A closer look has been taken of the rainwater in Kadikoy and the associated potentials and also the grey water treatment basins near the coast will be examined.

Rainwater

Every month there is approximately 139 million litre rainwater falling down on the surface of the complete area of Kadiköy. (See spreadsheet in appendix B) At the moment this water flushes away doing nothing which is a real pity. To illustrate how much water this is the following example is given. According to the NIBUD (2013) the average water consumption per household in the Netherland is 182 m3 per year which is approximately 15.000 litres per months. So with the water that is fallen down in Kadiköy around 9000 household can be provided from water. If you collect this water you could use it for multiple things, like watering the greenery in Kadiköy on city level, flushing the toilet which can be applied both on city level as on building level and cooling during the summer. This can be done on building level if everyone collects their own water and on city level with a system like the smart grid used in Amsterdam, the Netherlands. Collecting water on roofs can be made easier If PV cells are installed on the roof. The water that slides off can be gathered easily with an small piping system.

Grey water

At the moment there are two water treatment basin located near the coastline of Kadiköy. See figure 32 for the exact location. The current plans of the municipality of Kadiköy is to remove these basins and relocate them because they are quite smelly and are in a strange location. This decision has many consequences and the main question is if this decision is the right one since there are a couple scenarios possible for these basins.

Scenario 1: Is remove the basins and relocate them. For this scenario and new location need to be found. In Kadiköy are less area unbuilt so this could be a problem to find a new location. Besides that a major disadvantage is that the whole infrastructure needs to be redone as well. Every house in the area is connected to these basins and it would be a major operation (which is very expensive) to change this to a new location. A advantage of removing these basins is that a lot of space near the coast become available for recreational purposes. It is a very nice area of Kadiköy and having it open and accessible for every citizen would be a real plus.

Scenario 2: Keep the basins and integrate them in the landscape. Make the water treatment plant more green with clean technologies and follow the example of the one in Amsterdam. This one is closed so no nasty smells anymore and a lot of energy is created and reused at the plant. Also investigate the possibilities of having a biogas utilization as well. This area could be a information point for citizen where they can learn about green design aspects and were they can see how things will work. This way you do not only keep the infrastructure and integrate it in the landscape but you also inform people about the new ideas of a green city.

Figure 32 - Water treatment plant in Kadiköy

Wind Potential

The wind direction is analyzed for Istanbul in general and for the location Kadiköy. The wind direction and wind speed are focal points. The goal of this analysis is to get an insight of when heating and cooling is needed in which areas of Kadiköy and when the wind can be used to cool and heat to save energy and provide a more comfortable district. A quick look is taken at the wind speed and the possibilities to gain energy out of it. The used data is from Design Data 2005 ASHRAE Handbook; Location -- Istanbul – Turkey {N 40° 58'} {E 28° 49'} and the exact tables with the data per month (average) can be found in appendix C.

Wind direction

The wind direction is divided in an average for summer and winter. For the summer the hottest months are chosen; April to September and for the winter the coldest months; October to March (Climate Consultant 5.4 – Istanbul, 2013). Within these months the wind directions are analyzed and put together to find the dominant wind. The figures of wind illustrated per wind direction per month and season are shown in appendix C. This together with the numbers, percentages of the amount of wind from each direction is made what resulted in a clear overview placed on a map of Kadiköy so conclusion can be drawn.

The maps of the summer and winter situation are shown in figure 33 and 34.

The results from this analysis are shown in the table below. In the map of Kadiköy several important areas are marked which influence the wind. The upper orange circle is the northern hill of Kadiköy and the lower orange one is a hill as well. The green circle represents a valley and is in between the two hills. This is going to have consequences for the temperature over there.

Dominant wind

The dominant wind during the summer is North-Northeast. While the dominant wind during the winter months is the same besides that there is also quite an amount of wind coming from the Southwest.

Summer

During the summer the area of the northern hill is okay. The temperature is acceptable thanks to the cold wind from the north and northeast. This cools down and that is why less cooling is needed in this area. Along the coast line it is a hot zone with very little shadow. There is almost no wind and the wind that is there is hot. To let people enjoy this zone as recreational area

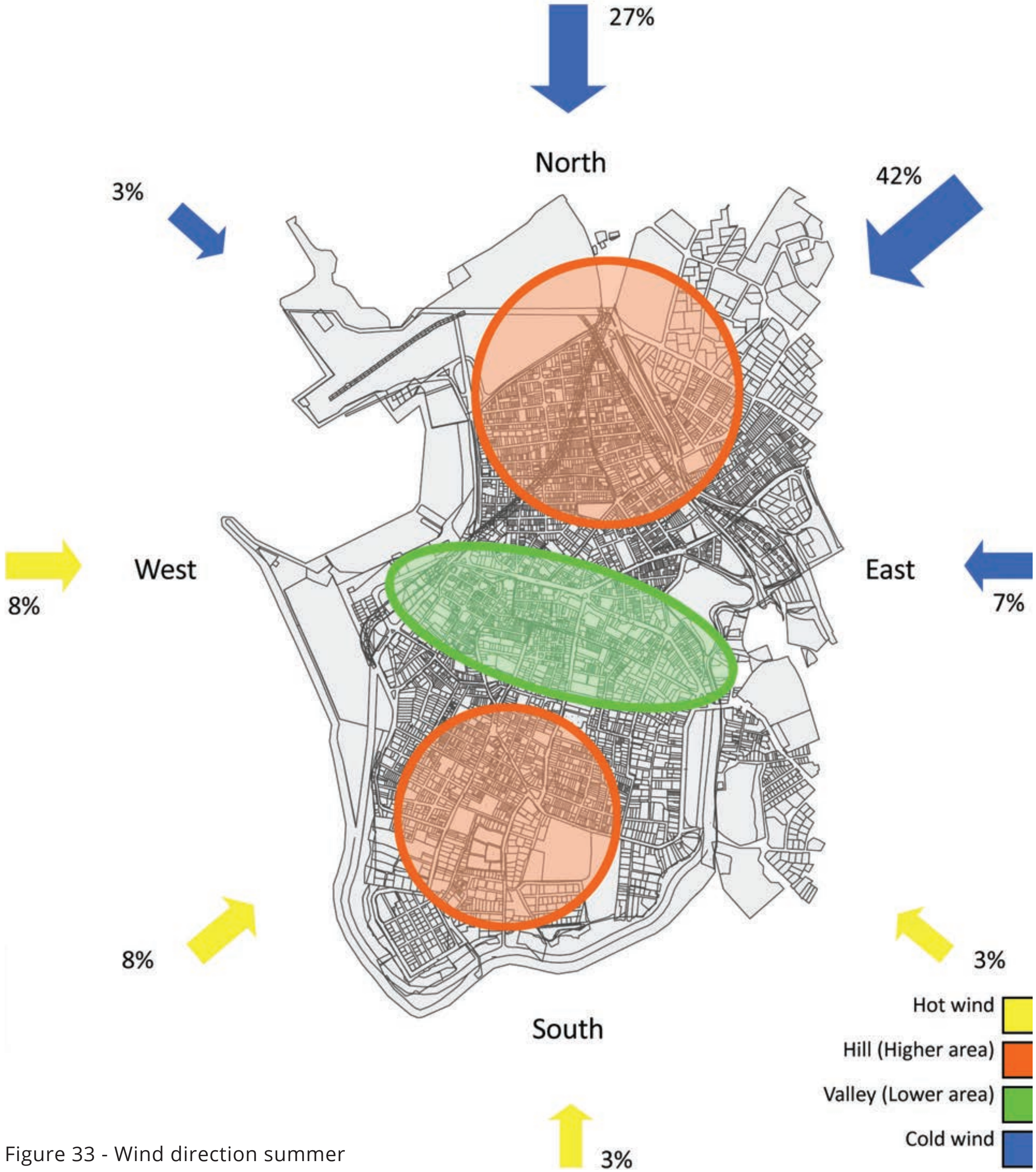


Figure 33 - Wind direction summer

there should be more shadow places to give them the feeling of a cooler area. In the valley in between the slopes there is no ventilation and no natural cooling because the cold wind from the north is blocked by the northern hill and the higher buildings from the east and hot wind is entering this area from the sea. So in this area there is a large demand for cooling during the summer. Besides that this area suffers from stuck gasses, microclimate and heat island effects. Lastly the area of the southern hill. This area is only getting hot wind and all the cold wind is blocked by the other slope. So this is a very hot zone during the summer and a lot of cooling is needed in this area.

Winter

During the winter the area of the northern hill is very cold thanks to the dominant wind. This results in a large demand for heating during these cold months. If this area contains a large business district this could be compensated by the extra heat these areas usually produce. Unlike during the summer the coast line is during the winter divided into two zones. The upper part of the coast like is very chilly during the winter season thanks to the dominant wind that passes by and also comes from around the northern hill. Extra heating is needed here and wind protection is advisable. Secondly the other part of the coastline near Moda, here the temperature is okay and less heating compared to other areas is needed because of the supply of the relatively hot south-western wind. But this wind makes it rather windy this period of time. This area almost has no wind and no ventilation just like in summer. In the Hotter than the area of the Southern hill thanks to location and the nearby slopes. Then the valley, this area has almost no wind and no ventilation just like in summer. It is an hotter area than the area of the southern hill thanks to location and the nearby slopes that blocks the cool wind and relatively less heating is needed. Lastly the area of the southern hill. The temperature is okay thanks to the hot south-western wind during the winter, this results in a lower demand of needed heating.

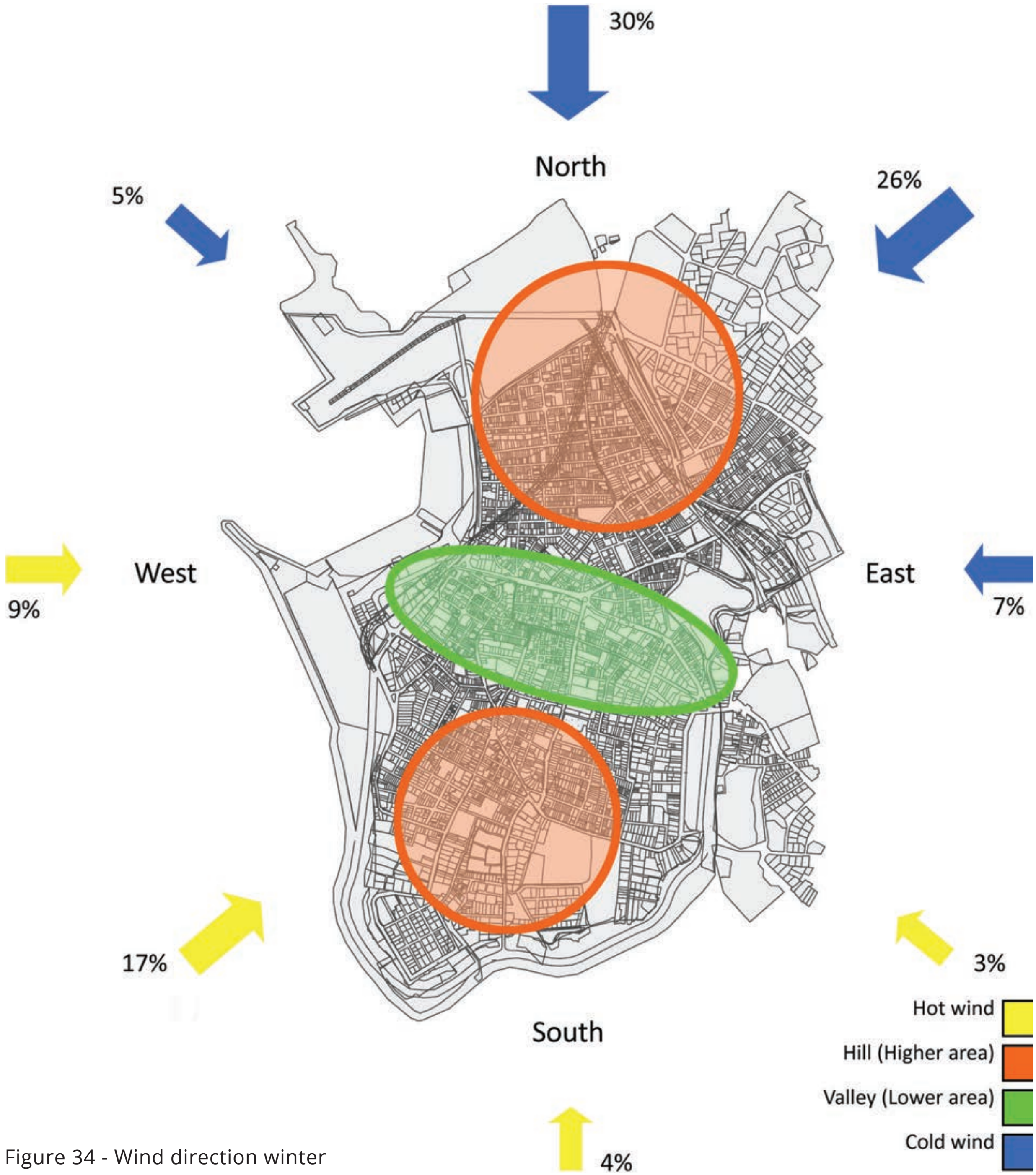


Figure 34 - Wind direction winter

Wind speed

Before the results of the wind analysis are shown some remarks has to be made. First, for this analysis the wind speed average of Istanbul in general is used and for further and more precise analysis more detailed information about Kadiköy and especially the waterfront is needed. During this project there was some data about wind speed and directions available for Kadiköy but to get clear results out of it would have taken too much time and compared to the Istanbul data there were on the first eye no significant differences. Besides that especially the waterfront of Kadiköy is interesting for this analysis and the calculations of energy gain from windmills. Since this information is still missing there is decided to use the averages of Istanbul for now.
According the results the average wind speed in summer is 4,7 m/s and the average wind speed during the winter is 4,8 m/s. So there is a bit more wind during the winter months. According to the Bauefort numbers (see table) these speeds are within the acceptable range. A speed of 4,7-4.8 m/s is categorized as a group 3 which correspondents with a fresh wind. Important is to look for peaks near the coastline of Kadiköy when the new data is available. These peaks should be within the acceptable range of the Baufort numbers 0-5; calm to severe wind, otherwise measurements should be taken. The predicting is that these peaks are higher than a category 3 on the Baufort list since Kadiköy citizens told that the coastline during the winter is really unbearable thanks to the strong and cold northeastern wind. If that is really the case it is recommendable to place windshields at recreation places at the waterfront. Preferably demountable because the wind at the coastline is acceptable during the summer.

Baufort scale	Descriptions	Speed	
		m/s	Km/h
0	Calm	0-0.2	1
1	Light air	0.3-1.5	1-5
2	Light breeze	1.6-3.3	6-11
3	Gentle breeze	3.4-5.4	12-19
4	Moderate breeze	5.5-7.9	20-18
5	Fresh breeze	8.0-10.7	29-38
6	Strong breeze	10.8-13.8	39-49
7	Moderate storm,	13.9-17.1	50-61
8	Gale, fresh storm	17.2-20.7	62-74
9	Strong storm	20.8-24.4	75-88
10	Storm	24.5-28.4	89-102
11	Violent storm	28.5-32.6	103-117
12	Hurricane force	>32.6	>117

Table 1 - Bauefort scale

Solar Potential

The potential of solar energy has been analyzed for Kadiköy. The goal of this analysis is to get an idea of how much energy can be produced from the solar resources. Data for direct solar radiation and diffuse solar radiation have been provided by Energy Plus Weather Data. The global solar radiation has been calculated and is shown in figure 35.

Knowing the surface area of Kadiköy, the total amount of solar energy obtained from the sun over the area of Kadiköy has been calculated on a monthly basis. It is shown in the figure 36.

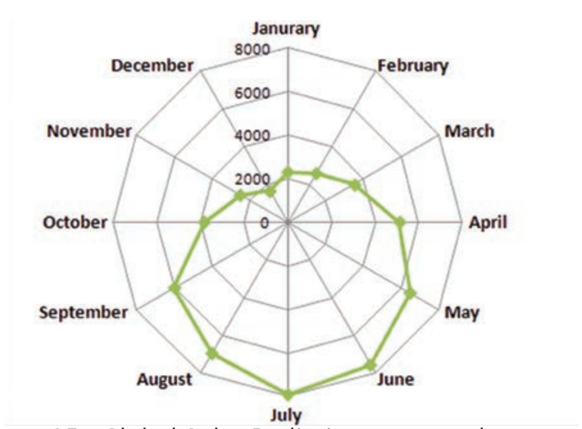


Figure 35 - Global Solar Radiation per month (Wh/m²) in Istanbul

However it has to be specified that the analysis has be done at a big scale for the whole area of Kadiköy. The limited data available didn't allow a distinction between the areas with higher solar energy potential and the others .

The yearly amount of solar energy received on the area of Kadiköy is 113MJ/m² and is shown in figure 37.

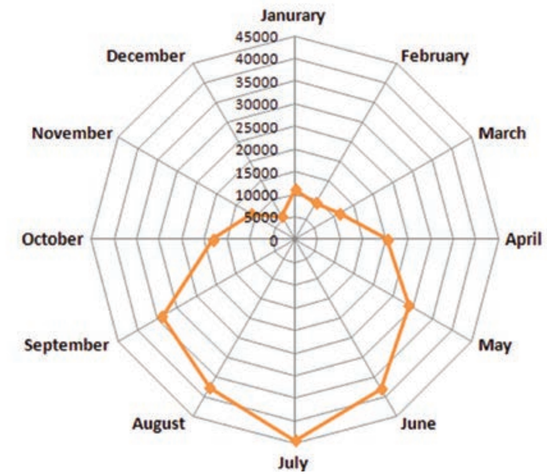


Figure 36 - Solar energy potential (GJ/month) in Kadiköy

FIgure 37: Yearly global Solar Radiation over Kadiköy

Geothermal Potential

Geothermal energy is heat obtained from the earth. It can be accessed by taking the heat from hot rocks in the form of steam or hot water located below the earth surface. On the one hand, geothermal power plants can be used to produce electricity. The hot water and steam from the geothermal activity are directed to the surface and are then redirected to drive steam turbines that run generators, producing electricity.
Geothermal energy can also be sued for heating/ cooling purposes. This energy can be accessed by shallow heat pumps.

The potential of geothermal energy has been analyzed for Kadikoy. Data for ground temperature have been provided by Climate Consultant 5.4. Once again it has to be specified that the ground temperature is an average over Istanbul and is not specific for the area of Kadiköy.

The ground temperature is shown in figure 40. It can be seen that as the depth increases, the temperature range over a year becomes smaller since the ground at the surface is always more affected by the changes along the year. Therefore, it appears reasonable to assume that there is a depth at which the ground temperature is stable over the year and around about 15 degrees.

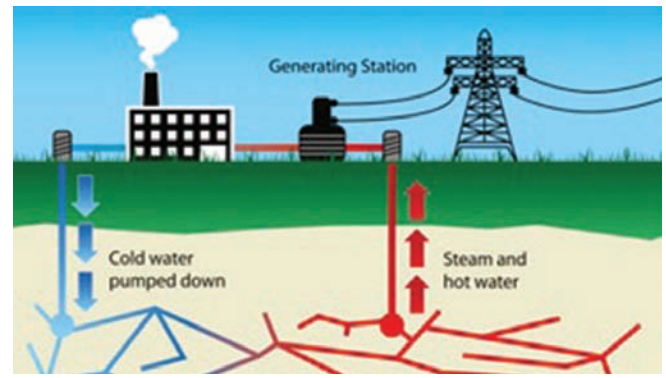


Figure 38: Geothermal power

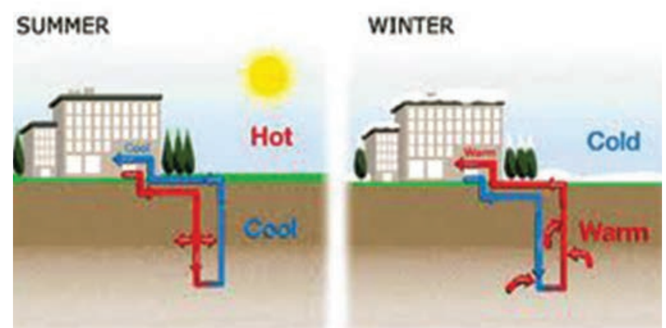


Figure 39: Geothermal energy combined with heat pump

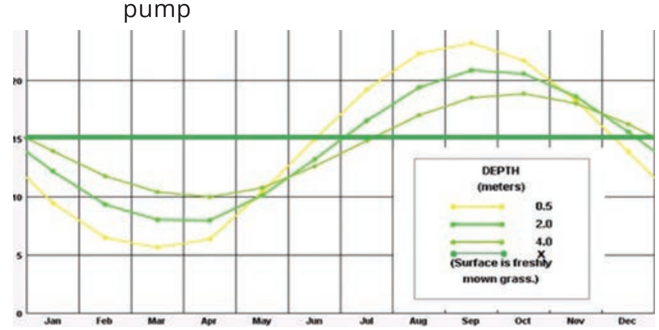
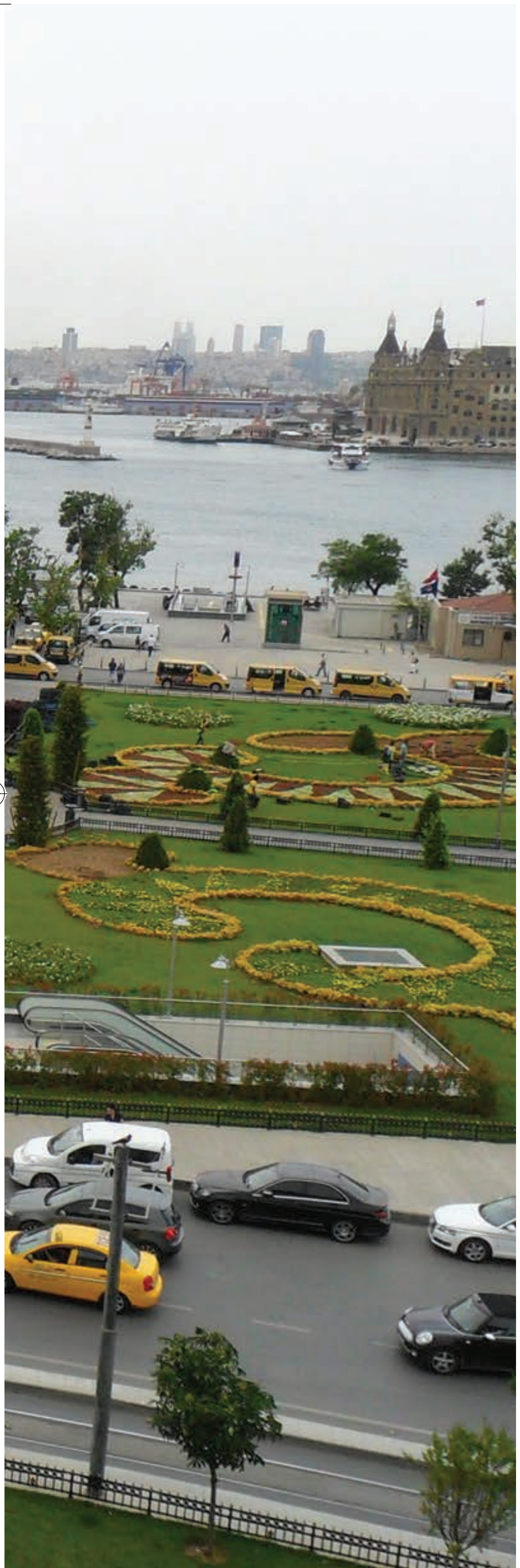


Figure 40: Ground Temperature in Instanbul at 0.5m, 2m and 4m deep



Chapter four

Green Design Recommendations

Recommendations Integration of Green Design Aspects

Energy Generation and Management

The way we deal with energy will shape our cities in the future. Green buildings will not be the focus anymore as synergetic networks will become more important.
First the potential of energy in the city needs to be analyzed. What is the energy consumption in the city? How big is the forest that can absorb the CO2 created by this consumption? How much space will be needed by wind farms, solar parks? How much m² of roof is available to convert solar radiation into electricity/to produce hot water?
Kadikoy can be surrounded by the generation of energy, a new powerful landscape that supplies the city. Energy generation could be completely distributed between the buildings. Is it possible to design a wireless city, where everything is decentralized? How can a smart grid with heat recovery between buildings throughout the city be implemented?

Solar Energy Potential in Kadiköy

The sun is the most significant source of renewable energy. Solar energy can be used directly or indirectly for heating, day lighting and generating electricity. Solar thermal conversion can be utilized to convert solar energy to thermal energy. The photovoltaic effect is used to convert solar energy to electricity.

In the chapter, the solar energy input has been given. The global solar radiation per m² over Kadiköy has been given. To calculate the amount of electricity that could be produced in the area of Kadiköy itself, some assumptions have been made:

The entire area of Kadiköy is covered by photovoltaïc cells The efficiency of the photovoltaïc cells is 20 % (which is the maximum value for photovoltaïc panels)

Figure 41 - Photovoltaïc cells

With these assumptions it has been calculated that more that 27 117 600 kWh can be produced over one year in the area of Kadiköy.

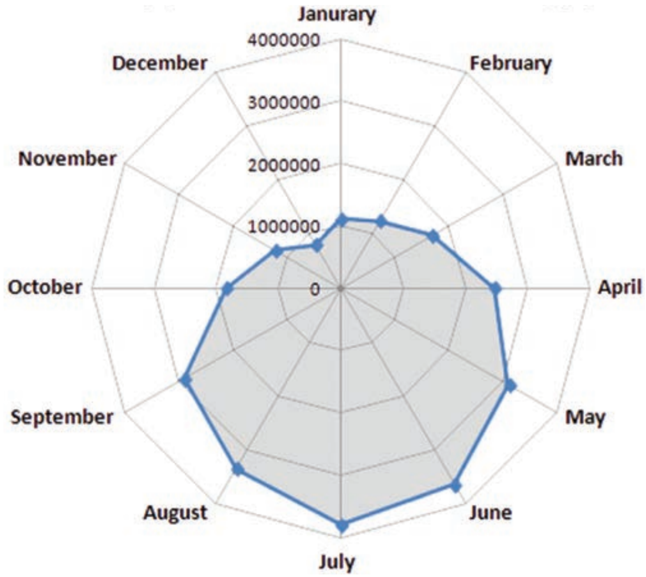


Figure 42 - Electricity produced from solar energy in kWh

In 2010, the World Energy Council annouced that the global average electricity consumption for households with electricity was roughly 3,500 kWh.

With the electricity production in the area of Kadiköy, it would be therefore possible to provide enough electricity to more than 7700 households.

Note: For further studies, the area of roads and open areas should be substracted from the area of Kadiköy in orden to only have the roof surface available in Kadikoy.

Geothermal Energy Potential in Kadiköy

The ground temperature in Istanbul has been provided in Chapter 3. Further in the development of the project, the idea is to find data that provide the depth in Kadiköy where the ground temperature stays stable over the year.

In this way, the heat from the ground can be used both in summer and winter for heating and cooling purposes. In combination with a heat pump, the water or steam just need to be heated up or cooled down a few degrees in order to obtain a comfortable inside temperature of 21°C.

Biogas

Biogas is a gas produced by the breakdown of organic matter in the absence of oxygen. It is a renewable energy source. Furthermore, biogas can be produced from regionally available raw materials and recycled waste. They also can be produced by green waste and plant materials (leaves, branches), agricultural waste, food waste, or even trash from the toilets. It is therefore environmentally friendly. The energy released during the process allows biogas to be used as a fuel. Biogas can be used as a fuel for any heating purpose, such as cooking. It can also be used in anaerobic digesters where it is typically used in a gas engine to convert the energy in the gas into electricity and heat. Roughly, 110 m^3 of biogas is produced from one tonne of organic waste, equivalent to 670 kWh of energy. Biogas can also be used in transport.

Making the assumption that the biological waste is 3 kg per day per person and adding 2 kg per day per person for green waste and plant materials, we would have 970 894 tonnes of organic waste, suitable for biogas (the population in Kadiköy was 531 997 hab in 2011) . This means that we could produce 650 498 980 kWh of energy per year. Once again, knowing that the global average electricity consumption for households with electricity is roughly 3.500 kWh it would be therefore possible to provide enough electricity to more than 185 800 households.

Location of office buildings and supermarkets

For future green design research the exact location of large heat producers like supermarkets and office buildings need to be mapped. They need a lot of heating and cooling because many people work there most hours of the day. If the exact location is known a proper plan can be made in order to reuse the waste heat. It is probably a good idea to create smart grid under Kadiköy to which these buildings transport their excessive heat so that it can be reused at another location and/or in another period of time. On the one hand, the heat going out from the buildings, when the doors stay open could be captured by a specialized system and on the other hand, the heat from the refrigeration systems in supermarkets could be recovered.

Water potential in Kadiköy

Rainwater

According to the rainwater records there is quite a lot of rainwater falling down in Kadiköy and this is currently all spilled. This is a great pity because if all rainwater could be collected in Kadiköy around 9000 households could be provided from water each month. This water provides opportunities for using this it and making this part of Istanbul a bit more green and the people more aware. For example, This rainwater could be used for: flushing the toilet, cooling during summer months and water local greenery.

It is recommended to create a smart grid (like in Amsterdam) underneath Kadiköy so that a piping system is made where everyone can take and give the rainwater that had fallen on their property. This way the rainwater can be used on city level instead of building level only.

Grey water

Besides rainwater there is also something been said about grey water. At the moment there is a grey water basin near the coastline of Kadiköy. The municipality of Kadiköy wants to replace it (option one) but there is also a possibility to keep it and modernise it and make it more green (option two). Both options has consequences. These need to be taken into account.

Option one: Replace the greywater basin

- (-) All piping need to be rearranged which is extremely expensive
- (-) New location need to be found but empty spaces are rare in Kadiköy
- (+/-) Feels like replacing the problem if the basin will not be modernised and cleaner
- (+) Extra space available at the coastline for recreation

Option two: Keep the greywater basin

- (-) A beautiful lot near the coast cannot be used as recreational area
- (-) Negative image, since the current basin is smelly and takes up much space
- (+/-) Implement clean technologies and follow the example of Amsterdam (expensive)
- (+/-) need to be integrated in landscape which is expensive
- (+) piping can be kept
- (+) Investigate the possibilities to add a biogas utilization
- (+) Possibility to make it an educational area for citizens to inform them about sustainability

These aspects need further investigation before a informed opinion can be formed, but the outlines are already here.

Wind potential in Kadiköy

The wind potential in Kadiköy is analysed with general data of Istanbul. The first recommendation is to redo this analysis with more specific data of Kadiköy and especially the waterfront of Kadiköy. The steps that are taken here can be mimicked. The prediction is that this new data mainly changes the results of the wind speed.

Wind direction

According to the results of the performed analysis the dominant wind is North-Northeast both in summer and winter. Kadiköy is defined during this analysis in four main areas; coastline, northern hill, southern hill and the valley in between the slopes. For the summer these conclusions can be drawn:

- The northern wind cools down the area of the northern hill, so less cooling in needed here.
- The northern wind got blocked by the northern slope so the valley is very hot and the air quality is low. There is no natural ventilation and a lot mechanical cooling needed.
- The coastline is hot. There is almost no wind and not much shadow. It is recommendable to create more shadow to give the people the feeling there is a cooler place to chill.

- The area of the southern hill is very hot during the summer. There is no cool wind and the wind from sea is hot. This results is a large demand for cooling these months.

For the winter there are some other conclusions could be drawn.

- The northern hill area is very chilly thanks to the dominant wind. Therefore there is a a lot of heating needed.
  - If this area has some business districts this need can be compensated by the extra heat these neighbourhoods produce.
- The valley is almost the same as in the winter. Still no ventilation and no wind. But this area will be hotter than the area of the southern hill in winter thanks to the location between the slopes.

- The southern hill area is way more comfortable during the winter than summer. The temperature is okay now thanks to the hot sea wind which lead to a lower demand for heating.

- The coastline is divided in two parts during the winter.
  - The temperature is okay at the coastline near Moda, but the area is quite windy.
  - The upper part of the Kadiköy coast is very chilly thanks to the dominant cold wind. Extra heat is needed and wind protection is recommended.

Wind speed

Lastly the wind speed. For this analysis the wind speed average of Istanbul in general is used and for further and more precise analysis more detailed information about Kadiköy and especially the waterfront is needed. The waterfront is interesting because than we can calculate if we could gain much energy from windmills and green solution to provide energy to Kadiköy.

According the results the average wind speed in summer and winter is nearly the same. According to the Bauefort numbers these speeds are within the acceptable range and need no extra actions. But these average wind speed numbers can give us a wrong impression. According to citizens the coastline is very windy and unbearable during the winter. If the new more specific wind speed data confirm these comments it is advisable to place windshields at recreation places at the waterfront. Preferably demountable because the wind at the coastline is acceptable during the summer.

Transportation planning and management for Ecomobility

When talking about transportation, undesirable side effects appear immediately: traffic saturation, accidents appear to be an issue in Kadiköy. Besides noise and air pollution, emissions of greenhouse gases which can impact global climate change are still unavoidable. The new transportation planning should focus on the following points:

- Improve customer service, reduce emissions of greenhouse gases, reduce noise pollutions, reduce congestions, reduce environmental impact improve efficiency, reduce driver stress, improve safety

- Promote intermodality, use of renewable energy sources (electric cars, bus…)
- Virtualized intersection intelligence (traffic control in the cloud)

- Adaptive traffic signaling based on changing priorities determined from environmental and situational sensors.
- Traffic-adaptive demand management for congestion pricing
- Demand-responsive parking management

Along with theses focus point, the public spaces need to remain both lively and livable. The transportation lines don't work as a boarder as it is now the case in Kadiköy. Transportation nodes are organized both horizontally: train station, bus station, ferry station, bicycle paths… and vertically: parking lots, metro…


Figure 43 - Running bypassers in Kadiköy

In terms of design, special attention has to be paid to the access route to the transportation nodes to make the zone more attractive and stimulate people to use public transport instead of cars. It has been observed that people are just bypassers as it can be seen in figure 43. People do not even take the time to admire the view
The key factors are underlined below:

- Liveliness: amount of people and activities all along the day
  - Mixed Use: people attractors are various (offices, residences, shops, places of education, recreation and entertainment)
  - Use along the day
  - Social safety
- Human Scale: the physical setting of Kadikoy matches the size of human being
  - Permeability: Short city blocks, more opportunity to turn corner
  - Walkability: walkable distance between different modes of transport
- Legibility of public space:
  - Good orientation
  - Linearity of the path so that people dont lose their orientation
  - Clarity of Maps and signage: it is easy for people to find their way
- Safety and Comfort:
  - Pedestrian priority
  - Maintenance: feeling of safety for people

The design of transportation nodes is very complex. Not only the locations of the different transport modes is important but also the access routes between them. By paying a particular attention to the factors enounced above, people will be more willing to use public transport and this will therefore lead to a reduction of car use and CO_2 emissions within the area, making the city greener.
Besides, in an ideal case, a public transport system of electric buses, electric cars and other clean-energy vehicles should be integrated. The private vehicles should be kept at the edge of the area of Kadiköy in parking lots that would be linked by public transportation to the rest of the city.

Sustainable building materials and waste management

Nowadays unsustainability is due to at least four basic problems which are more or less unsolved:

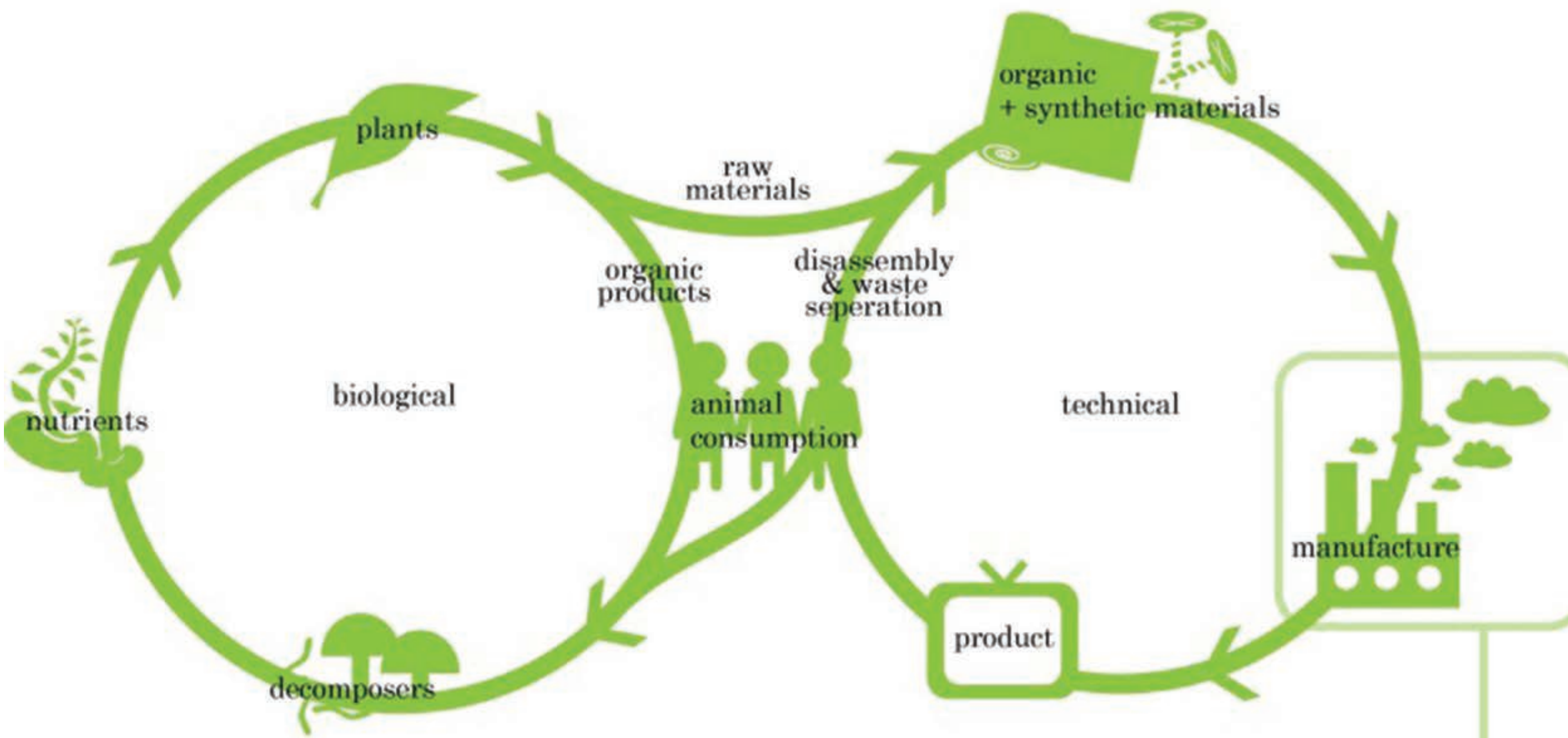
- Over-consumption: the use of material and energy for packaging and the products themselves keeps increasing.
- Resource utilization: too much energy and material is lost during production and transportation, which includes waste materials en emissions.
- Pollution
- Over population: an increasing amount of energy and materials is due to the population growth

The composition of materials used in everyday products and buildings is key factor in their environmental impacts. Products and processes are environmental friendly. They do not pollute, affect human health or limited natural resources. A cradle to cradle approach is necessary to help reduce the waste. Some general design advices for more efficient use of materials are underlined:

- Modular design: Easy to repair and change of components
- Design for material substitution
- Material efficient designing: as little material as possible is used
- Design for disassembly: the product is easy to disassemble
- Design for recycling: different materials should not be mixed if not necessary
- Design for reusability: possible reuses of different components are taken into account
- Design for disposability: non recyclables part or materials can be disposed in an ecological way
- Design for energy recovery: the materials are suitable for burning with a minimum of toxic or harmful emissions

According to step 2 of Trias Hylica and the “Cradle to Cradle” principles, the materials chosen for public spaces and buildings preferably come from renewable sources and recyclable materials. They can safely return in a biological cycle or technical cycle in which the value and quality of the materials remain intact or even improve over time. There is no such thing as waste, like there is no waste in nature. The leaves of trees fall to the ground where they are broken down and become nutrients for other organisms. In the same way, buildings could serve as a primary source for new construction. The waste becomes a “raw material”. The materials used are beneficial to human health and the environment. To achieve this, the use scenario of the materials needs to be identified. The components/ nutrients and sources of each building element is known.

To contribute to awareness, Cradle to Cradle urban furniture such as bus stop, benches, should be introduced into the area of Kadiköy.



5
criteria

1 100% Renewable Energy Use

2 Water Stewardship clean water output

3 Social Responsibility positive impact on community

4 Material Reutilization recyclability / compostability

5 Material Health impact on human & environmental

Landscape and Greenery

The design of landscape elements is a significant component of green cities. With appropriate use and integration of landscape elements, it is possible to achieve remarkable reductions in energy and resource consumption. Landscape elements can provide such benefits to buildings as shelding them from the sun, protecting them against the wind, providing opportunities for natural ventilation and facilitating passive cooling. Besides, landscape strategies can be utilized to develop ecological habitats for wildlife, clean the air and water, absorb floodwater, and provide added recreational amenities and improve aesthetics. With the potential benefits that can be achieved through proper landscape design, its consideration is essential to a sustainable approach to the design and construction of the built environment.

Microclimate in Kadiköy

Microclimate describes a small and local climate zone that can be differentiated from the dominant climate of the surrounding area. A microclimate can have significant impacts on the local conditions of a site. The slope or aspect of an area can be a significant factor in microclimate. South facing slopes in the northern hemisphere are exposed to more direct sunlight and are therefore warmer for longer periods of time.

The middle part of Kadikoy suffers from a microclimate. This area is situated between two high hills with one south-facing slope as it can been seen in figure 45. In summer, the temperature difference between these different zones is easily noticeable.

Figure 45 - Global mapping of heights in Kadiköy

Urban Heat Island Effect in Kadiköy

It refers to a microclimate phenomenon of increased temperatures in urban areas. It is mainly generated by the materials used in the urban environment, and by human activity. Concrete, stone, brick, from the built environment, have high levels of absorption for solar energy. The absorbed energy accumulated is slowly released as heat in the surroundings environment, which produces and maintains higher temperatures. Along with the urban materiality, waste heat is also a significant contributor to the urban heat island effect. Significant waste heat is generated by many urban activities, including mechanical heating and cooling,

lighting, transportation and machinery. The urban heat island effect can generate average temperatures 3°C to 5°C warmer in the urban core than the rural or open areas outside the urban area.
The situation described above is similar to the situation in the middle part of Kadikoy. This area is always crowded and there is a lot of traffic and different activities in this area. Due to both the valley and the high buildings; it cannot be properly ventilated, leading to higher air pollution and lower air quality due to the emissions besides the heat island effect.

Solar heat moderation

Solar radiation has significant impact on buildings, depending on building orientation, architectural form, and materials along with site condition aspects such as climate, geography and seasonal changes. During summer, solar radiation can heighten building temperature to undesirable levels and increase the need for mechanical cooling.

Hereafter, some suggestions are made in order to prevent the heat island effect and moderate the micrclimate.

Canopy Shading

The most effective shading arrangement for reducing maximum air temperatures is by shading the south-west and west-facing walls and windows. Shading other portions of the building and its adjacent site can also help to reduce ambient air temperatures around the building as well as indoor temperatures to some degree. The amount of incident sunlight depends on the foliage density. Large-canopy shade trees will typically block 80 to 90 percent of light transmission.

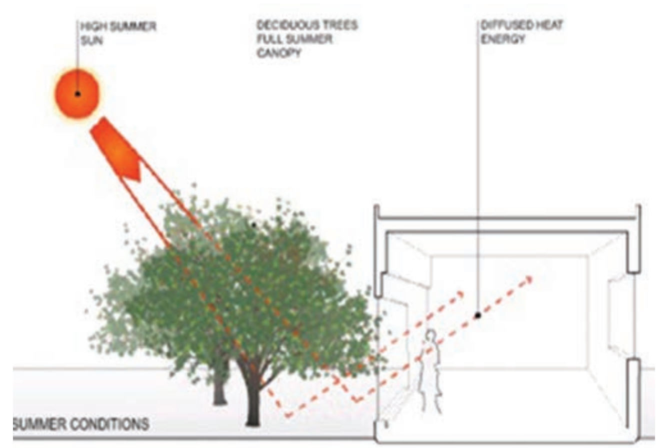


Figure 46 - Canopy shading: summer conditions

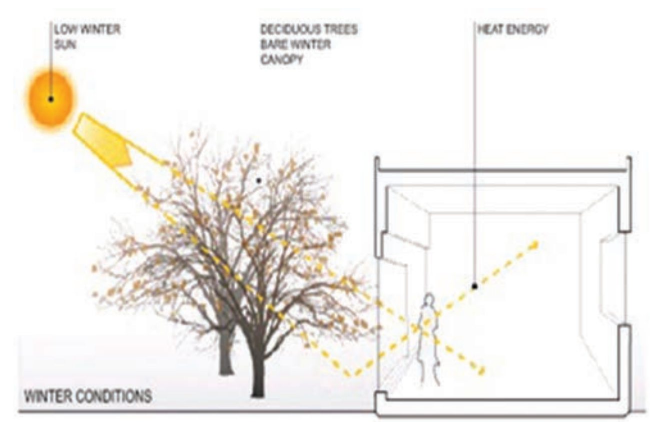


Figure 47 - Canopy shading: winter conditions

Site planting coverage

Paved surfaces tend to absorb solar energy and therefore generate heat that is then radiated back into the immediate environment, contributing to the urban heat island effect. Temperature over asphalt or concrete may be as much as 8°C to 14°Chigher than surrounding non paved areas. Site planting can be used to reduce solar heat gain through the cooling effects of evapotranspiration.

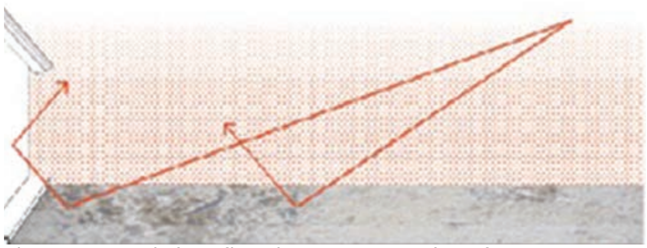


Figure 48 - High reflection on paved surface

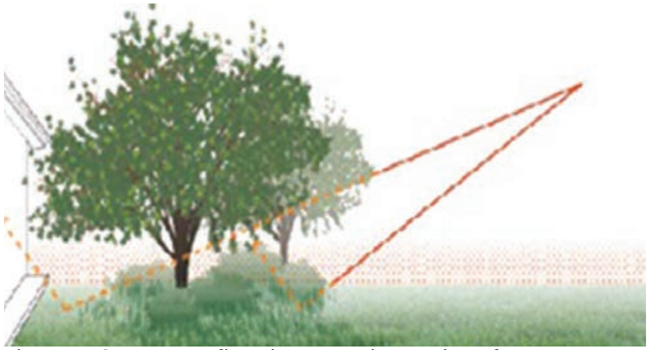


Figure 49 - Low reflection on planted surfaces

Vegetative surface systems:
green living walls and green roofs

These systems offer protection from solar heat in several ways. They form a buffer between building surfaces and direct sunlight and the evapotranspiration process reduces building's surface temperature.

Besides, they work as an additional insulation layer for the buildings. The effectiveness of green roofs in providing insulation has been studied extensively and well documented. The effect of green walls has been less studied but some early studies indicate significant insulating properties that can lead to improvements of 2°C to 11°C.

Vine covered walls is a relatively simple and low cost method of adding vegetated surface to a building. They do not require infrastructure as green living walls. However, these offer a level of increased design control. Living walls need an irrigation system.

Figure 50 - Facultaty of Mechanical Engineering
Yildiz University, Istanbul

In the same way, green roof are an alternative to conventional roof systems - that contribute to higher heat loads on and around buildings - due to their economic, environmental and aesthetics benefits.

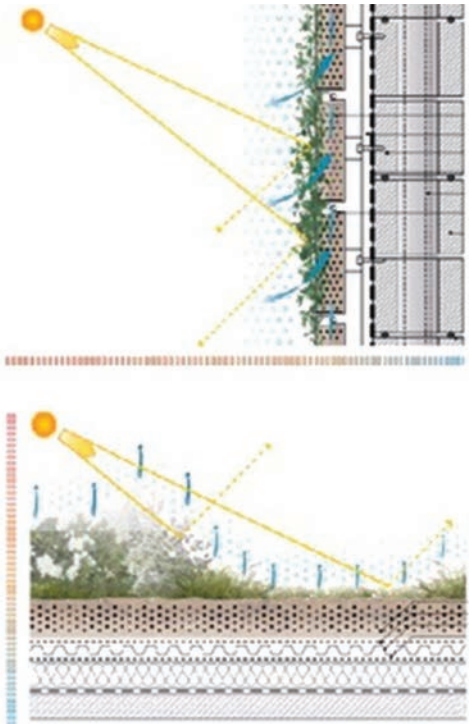


Figure 51 - Green living walls and green roof systems

Figure 52 - Green roofs in One&Ortakoy Project, Istanbul

On the one hand, canopy shading, site planting coverage, green living wlls and green roofs leads to lower temperature inside buildings and on the other hand they are incredible tools to prevent against the urban heat island effect since the green surfaces do not radiate back into the direct environment the absorbed solar energy.

Urban Farming

Cities have an important relationship with food. They are highly dependent on reliable supply, while what is left over after consumption forms a challenge for the cities' infrastructure.

Cities are real network of production and transportation of food. This network potentially provides healthy and diverse food, but is at the same time a weak point for cities. And it has a large impact on the environment. The production and transportation of food are responsible for a large share of today's global emission of greenhouse gasses. This is why we need more advanced plans for eco-cities such plans that include local food production.

Cities are not only consuming food, they are also digesting and disposing it. Food, as materials needs closed cycles. Food is produced within the city, consumed within the city, and the waste is used as fertilizers for the agricultural grounds and no longer disposed in the sea.

The question is the following: What is needed to provide Kadikoy with its 500 000 inhabitants with all the food it needs? How much food can we produce within the city? What new typologies can we create? What will be the effects on buildings, parks...? How can we close the food cycle in order make an end to the waste of nutrition?

A potential solution could be Vertical Farming. Vertical farms, many stories high, could be situated in the heart of the world's urban centers. They offer the promise of urban renewal, sustainable production of a safe and varied food supply, and the eventual repair of ecosystems that have been sacrificed for horizontal farming. Vertical Farming presents many advantages:

- No weather-related crop failures due to droughts, floods, pests
- Food is grown organically: no herbicides, pesticides, or fertilizers
- Farmland can return to nature, restoring ecosystem functions and services
- Reduction of many infectious diseases that are acquired at the agricultural interface
- Black and gray water can be converted into potable water by collecting the water of evapotranspiration
- VF adds energy back to the grid via methane generation from composting non-eatable parts of plants and animals
- Dramatical reduction of fossil fuel use (no tractors, plows, shipping.)
- Abandoned urban properties can be converted into food production centers
- Creation of sustainable environments for urban centers
- Creation of new employment opportunities
- Reduction of armed conflict over natural resources, such as water and land for agriculture

Figure 53 - Urban Farming, 'The living skyscraper' by Blake Kurasek

Figure 54 - Urban Farming, 'The living skyscraper' by Blake Kurasek

Biodiver"city"

In such a big city as Istanbul, people are completely disconnected from nature. The noise, the traffic, the pollution, the low air quality, the continuous flow of people, the lack of open views, the heat island effect, dense housing and overbuilding areas are factors that can easily lead to a "sick city syndrome".

A green city is thought as a way to fix the link between people and nature. The world has been abused by us, and it is time to "thank" the nature for what it has been providing us for centuries by reintegrating it in cities and allow meaningful relationships between humans and other species. Buildings should be designed as trees and cities as forests. The question is: what will be the city that both human beings and animals would love? Incorporating more greenery in cities facilitates the attraction and integration of new or facing-extinction species such as insects, butterflies, fishes or even birds.

Figure 55 - Bioderversity

Green Buildings

The characteristics of green building are smilar to the characteristics of green cities. The only difference is that they are applied at a smaller scale. The common objective is that green buildings as well as green cities are designed to reduce the impact of the built environment on human health and the natural environmen.

Buildings account for a large part of the annual energy consumption in modern societies. Within the European Union, the energy use by the built environment is more than 40% of the total energy consumption. Besides, 50 % of the materials resources taken from the nature and 40 % of waste production are building-related. In our traditional way of making buildings, there is a disconnection between on the one hand the ecological system which provides us with water, air, food and on the other hand the artificial man-made system which generally has a very negative impact on the environment (water, air, soil...) with high emission of CO_2 during the entire life of the building, from construction to demolition. The environmental capital is becoming smaller. That is why it is urgent to start thinking differently and bringing resources and materials back into the nature. The challenge is thus to make both liveable and lively buildings connected to the environment we live in. They have to be efficient using energy, water, and other resources. This is why a shift from centralized system to decentralized system in terms of energy production is necessary in order to avoid losses during energy transportation. They protect the occupant health and improve employee productivity. They don't produce waste, or if they do, the waste is managed in an environmental friendly way; they do not pollute or degrade the environment. Materials used are as long as possible from local resources. In a nutshell buildings are no longer thought as static systems.

Hybrid Buildings

In a context of scarcity of resources and limited available space, the first step of the design phase of new building should be the identification of different functions that buildings will be likely to accommodate during its life time. The traditional separation of functions of housing, offices, stores and restaurants in buildings, and sometimes even in entire neighborhood leads to excessive consumption of energy, under-utilization of space and lack of urban vitality. Hybrid buildings offer great flexibility in the evolution of its form which can welcome additional functions. Variety of function is provided by vertical or horizontal arrangement of the functions. Therefore, design for disassembly and flexibility plays a great role. The space is extendable (enlargement of the space, units can be added/ detached), and can be partitioned (rearrangements of space units)

Modular and upgradable spaces for evolutive buildings

These buildings are thought in order to anticipate two major sociological trends:

- The ageing of the population
- The moving because of lack of space when the population is getting married or having children

Accessibility and safety for elderly people, disabled people and children are therefore key focus point when designing an evolutive building.

The envelope of buildings

The envelope of buildings is the key factor in the energy consumption of buildings, responsible for about 50 percent of its energy needs. The façades should be defined as a function of the use and exposure of each building. In partially built-up area, renovation of existing building is a great challenge. Special attention has to be paid at the renovation of facades.





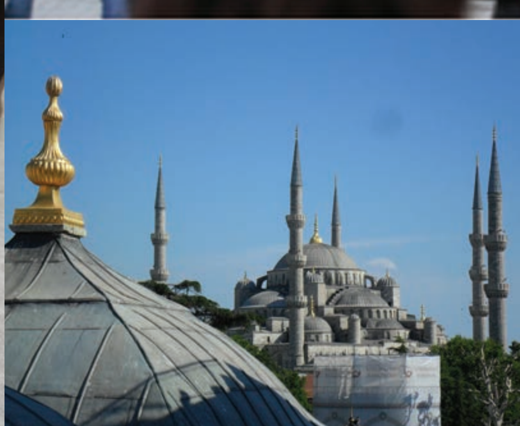








TAKSİM - TÜNEL



OCTAYYIP


MEHMET
AYVALITAS
(19) - ISTANBUL
ABDULLAH
CÖMERT
(22) - HATAY


TURKCELL


POLİS
Gümüşsu
Taksim
Milyonları
topla gel Tayyip,
kafamız
bir milyon olsun.

Conclusion

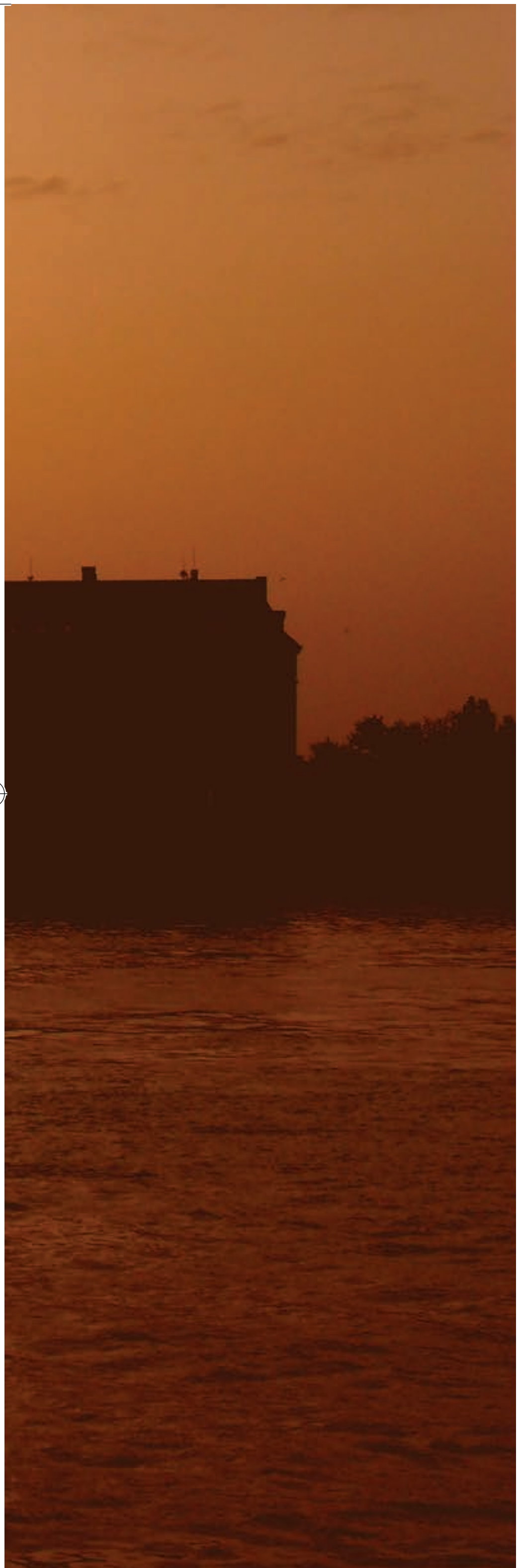
Conclusion

Planning of Kadiköy waterfront deals with complex relationship between water front/harbour and railway infrastructure as part of higher jurisdiction and decision making on the state/city level and business, recreation and housing districts as a part of lower jurisdiction and decision making on municipality level. The major focus of the studio was on integral analyses of the potentials of the second important cultural, recreational centre of Istanbul, called by many a port to Asia. The elements of special planning with all its physical, social and infrastructural characteristics were considered in the analyses as well as aspects of green city design and possible transformation areas were indicated.

The result of the studio work is presented in a form of definition of green design potentials of Kadiköy and recommendations for the integration of these design aspects into a further integrated planning strategy of the area.

The book illustrates the process of analyses through number of decision making steps and gives a detailed overview of the potentials per aspect for the further planning of Kadiköy.


CAUSE
ANALYSIS
Find Cause
ANTICIPATE
&
PLAN
Assure Success
TEAMWORK
CREATIVE
PROBLEM
SOLVING
New Ideas
DECISION
MAKING
Best Choice



Appendix
A-C

Appendix A - Solar Energy Potential

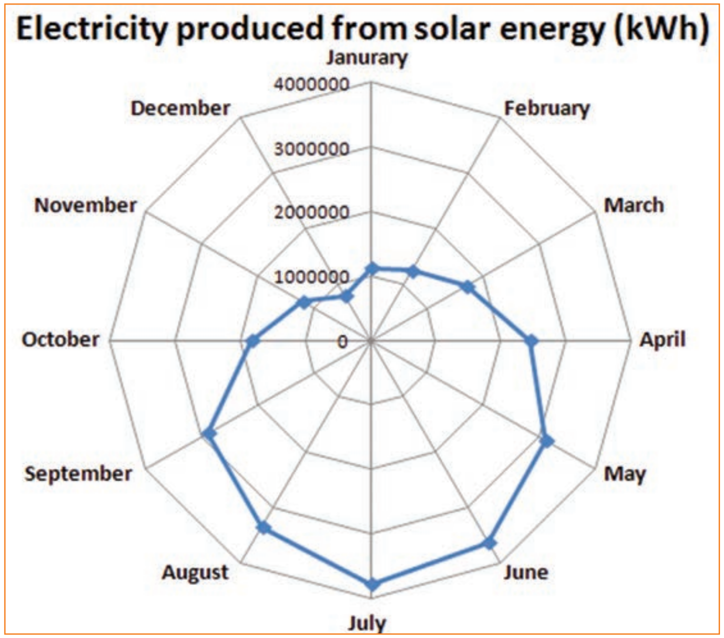
Appendix B - Water Potential

Appendix C - Wind Potential

Appendix A - Solar Energy Potential

Month	Janurary	February	March	April	May	June	July	August	September	October	November	December	Total
Direct Normal Solar Radiation (Wh/m^2)	1283	1080	1313	2359	3364	4400	5124	4363	3922	2099	1299	685	31291
Diffuse solar radiation (Wh/m^2)	1036	1518	2199	2760	3114	3169	2771	2602	2100	1736	1214	985	25204
Global Solar Radiation(Wh/m^2)	2319	2598	3512	5119	6478	7569	7895	6965	6022	3835	2513	1670	56495
Global Solar Radiation (MJ/m^2)	5	4	5	8	12	16	18	16	14	8	5	2	113
Electricity produced (kWh)	1113120	1247040	1685760	2457120	3109440	3633120	3789600	3343200	2890560	1840800	1206240	801600	27117600
GJ (over Kadikoy)	11085	9331	11344	20382	29065	38016	44271	37696	33886	18135	11223	5918	270354

Table 2 - Speadsheet of the solar engery potential



	Janurary	February	March	April	May	June	July	August	September	October	November	December
0:00-1:00	0	0	0	0	0	0	0	0	0	0	0	0
1:00-2:00	0	0	0	0	0	0	0	0	0	0	0	0
2:00-3:00	0	0	0	0	0	0	0	0	0	0	0	0
3:00-4:00	0	0	0	0	0	0	0	0	0	0	0	0
4:00-5:00	0	0	0	0	0	0	0	0	0	0	0	0
5:00-6:00	0	0	0	0	2	10	6	0	0	0	0	0
6:00-7:00	0	0	0	16	104	159	132	73	26	0	0	0
7:00-8:00	0	1	19	91	180	284	267	227	180	58	4	0
8:00-9:00	52	48	71	164	255	401	367	351	317	159	82	37
9:00-10:00	128	116	122	222	288	461	421	414	399	247	150	93
10:00-11:00	188	177	163	267	297	462	449	448	451	311	189	114
11:00-12:00	203	182	187	284	341	476	518	485	475	331	206	109
12:00-13:00	214	172	194	292	366	471	536	500	491	329	223	103
13:00-14:00	217	150	201	304	397	443	545	517	485	304	219	94
14:00-15:00	167	128	177	278	399	421	570	482	445	218	159	87
15:00-16:00	103	84	122	241	354	367	545	424	376	122	67	46
16:00-17:00	11	23	55	158	265	280	470	308	235	20	0	0
17:00-18:00	0	0	2	41	116	144	248	133	42	0	0	0
18:00-19:00	0	0	0	0	2	22	48	2	0	0	0	0
19:00-20:00	0	0	0	0	0	0	0	0	0	0	0	0
20:00-21:00	0	0	0	0	0	0	0	0	0	0	0	0
21:00-22:00	0	0	0	0	0	0	0	0	0	0	0	0
22:00-23:00	0	0	0	0	0	0	0	0	0	0	0	0
23:00-24:00	0	0	0	0	0	0	0	0	0	0	0	0

Table 3 - Speadsheet Solar radiation each hour per month

Appendix B - Rainwater Potential

Average Rainfall Istanbul	Jan	Feb	Mrt	Apr	Mei	Jun	Jul	Aug	Sep	Okt	Nov	Dec
[mm] [L/m^2]	57,6	69,5	61,8	41,5	39,5	24,6	31	37	43,7	100,1	85,7	102

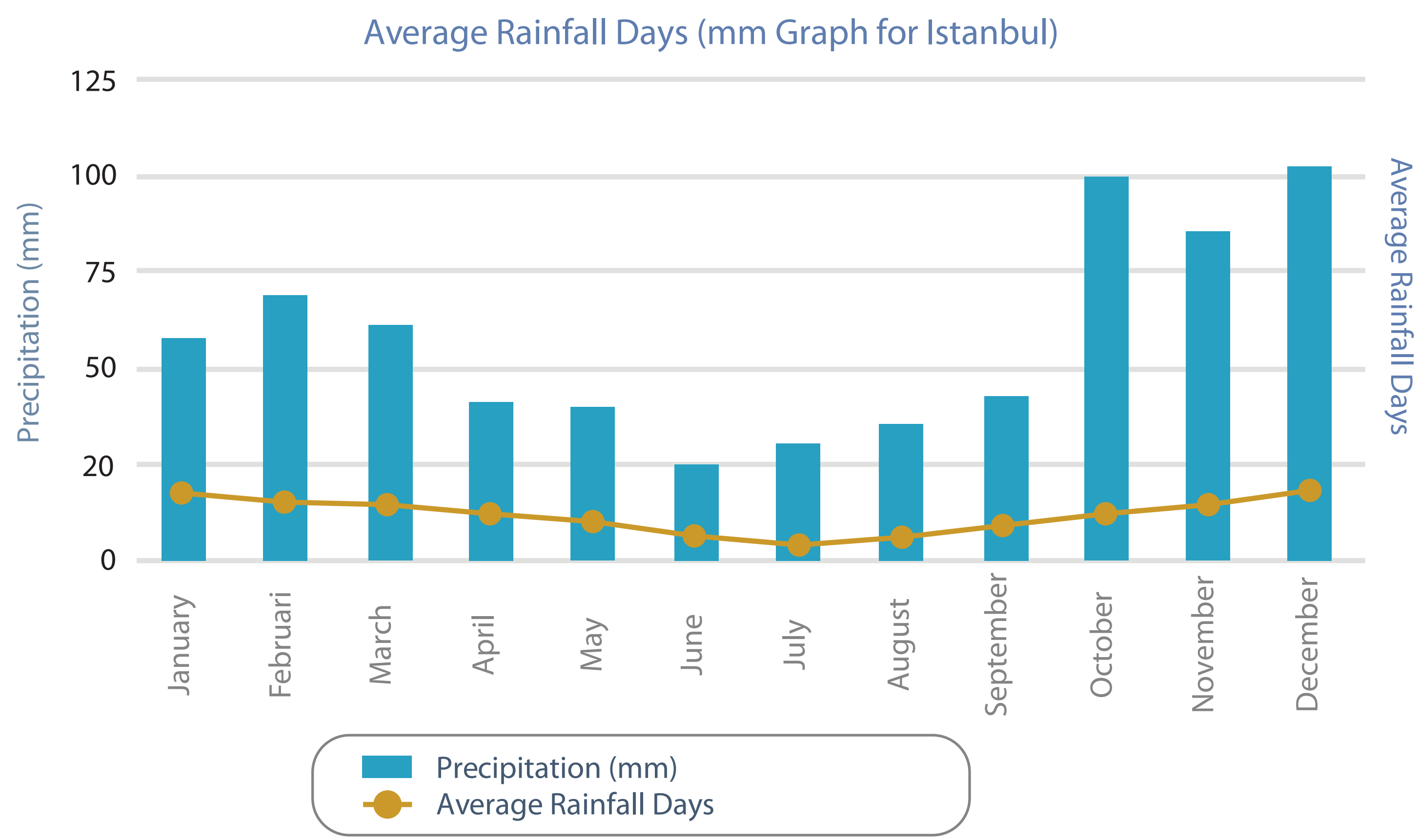
Kadikoy surface
2400000 m^2

Rainfall in Kadikoy	Jan	Feb	Mrt	Apr	Mei	Jun	Jul	Aug	Sep	Okt	Nov	Dec
[Liters]	1E+08	2E+08	1E+08	1E+08	9E+07	6E+07	7E+07	9E+07	1E+08	2E+08	2,06E+08	2,45E+08
[Liters*10^6]	138,2	166,8	148,32	99,6	94,8	59,04	74,4	88,8	104,9	240,2	205,68	244,8

Avg monthly Rainfall
138800000 Liters
139 10^6 Liters

Source: Rainfall in Istanbul (From:http://www.worldweatheronline.com/Istanbul-weather-averages/Istanbul/TR.aspx)

Table 4 - Speadsheet about the rainfall in Istanbul/Kadiköy



Graph 1 - Graph with data about the average rainfall in Istanbul

Appendix C - Wind Potential

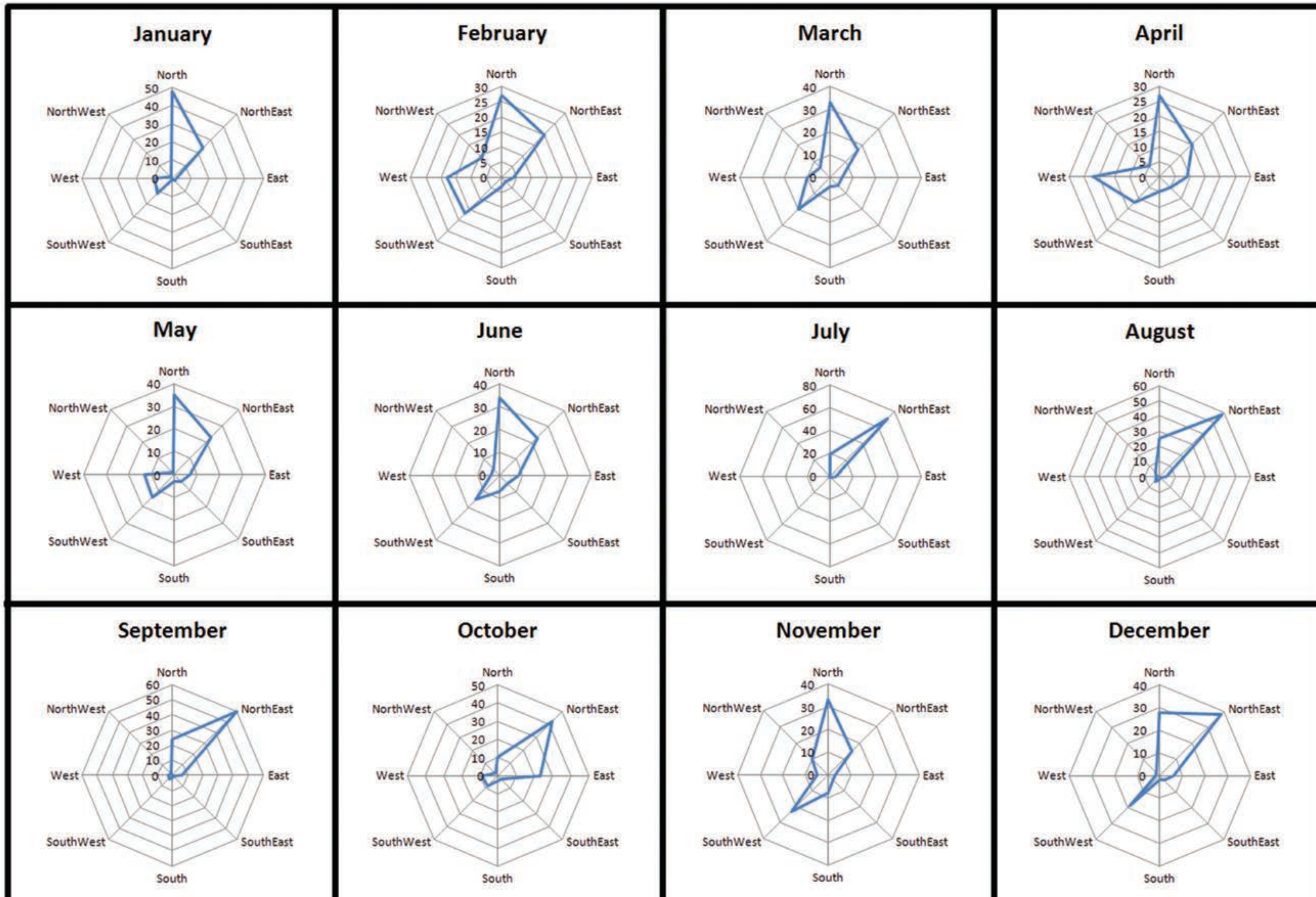
Wind direction	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
North	48	27	33	27	35	34	19	25	24	10	33	28
NorthEast	24	20	17	15	23	23	72	58	60	42	15	38
East	2	4	5	9	7	8	5	4	6	23	3	6
SouthEast	2	2	5	5	4	5	1	1	1	3	3	3
South	1	3	4	5	3	7	1	2	2	3	8	2
SouthWest	12	17	20	12	14	15	1	4	3	8	23	19
West	10	18	10	22	13	4	1	2	3	9	5	2
NorthWest	1	9	6	5	1	4	0	4	1	2	10	2

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avg Speed [m/s]	4,8	5,5	4,1	4,1	4,4	4	5,8	5,7	4,9	4,2	4	5,6

Avg Speed winter	4,7
Avg Speed summer	4,8

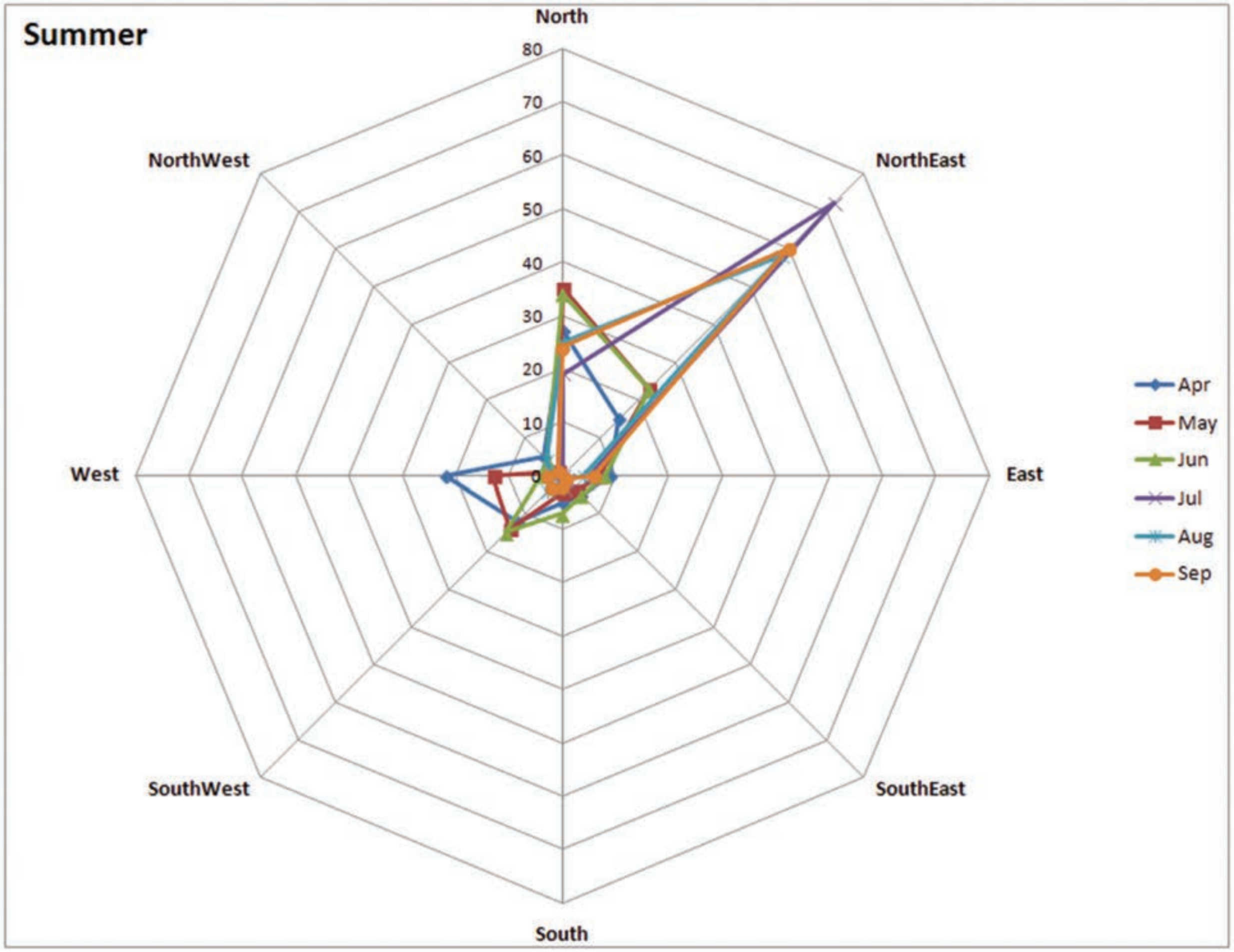
Table 5 - Speadsheet about the winddirection and windspeed
On the right the percentages are given

	Summer		Winter	
	Sum	Percentage	Sum	Percentage
North	164	27	179	30
NorthEast	251	42	156	26
East	39	7	43	7
SouthEast	17	3	18	3
South	20	3	21	4
SouthWest	49	8	99	17
West	45	8	54	9
NorthWest	15	3	30	5
Total	600		600	

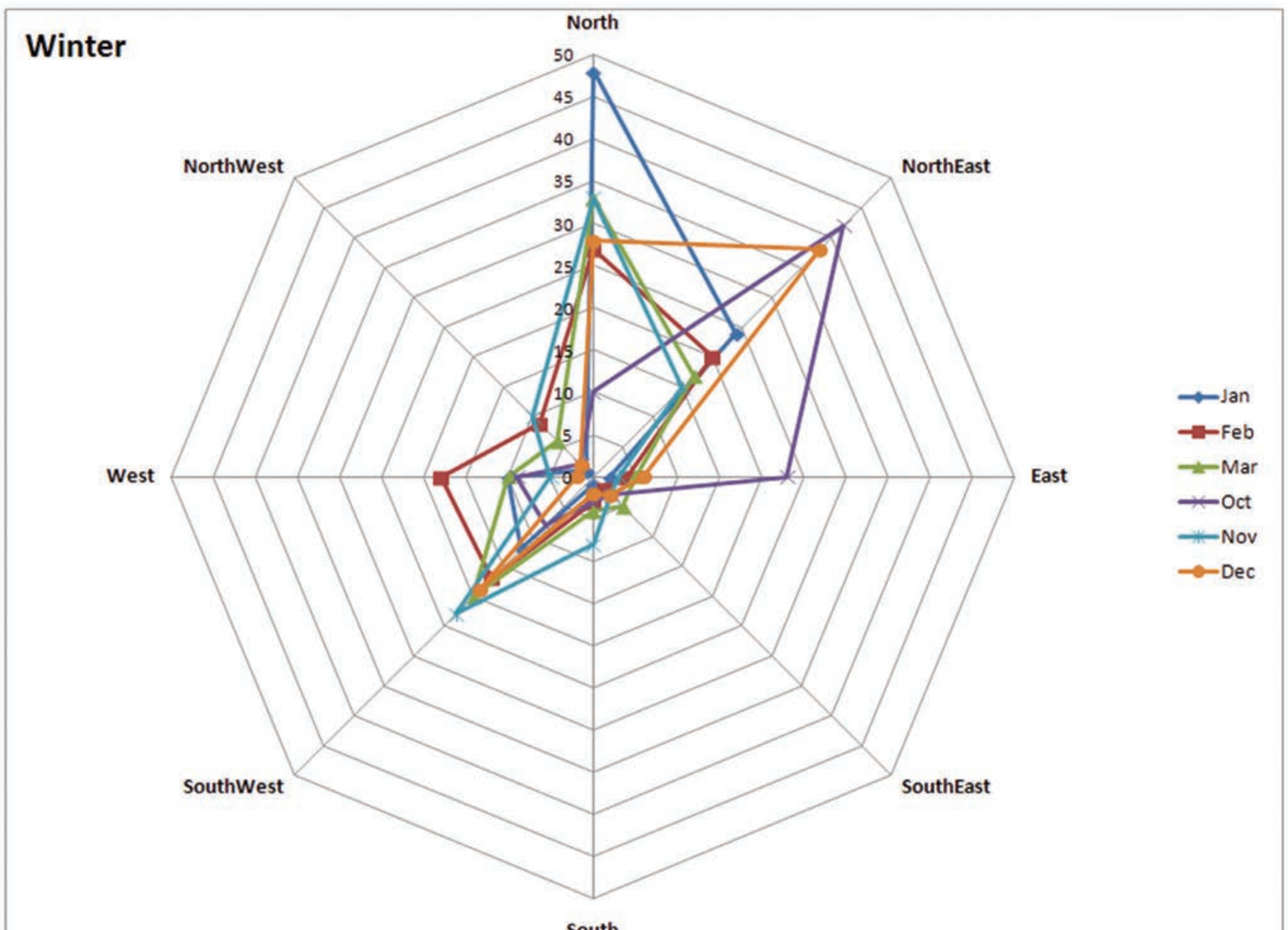


Graph 2 - Winddirection per month

Appendix C - Wind Potential



Graph 3 and 4 - Speadsheet about the dominant winddirection per season


Winter
North
NorthEast
East
SouthEast
South
SouthWest
West
NorthWest
50
45
40
35
30
25
20
15
10
5
0
Jan
Feb
Mar
Oct
Nov
Dec

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