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Guidelines for Ecological and Technological Built Environment: A Case Study on Güdül-Ankara, Turkey

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ABSTRACT

In line with sustainable development, the reactions to current urban planning and design have led to a new alternative and futuristic approach called "ecological and technological (eco-tech) planning and design which is non-damaging to the environment, brings efficient uses of resources with local skills, turns the negative aspects of technological advances to positive, guides good landuse planning with compact forms, uses natural analyses in site selection and planning, combines environmental technologies in terms of renewable energy, explores sustainable transportation and infrastructure, brings urban agriculture to the cities for self sufficiency and uses information and geographic information technologies for ecological issues in the settlements. The objectives of this article are to present a design framework and strategic approach with eco-tech planning and GIS, to develop a design strategy guide, and to increase awareness about urban aspect of ecological challenge and environmental aspect of urban development based on conclusions from a case study in Güdül-Ankara, Turkey. New eco-tech guidelines for small settlements in this research are promoted.

Keywords: Eco-tech Planning-Design, Cities of Tomorrow, Urban Sustainability, Green-Smart Settlements, Advanced Technologies, Planning-Design Guidelines

1. INTRODUCTION

While 15% of the world was urbanized in 1900s, today this rate is over 50% and it is expected to be about 65% in 2025. United Nations estimates that in 50 years time the world's urbanized population will be doubled. Hence, cities are the spaces for consumption. Indeed, it is not quite an easy process to sustain cities or rehabilitate the destroyed ones. Especially, the problems of metropolitan cities increase day to day. The main problems of metropolitan cities in the global, national and local scale are summarized in the Table 1. Either eco-tech planning or design would be possible responses for these problems. This paper represents a new way of looking at what our future might hold, approaching the subject with a proactive response rather than a reactive one, we can still shape that future within the rapidly changing energy context.

Central to this paper is the concept of resilience. Resilience refers to the ability of a system, from individual people to whole economies, to hold together and maintain their ability to function in the face of change and shocks from the outside [1]. Eco-tech planning is a strategy to reach resilience. *From oil dependency to local resilience, the move towards more localized energy efficient and productive living arrangements is not a choice; it is an inevitable direction for humanity.* Rebuilding local architecture and food production, localizing energy production, rediscovering local building materials in the context of eco-tech building, rethinking how we manage waste, all the things listed above provide resilience and offer the potential of an extraordinary renaissance in - economic, social and ecological terms. Resilience building is about working on small eco-tech changes to lots of niches in the place, making lots of small interventions and developments beginning in the small settlements that are easy to handle, rather than a few large ones.

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Table 1 Main problems in the global, national and local level in the sequence of priority [1-8]

Level	Problems
Global	Oil dependency
	The end of the age of cheap oil-peak oil
	Climate change
	Water shortage
	Unhealthy food
	Ascending footprint
	Urban sprawl in the metropolitan cities
National-Local	Degradation of local natural capital, local farming and production
	Migration to metropolitan cities
	Unemployment
	Illegal urbanization, insufficient infrastructure
	Lack of energy descent action plans, urban design plans and legislation
	Stereotype conventional apartment housing, urban transformation
	Loss of social relationships, local values and traditions

Some specific settlements near to the metropolitan cities are the potential ones which can find the sustainable way of life and decrease the agglomeration in the metropolitan cities. These settlements, which have ecological values can also use technology as a tool and can be the candidates for ecological and technological (eco-tech) settlements in the 21st century. This research focuses on eco-tech design of small settlements near metropolitan cities explaining why this is a way forward in Turkish context.

Eco-tech settlement design is based on topics like "cities of tomorrow", "resilience" [1], "ecological development", "energy efficiency", "use of recycled materials", "sustainable transportation" , "healthy cities", "smart information and communication technologies", "open and green area planning", "management applications supporting bio-diversity", "system monitoring with geographic information systems" and "advanced environmental technologies" [9].

This research is based on creating guidelines for ecological and technological built environment as a case study on Güdül which is located near by metropolitan of Ankara, Turkey and *the aim is to find an alternative and resilient solution for creating a sustainable city of the future.* The objectives of this article are to present a design framework and strategic approach with eco-tech planning and GIS, to focus on design guidelines at a small town scale, with the intention of helping people to use the right tools in a sustainable manner and to develop new eco-tech guidelines based on conclusions from a case study in Güdül-Ankara.

Güdül, which is situated in north-west of Ankara, Turkey, was selected for a case study area. Güdül settlement in Kirmir Valley is a candidate of becoming an eco-tech settlement with its microclimatic features, natural, archaeological and urban protection areas, rich flora and fauna diversity, organic production, traditional urban pattern and closely-knit community life. The reasons of the area selection are presented in detail in Section 3.

The former part of this article elaborates on the background and on the relevant work on the topic; hence it briefly defines the concepts of eco-tech and eco-tech city, and design principles of world examples. The latter part of the article provides a description of the case study and goes through the case study area analyses [10]. The last part of the article consists of a synthesis for a site selection for eco-tech development area in Güdül, emphasizing some guidelines developed for ecological and technological built environment. Developing principles which will act as guidelines for appropriate design outcomes for Güdül is the main challenge to be explicated about how the changing urban environment can continue to express an ongoing positive relationship with the natural environment.

2. ECO-TECH CONCEPT AND ECO-TECH CITIES

Eco-tech is defined as some technological equipment and tools working with alternative energy resources in the world. In the field of architecture, Slessor [11] defines eco-tech architecture and gives some world examples in building scale about sustainable architecture, high technology and eco-tech. Slessor explores the technological, social and architectural concerns that inform eco-tech architecture such as structural technology, light, energy efficiency, humanist and sustainable city, buildings of transportation and public buildings as examples of civic symbolism. She states that 'eco-tech architecture expresses the importance of a responsive symbiosis between tradition and technology, the local and the universal, nature and building' [11:19]. Marras [12] discusses the philosophy of eco-tech architecture as well. These studies are known as the major ones which directly explain eco-tech concept. The topic is quite new; so there is only a plenty of research and city planning literature about application of eco-tech concepts to the city planning. The research of Bogunovich [13] was the source of inspiration of this study. Moreover, Amborski and Lister [14] give some clues about eco-tech settlement structure in their project report of Milton's development area in Canada. So, this paper provides reference to the

researchers listed above and creates unique ideas for Turkish settlements.

The term 'eco-tech' stands for the transformation of a branch of ecology (oykos-logos[1]) to technology (tekne-logos[2]) using smart tools compatible with nature and its rules. Eco-tech, a concept that stands in-between ecology and technology, is a paradigm based on natural elements and processes that meet the requirements of sustainable planning fitting it to the new century by technology. The relevant question centers on the degree of intelligence of technology, collective availability of knowledge and political control of communities needed to build effective damage-controls of habitats by re-engaging green technology [12].

Today, garden cities with a lot of preserved natural open space or, energy efficient cities which use alternative energy and reduce commuting or, any other New Urbanism model which promote urban sustainability should not only stay as green or compact but also be smart in 21st century. In order to contribute to the better sustainability of the cities the solution could be sought and found in eco-tech city designs [13].

By means of technology, four kinds of technology can be useful in eco-tech cities: "Environmental Technologies (ET)" which encompass a broad range of technologies of energy, water and waste; "Information Technologies (IT)" which include the well known range of computer based hardware and software and the environmental sensing technologies to gather environmental data; "Geographic Information Technologies (GIS)" where geo-referenced data is stored, transformed, manipulated, managed, visualized, updated, queried and reported related with databases as tabular data [17]. Urban information system which is a part of GIS include land use analysis, preparing development plans, environmental plans, monitoring and control of eco-zones, transportation etc. and sharing these on internet [18]. The fourth one is the "Communication Technologies (CT)" which enables the transfer of environmental data, information, knowledge, and decisions; in wired or wireless environments. Their overall purpose is to overcome spatial distance and enable the flow and availability of urban and environmental information in real time to gain time. The implementation of these technologies is exemplified in Section 6.

Eco-tech city is a *local solution*- a locally shaped small scale model, for raising awareness through making designs compatible with nature. The concept of eco-tech city is created through *economic planning* and energy saving; implemented with a plan promoting local climate, local culture and landscape; supported by *eco-technologies* which bring adaptation, flexibility, multi-use and which reduce the distance. Figure 1 summarizes a schematic model which visually combines so-called technologies with energy and nature. *Proactive planning* approach [19] is a necessity to make a sustainable development plan which is participatory, and shares and considers local information.

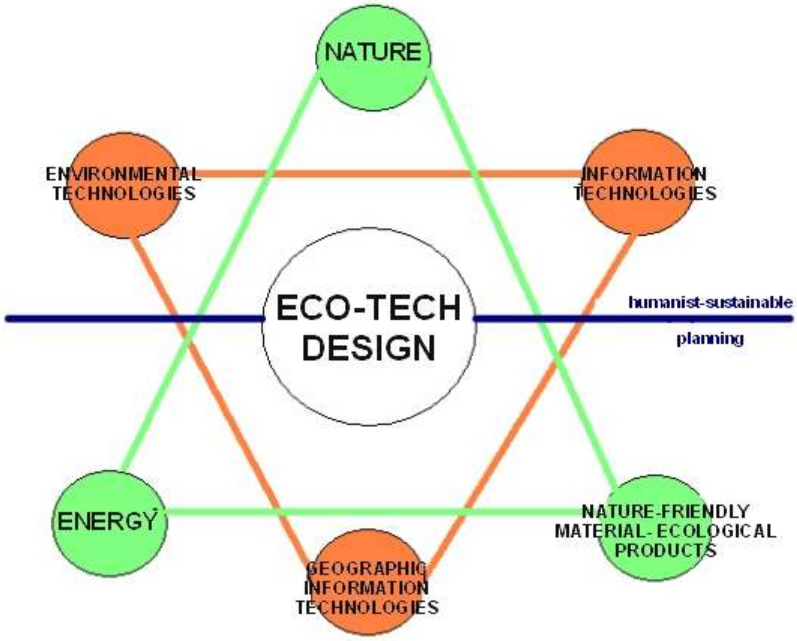

Figure 1 The components of eco-tech design

The principles of eco-tech city can be explained as the following [20]: Eco-tech city, when planned in collaboration with local investor, local management and technical team, can decrease ecological footprint of that

[1] *Oykos*-living environment, *logos*-science [15]
[2] *Tekne*-production, skill, *logos*-science [16]

city by using high performance ecological building and city technologies. Flexible, adaptable living and working spaces are created by state of the art telecommunication infrastructure. By using distance learning, interactive education and real time teleconferencing technologies; the social and environmental transportation costs will decrease [21]. Three basic principles will be integrated: "the public", "well operated economy" and "clean and healthy environment" [14]. Today, many eco-cities and techno-cities exist in the world, still the settlements that put significant emphasis both on ecology and technology are quite few.

The worldwide examples for such developments include an eco-tech village project which was made for the development area of City of Milton in Canada [22]. A campaign named eco-tech action is held in Waitakere, New Zealand which aims to transform the technological city to eco-tech with public participation [23]. Another example, Eco-Viikki, in the periphery of Helsinki, Finland is a techno-city with ecological principles [24]. Arcosanti is a famous and old eco-settlement in the middle of a desert where there is technological [25, 26]. Another Scandinavian example is Bo01, an urban fragment in Malmö, Sweden. It maybe the most sustainable settlement in Europe has an award in Housing Expo in 2001, can compete with Milton project by being more close to eco-tech concept [27, 28]. Another example is Integer project in UK, which is a more flexible project package and can be built in anywhere [29]. The brand of "eco-tech" is only used in Milton and Waitakere however, it is not pronounced in the examples of Eco-Viikki, Arcosanti, Bo01 and Integer. Still, it can be stated that these settlements resemble the eco-tech concept.

The detailed features of the world examples are presented in Table 2. After some comparisons, it can be stated as such: Arcosanti is the best one in compact mixed use for sustainable layout. Bo01 which is an eco-tech transformation of an old harbor area is another successful example of this subject. In all examples, all kinds of services and public spaces are accessible to the local community within a walking distance. Pedestrian, bicycle and public transportation are promoted, while public spaces and links are well-designed in Eco-Viikki and Milton among others. Private car is prohibited in Bo01 and Arcosanti, electric cars, online car pooling and green buses are used in Bo01. Light rail systems are encouraged in Waitakere and Milton.

Local air quality is monitored in all examples. Noise pollution is measured in the settlements, noise barriers are built in Waitakere and Eco-Viikki. Local firms are promoted for sustainable green business in all settlements; research centers support these firms in Eco-Viikki and Bo01. Ecological products are grown in all settlements, green labeling is encouraged in Bo01, certificated organic vegetables and fruit are developed in Waitakere and Eco-Viikki farms. Local participation is important in these settlements where electronic information network is created, further an action plan is prepared in Waitakere. Corporate partnerships are built in Eco-Viikki and Bo01. Alternative energy use such as solar, wind, biogas etc. is higher in these settlements, namely solar-thermal –electricity generator in Arcosanti, negative pressure fans in Eco-Viikki, heat generation from seawater in Bo01 are the examples of some innovative studies among them. Urban dwellers in Waitakere, Milton and Bo01 can monitor all services and measurements of environment and transportation online.

These cases are the best practices, which can be the sources of inspiration for the cities of tomorrow in both developed and developing countries. They show how eco-tech developments can contribute to global and local sustainability by solving problems listed in Table 1, minimising the use of finite resources, ensuring that renewable resources actually are renewed. Working at the local and regional levels adds immediate and tangible benefits to the long-term imperative of global sustainability. It maximises local productivity, brings local employment, and reduces the leakage of wealth, and helps bring communities together with a real stake in their collective future.

Table 2 The world examples [10,14, 22-26, 28-30]

Name Population (inh.)	**Region-Country**	**Project group**	**Aim**	**Content**	**Current situation**
Milton- 4000	Ontario-Canada	Ontario Ministry of Local Management and Housing, Halton Regional Management, Mattamy Homes, Rogers Inc., Milton Hydro	Trying to decrease the eco-footprint by local solutions, ecological planning, profitable, flexible design, use of ICT, participatory planning and strategic vision	The self sufficient city of tomorrow. Residential, commercial, living-working units are designed in a rich natural mixed-use environment, renewable energy is promoted, recyclable material is used, and next generation technologies are supported.	Construction phase
Waitakere 150000	New Zealand	Waitakere Eco-Tech Action-WETA campaign-municipality, public institutions, private companies and NGOs	Access to ICT, participate online, use them for sustainable business and good ecological quality of life in Waitakere	Video-conference activities, network between municipality, public buildings and schools, kiosks for stations, cemetery and retail functions, demo live-work units and education centers, e-commerce portal, digital urban heritage inventory, online access to health centers, distribution of green and smart housing design guides, local ecosystem monitoring and management network, eco-tech industrial site, eco-tech fair.	14 workgroups study for e-transformation.
Eco-Viikki 6000	Helsinki-Finland	Helsinki Municipality, Ministry of Environment , The Chamber of Architects, National Technology Agency	Energy and water saving, wastewater and waste reduction, non-toxic, environment-friendly material use, optimum practice of modern telecommunication and computer, support of biodiversity and organic functioning	Integrated design of residential, working, service and recreation areas. Some specific facilities are: public library, congress hall, agriculture and forestry faculties, biotechnology research centers, pilot farms, daycare center, supermarket, restaurants, eco-tech houses and eco-parks. Solar electricity generation, and heating, ventilation systems, sustainable tree design as wind barriers are pioneer.	Construction of 1st phase was completed.
Arcosanti 5000	Arizona-USA	Cosanti Foundation	Arcology (architecture+ ecology) philosophy, integrated design of natural and built environment, design of multi-functional buildings, use of alternative energies and technologies.	Integrated design of housing, offices, technology production, open spaces, educational and cultural areas in a creative environment. Greenhouse design, multimedia and ICT solar generator use.	Some of the construction was completed, continuing
Bo01 10000	Malmö–Sweden	Europe Housing Expo 2001, EU funded	To solve ecological problems of the cities, to prepare ecological housing project for a sustainable future.	Offices, shops, marina, canal, parks, meeting points, schools in the urban environment. High rise buildings surround the site for wind barrier, rainwater harvesting, vacuum waste collection, biogas use in the public transportation, solar cell use, wind energy station, green vehicles and online car pooling.	1st phase was completed, continuing
Integer (Intelligent and Green)	Maidenhead- the U.K.	Integer Co.	An innovative example of prefabricated systems in the context of eco-tech housing	Use of recyclable building material, roof gardens, interior multimedia and security systems, smart metering, solar panels, rainwater collection systems	Flexible project packages

3. CASE STUDY AREA: GÜDÜL, ANKARA-TURKEY

Ankara is mainly situated in a bowl-like topographical structure surrounded by mountains on three sides and opening a plain towards the west. It has grown towards the limits of this bowl-like topography, even to the inhabitable steep slope of the hills and valleys around it with squatter zones in three directions, and further on the plain towards west with planned developments. The oil-drop development has caused loss of natural areas and the sprawl brought more energy consumption. With the sprawl of the city, conventional housing has emerged in the west and north-west of the city. Zoning policies still continue and the public transportation system and infrastructure have become insufficient, accordingly the usage of private cars has increased gradually. This caused lots of environmental problems like air, water and noise pollution and traffic congestion. In this sprawling city, journeys are long and there is great segregation. The green areas have decreased because of growing population and the density increment in the city center [32]. Many other problems in Table 1 have occurred in Ankara, the quality of life has been reducing and urban sustainability of the city runs a risk. *If eco-tech sites are implemented, there will be a potential to decrease the agglomeration of metropolitan cities. A re-migration to these small towns may start and densification of metropolitan cities can be rehabilitated in this way.*

The selected region for the case study is Güdül which is situated, in north-west of capital Ankara, Turkey (Figure 2). Güdül settlement is listed as a candidate of becoming an eco-tech settlement with its microclimatic features; natural, archaeological and urban protection areas; rich flora and fauna diversity; organic production and traditional urban pattern.

It has been realized that settlements which put much emphasis on ecology and technology are usually near to the metropolitan cities but, settlements that are independent, compact, and walkable, have a population about 4000-6000 inhabitants and have an integrated green system. In these settlements urban agriculture has great importance, local public participation is high and local management has great interest in ecological subjects. Being an administrative district of Ankara, Güdül habilitates the features listed above, hence it is one of the best settlements for this research.

Figure 2 The location of the case study area, Güdül, Ankara

According to 2007 census, whole administrative district population is recorded as 10.676. The population living in the urban area is attested to be 3.155, and the population living in the rural area is 7.521. It is 12th among 24 districts of Ankara. Population increase is under the province average (24%.) Its area is 383 square kilometers and the number of inhabitants per km is 55 (this number is 163 in the province, 16 in Bala, 3541 in Keçiören comparatively) [33]. The population does not increase and young people from rural parts migrate to Ankara city center for job opportunities. Live and work units recommended in this paper can be attractive for young people for re-migration. 88% of the population in the Güdül center was born in Güdül. The active population (between 15-64 ages) is about 75% of all population. The literacy rate is 94% which is over the average of the province. The graduation from high school is 28% [34]. Childbirth rate is 1.03% of the women between 15 and 49 ages; this number is under the province average (1.90%). The household size is 3 in Güdül city center whereas 3.8 in the province [35]. The population estimate was made by the help of Excel software. The linear estimate is 7932, exponential is 7078 and logarithmic one is 7062 for the year of 2015. The linear one's R^2 value is 0.79 which is the nearest to 1. In eco-tech design, this linear estimate was used and the population will be 7900 (5800+2100) in year 2015 (see 6.1.).

The settlement is accessible from the Ankara- Istanbul highway, and is about 90 km away from Ankara. Its climate is in the transition area of Black Sea Region and Middle Anatolia Region, and has a warm-dry climatic character. This warm climate is a great advantage in the Middle of Anatolia for the eco-tech design. In the center of Güdül the mainstay is agriculture (30%). After that comes stockbreeding, commercial and service sectors. The retired people are in the majority. The landownership is high (84%) [35]. There are 60 shops in the city center dealing with roasted chickpea, cloth, white goods etc. This shows the significant retailer existence in the city. Artisans, farmers and villagers' cooperatives are active in the city center. Agricultural fields are located in the north, west and eastern parts of the center and vineyards and vegetable gardens are located in the south of the settlement. The land is about 419000 ha in the district of which 24198 ha is an agricultural area. The crop was sowed in 13750 ha, fruit and vegetable 3500, 500 is forage crops [36]. Kirmir River, a tributary of Sakarya River is located northeast-southwest of the Güdül city center. The deep canyon of this river provides a habitat of rich bio-diversity, microclimate and valley ecosystem. Güdül where has a traditional urban pattern, urban and archaeological protection sites, attractive caves, trekking routes to Sorgun Plateau and Lake thorugh Bolu Forests, can be the center of cultural, agro and nature tourism. It is possible to find pistachio trees because of this special microclimate. In 2003, 3000 pistachio trees were planted near Yeşilöz. The pomegranate gardens have high yield as well [37]. Pilot vineyards about 3000 decares can be found where 15 types of grape were grown with the support of district directorate of agriculture [38]. 5754 hectares of land was used as grassland [36]. Sheep, goat and poultry were grown mostly in the district [39]. In eco-tech settlement, vineyards, rice fields should be supported, the colza and sugarbeet plantation are important for biomass, Poultry coop should be supported and the wastes should be used in biogas generation.

It is presumed that closer proximity of Güdül community to the capital city, Ankara, means that they have a greater access to education, information and support services in many technoparks. Importantly, the community in Güdül has strong motivation for adopting eco-technologies. They are open to reforms; their income is at the middle range with regard to the scale of Turkey. Retailers and farmers are in majority. Güdül Association establishes the communication between the society in Güdül and the businessmen who were born in Güdül and live in Ankara. These people can contribute a variety of investments to the district. The youth in Güdül is interested in internet, mobile systems and other computer technologies which are supported in the vocational schools in the site.

The local authorities who are willing to do many investments for Güdül are in touch with the ministries, universities and some NGOs with some projects such as new housing, restoration of old houses, revitalization of streets and squares in the settlement, some of which were implemented with great funds.

The need for housing increases in the settlement and some high income groups also own weekend houses and farms in the settlement. *The target groups of eco-tech site proposed in Güdül guide are* local people of Güdül; officials, workers and students, retired people who want to turn back to Güdül from Ankara, home-office workers such as authors, artists, some managers etc. who want to interact with nature, who want to escape from the stress of the metropolitan city and who miss the ecological lifestyle. *In 2009, some eco-groups started to settle down for building the roots of eco-community and permaculture.*

European Commision Urban Environment team determined some sets of indicators with the collaboration of European local governments for decreasing the social, economic and ecological footprint [40]. Here is the analysis of Güdül according to these indicators (Table 3).

Table 3 analysis of Güdül according to EU sustainability indicators

EU indicators	***Güdül City Center***
Sustainable landuse	Population: 5806, compact urban form, large agricultural fields and vegetable gardens, mixed use landuse, urban protection area, many children parks, regional highschool
Accessibility of public areas and services	Living, working, shopping and recreation facilities are in walking distance
Local mobility and transportation	Car dependent system, easier to access from highway, bus service to Ankara works well.
Commuting to school	Students walk to school, shuttle service to villages
Local air quality	No measurement station, coal usage and car emission gases can be dangerous.
Noise pollution	Beypazarı-Kızılcahamam route passes nearby the settlement however traffic load is not heavy.
Sustainable local firms	Farmers and roasted chickpea producers will be supported.
Sustainable local products	Grape, cherry, tomato, bean are efficient, poultry is important, no green label.
Local participation	Collaboration with central government, municipality, Güdül Foundation, universities and some NGOs, meetings, festivals, trainings
Community satisfaction	Older ages are satisfied with their lifestyle
Energy conservation	Fuel from animal waste and solar collectors for hot water usage are common.
Use of technology	internet and mobile technologies- individually

SWOT analysis was made to evaluate the strengths, weaknesses, opportunities and threats of the settlement (Table 4).

Table 4 SWOT analysis

	Strengths	Weaknesses	Opportunities	Threats
Physical structure	*near to Ankara metropolitan area with highway connection *the entrance to Kirmir Valley *preserved natural and historic values *warmer than Ankara with microlimatic features *İnönü Caves, Roman ruins, Ottoman pattern *Traditional houses in the city center	*hidden value between Beypazarı and Kızılcahamam *no environmental upgrading near Kirmir river and its tributaries *no defined trekking routes for eco-tourism *infrastructure problems	* solar energy potential *near to Çağa thermal springs, geo-exchange pumps can be efficient *crop leftovers and chicken waste can be used for biogas energy. *sugarbeet, canola can be used for biodiesel energy.	*irrigating from polluted Kirmir River *Uruş-Güdül earthquake fault can be a threat.
Socio-cultural structure	*collaboration with central governments, municipality, Güdül Foundation, universities and NGOs *slow population growth rate *some eco-groups started to settle in Güdül	*insufficient socio-cultural activities *limited educational and health facilities *historic and archaeological ruins get worse without restoration *young people migrate to metropolitan areas	*investment and attraction to eco-tech settlement can be made from Güdül people living in Ankara and Güdül Foundation. *freelance workers, retired people, eco-communities prefer this settlement near to Ankara.	
Economic structure	*preserved nature can be an attraction point. *local products such as pistachio, grape and tomato are valuable. *mohair production is local and historic. *traditional houses, İnönü Caves, Kirmir Valley and Sorgun Plateau are the natural and historic tourism values. *pilot vineyards	*agricultural efficiency decrease because of lack of support and migration *irrigated lands are insufficient. *polluted Kirmir River is used for irrigation *vineyards are not fully efficient *market problems for tomato *limited budgets *tourism ads are not enough *aesthetically bad new buildings *insufficient restaurant, gift shop, local crafts units *no small processing-packaging units *young people migrate to Ankara	*Agricultural lands for organic production *pistachio production *beekeeping in forests *vineyard upgrading *agro-tourism potential *tomato production and paste, juice etc. *climbing, caving, trekking, hunting and other outdoor sports can be made. *Çağa thermal springs can be used for heating and health tourism *daily or 2 day tourism investments can be made near Ankara *cosmetic workshops can be made from herbal and endemic plants.	*Building development onto agricultural lands *Traditional pattern can be lost.

Aftr SWOT analysis, a spidergram was created. The sustainability parameters were taken from EU 5th and 6th Framework projects [41] and Australia-Sydney development programs [42]. Eight sustainability parameters were given in X and Y axis, their levels were put such as poor, fair, good and very good (Figure 3). The levels in each parameter creates web. Güdül had very good points in environment and natural resources, space quality, labor and economy had fair or lower points. These should be developed in eco-tech city guide.

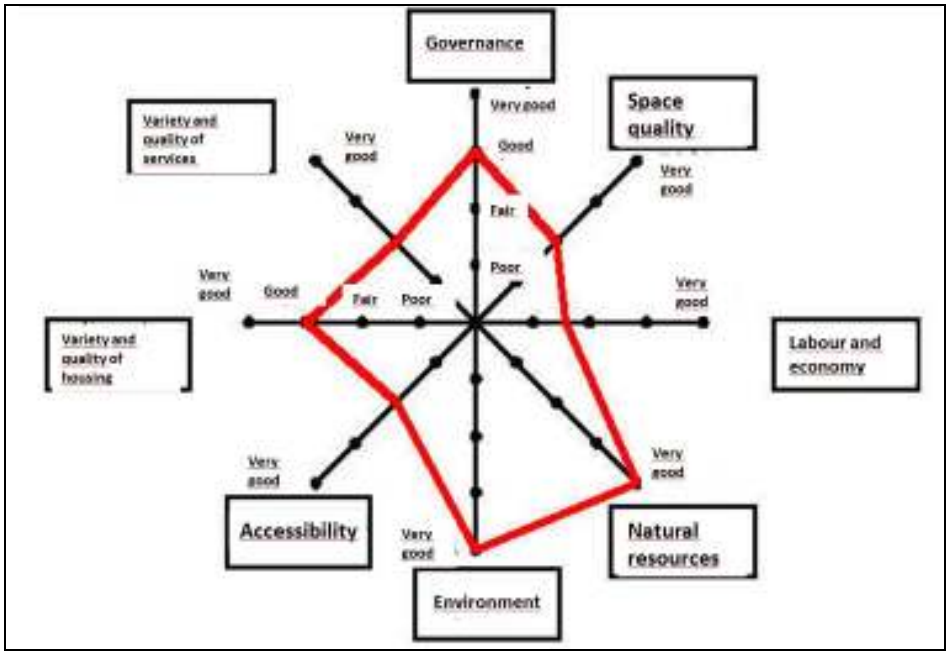

Figure 3 Spidergram of Güdül for eco-tech design

4. MATERIAL AND METHOD

Eco-tech design guidelines for use in small towns will be presented in the paper, which promises to be an important document in terms of its suitability to sustainable urban design. Additional information will be supplied in the form of a literature survey; a new set of themes and principles of sustainability, and examples of guides from around the world, classified and analyzed according to their principle targets. The study will then focus on the Turkish town of Güdül, for which eco-tech design guidelines will be set. The information presented in this guide is based on studies carried out between 2004–2007 by the urban design studio at Gazi University, which selected Güdül for a field study in the 2004–2005 academic year. In-depth interviews with the local authorities and the community, public exhibitions of the project in the city square, local media and public forums all revealed strong public support for improving the image of the settlement. Between 2005–2007, several site surveys, observations and meetings were conducted, which allowed an insight into the socio-physical context of Güdül; and the collected data was used in a dissertation that proposed an eco-tech design guide for the sustainability of the town [10] (Table 5).

Table 5 List of main resources

Güdül Topographic maps-1/25.000 from General Command of Mapping
Aerial ortophoto of Güdül- 1/5000 in year 2000 from General Command of Mapping
Land cover and soil structure maps of Güdül- 1/100.000, 1/25.000 from General Directorate of Rural Affairs
Meteorological statistics from near station
Population, age, education statistics from TUIK
Agricultural yield statistics from Güdül District Directorate of Agriculture
Geology and earthquake report from General Directorate of Disaster Affairs
Güdül city center research report for protection plan from Iller Bank
Development plan, 1/1000 from Güdül Municipality
TUBITAK report named ‘Eco-agriculture, eco-tourism and eco-settlements’ from Ankara Uni. Dept. of Landscape Arch.
Research report of Gazi Uni. SBP262 Urban Design Studio in 2004
Masters theses of geography, flora, viniculture of Güdül from YOK
Site survey, analyses, interviews in Güdül city center, Çağa, Yeşilöz and Sorgun
Oral sources, visual materials, photos for determination of features, quality and character of the site.

Base maps were digitized, the database was built and the analyses of the natural and built environment for eco-tech site selection such as topography, drainage system, vegetation, infrastructure, landuse and climatic analyses were made by Geographical Information Systems (GIS). A summary of data used and spatial analyses, 3D modeling, sieve analysis and multi criteria evaluation techniques by GIS are explained in the next section. The details of the guidelines and how they were generated are defined in Section 6 after a deep literature survey on sustainable design principles.

5. ANALYSES AND SITE SELECTION FOR GÜDÜL ECO-TECH SETTLEMENT

Based on the preliminary findings of the case study, various data and analogue maps of the area were compiled for eco-tech settlement. Topography, drainage system, vegetation, infrastructure, landuse and climatic analyses were the important ones for the analysis of the natural and built environment; and designing an eco-tech settlement. Recommended criteria about site design, building design, the buildings and their distance to each other, their volume, material, footprint area, accessibility, sunlight position, infrastructure and safety precautions are all based on these analyses.

All analogue maps and other statistical data were digitized in GIS environment and we built an integrated database with maps of Güdül. When the results of the analyses are examined, it was seen that topography of Güdül is between 690 and 810 meters above sea level (Figure 4). Kirmir Valley is the largest water collection channel and the rough topography of southwest and southeast parts are other drainage areas. The agricultural fields surround the settlement and the valley on the north. Bolu Forest starts behind the valley. Turker [43] found 85 different endemic species around the valley. The valley has a special microclimate and northeast wind is dominant in the region.

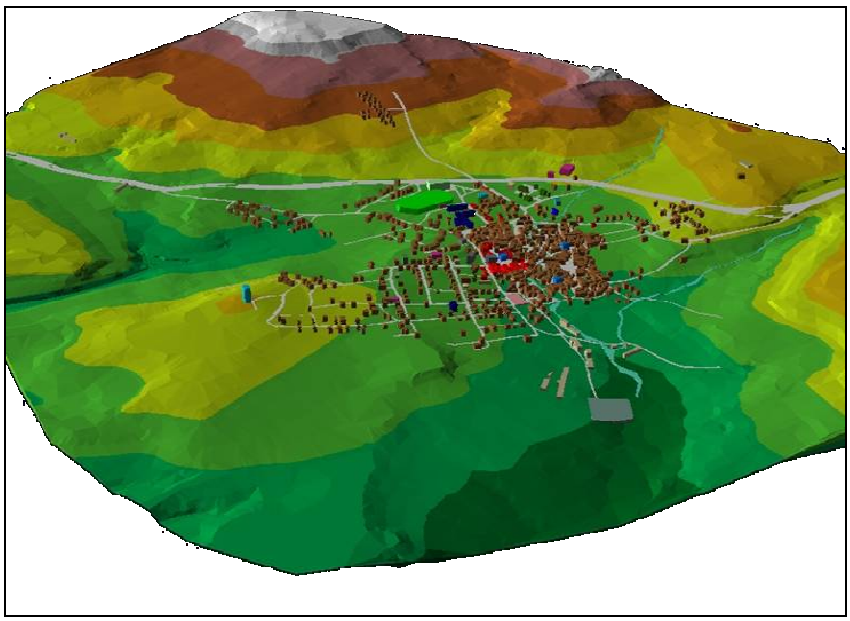

Figure 4. 3D model of Güdül

The landuse database was built in GIS environment. The center has an urban protection area with 60 vernacular buildings which covers about 15 hectares and 3 neighborhoods (Aşağı Mahalle, Emirler and Yukarı Mahalle). The whole retail is held in this area in small local buildings. Banks, governmental buildings and high school are also situated in this protected area. 45 traditional buildings were under protection in 1996. Most of them are mansions and houses but a row of roasted chickpea shops are under protection, too. After pattern analyses, it can be stated as the small parcels were in the city center enlarging through the periphery between 50-2500m^2. The building footprints are between 40-250 m^2. The base area coefficient is 0.60-0.80 in 2 storey houses. In 2005, restoration and façade repair of 30 buildings were made in the urban protection area. In 2006, all roads are repaired.

The use of wood is common in these buildings and these special buildings create some small squares, organic street patterns and some semi-open courtyards. Squares, historic fountains, large trees are directed to the small creek which goes through urban protection area. The development area of Güdül lies to the north and east of the urban protection area (Figure 5).

Figure 5. Aerial photo of Güdül

The analyses were broadened with the use of GIS, to contribute advanced tools to assist site selection for eco-tech settlement. Eco-tech settlement should be near to the current settlement. It should function in a holistic, beneficial mutualism with the surrounding rural and natural environment. Multi criteria evaluation technique was adopted for analyzing between choice alternatives with different environmental impacts. GIS provides the user with means for evaluating various alternatives on the basis of multiple and conflicting criteria and objectives. The criteria can be either constraints or factors. The data used for this research are summarized in Table 6.

Based on the evaluation of suggested criteria, four important factors that facilitate eco-tech settlement areas were identified. These factors include, a) south slopes having max. sunlight, b) slopes which face the northeast wind in order to use wind turbines, c) light slope for design, d) proximity to water distribution areas, e) close proximity to agricultural areas (food), f) keeping far from main road which was a source of noise and bad emission gases and g) selection of areas suitable for building which were neither vineyards nor agricultural fields. Other factors that restrict the usage of an area (called constraints) were also noted. Constraints include a) north slopes, b) areas which does not take wind, c) rough areas, d) agricultural fields, e) vineyards and vegetable gardens or orchards and f) areas next to the main artery.

Table 6. A summary of data used

No	**Data type**	**Data description**
1	Aspect	Data about the direction to which a slope faces
2	Wind	Data about the slopes which face to the Northeast wind
3	Slope	Percentage degree of the steepness
4	Drainage	Water collection and distribution drainage areas
5	Soil class	Information on various categories of soils within the study area
6	Transportation	The distance to the main arter
7	Land cover	Data of different ways the land has been put to use

In GIS environment, zero values were given to the constraint for unacceptable areas, up to 10 point to the acceptable areas. All analyses were turned to grid then values attached to every grid. After the software calculation a grid map was produced and areas which have highest values are capable of supporting eco-tech settlement.

When the results are examined (Figure 6), it is found that the north of the current settlement is more suitable for eco-tech settlement which has optimum direction, close to agricultural areas, windy, accessible and also close to the water resources. An area about 20 hectares was selected for eco-tech settlement. It then has become to draw some guidelines for this special area.

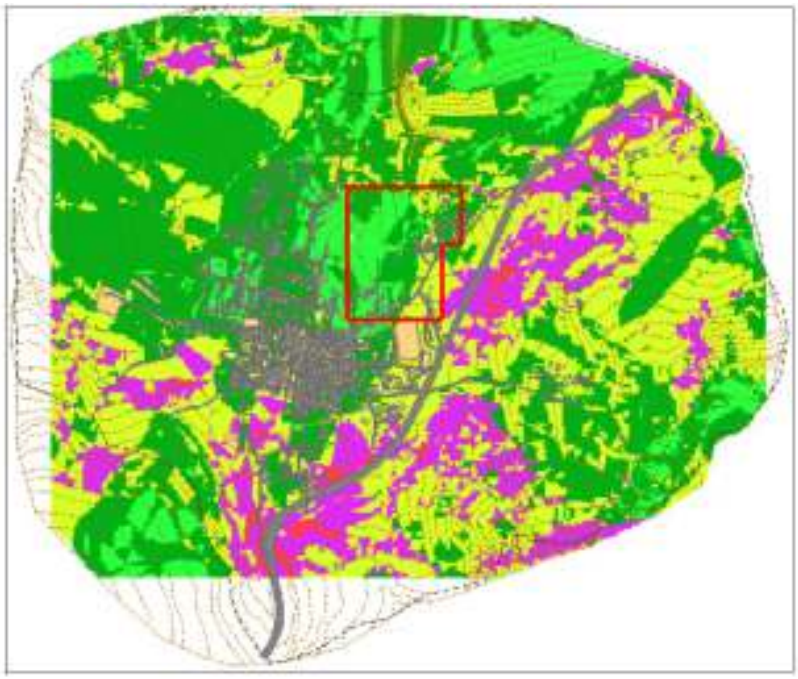

Figure 6. The design area for eco-tech settlement

6. GUIDELINES FOR ECO-TECH SETTLEMENT

The details of the eco-tech guidelines for eco-tech development area of Güdül are given in the next section. This study was supported by the local and central government of Güdül. According to the Mayor they succeeded, first of all, due to the cooperation they made with us-the university. Secondly, the focus being rather on the quality than the quantity of new developments was another parameter for success, which will hopefully be constructed in the near future. So, this guide is supposed to play an essential role in decision-making for the new residential community with regard to the ecological and social sustainability of the current settlement- Güdül.

Many studies were made about determining a set of key design principles through exploring the latest approaches to urban design. The guidelines arrived in this study are based on author's Ph.D. thesis [10] and provide reference mainly to eco-tech village Milton study [14], design principles combining traditional Turkish urbanism with current developments [8], permaculture principles [44], ecological guidelines of environmental sustainability [45] and guidelines as a rediscovery of the art and science of designing sustainable neighborhoods. Additionally, Choguill [47] provides a basis for devising a set of criteria on all facets of sustainability, especially technical sustainability, for minimizing traffic for pedestrian safety and social interaction. White and Ellis [48] explain popular smart growth and New Urbanist movements and they propose that physical compact development minimizes travel and improves sociality.

Bogunovich [13] seeks a model of the sustainable city of the future which is both green and smart by eco-tech design. Moreover, Ercoşkun [10] brings use of geographic information technologies, ICTs and recycling technologies, online public participation, social sustainability to the list of themes and principles. Clark [29] explores sustainable forms of housing with less environmental impact such as eco-tech design. Oral and Manioğlu [49] study on physical environmental control principles of sites, forms and relationship of new buildings with the climatic region features and indoor-outdoor energy control. Register [50] and Todd and Todd [51] propose eco-city principles seeking the health and vitality of neighborhoods, downtown, transport and energy.

EU Urban Design for Sustainability Guide [52] also promotes the Compact City and Short Cycle City Strategy, makes use of ICT in transport systems and supports designing for affordable housing. It recommends LA21 action for public participation and takes account of strong sense of community and social equity in the urban design. Eventually, LEED-ND is a new neighborhood development rating system (36 certified pilot projects in the world in 2009) which encourages healthy living, reduces urban sprawl and protects threatened species. This system gives high rating to smart location and access to public space, reduced parking footprint and heat island. LEED promotes sustainable development to minimize habitat fragmentation and it also helps to preserve areas for recreation [53]. It supports green infrastructure and on-site renewable energy sources as well, which enhances this section.

Lang [54] draws the types of urban design guides in his research. Güdül's eco-tech guidelines will be in the category of a performance guide. Flexible, systematic themes will be directed with strategies. Performance targets will be numerical, thus measurable, and will provide suggestions for lower ecological footprint. The guidelines are categorized into 6 themes as site design, transportation, technology, infrastructure, building design and green areas and urban agricultural areas [10]. A

series of strategy in eco-tech approach was put for every theme in the next section. 24 key strategies were produced as the guidelines for an eco-tech settlement design which can be used generally in similar small ecological towns. The guidelines are simple, easy-to-use and one can use them as a checklist for developing an eco-tech site. We will discuss the general guideline in 6 main categories and then address how it would be implemented in Güdül right afterward. Small summary paragraphs from the Güdül eco-tech guide are given in relation to these strategies.

6.1. General Guidelines for Eco-tech Settlement

Eco-tech site design

1. Do not sprawl - Design should be made for effective landuse and density and mimic the patterns of the nature. Clustered houses with denser typologies achieve quality, efficiency and affordable housing and save agricultural fields.

Güdül's eco-tech settlement will cover about 20 ha, 10 ha mixed use area 10 ha for residential areas. Today, Güdül covers about 15 ha and population density is about 150 inh./ha. An analogy was made and the same population density was accepted in Güdül for a compact settlement [46] as a performance target. A projection was made for Güdül and it is estimated that its population would increase and 2100 new inhabitants will be expected within 10 years. As a result it is foreseen that 700 residences will be designed, 1/3 of the built-up area is a low-rise residential area, and 2/3 of it is a mixed-use area.

2. Orient the units to sun and site - Each unit should be carefully oriented to sun by providing winter gardens on the south and should be shaded with trees and plants; openings should be minimized to west and east in hot summer time and they should be designed for natural ventilation.

Residential areas are designed to be located on the silent part of the area, approximately 500-600 m away to the current settlement. Computer programs with shade cones measure height of the buildings and the distances between the buildings and their energy performances are simulated. The mixed-use area is oriented close to the current center with an appropriate distance. The area is walkable and close to the public transit stops. The amenities serve this new population close of about 3000-5000 inhabitants. The sense of neighborhood should be improved.

3. Integrate Rather than Segregate- The balance between blending and segregating functional activities should be re-established. Mixed-use functions with shops, fairs, exhibition, offices and housing should be designed for a vital and safe environment. Local entrepreneurs should be encouraged to do eco-friendly projects. A community centre for meeting and exchange should be designed.

Low density and medium density residential areas are recommended for eco-tech settlement. Low-density areas have large permaculture gardens. Medium density areas are closer to the mixed-use area. In the area, living and working units are designed with flexible interior design components for freelance workers. An eco-tech community center is of 8000 m^2 with a large green roof. A supermarket serving organic products and hardware department exist in the area. Introducing new facilities such as a theater, a cinema, daycare center, a multifunctional hall, youth clubs and an ecological education center are recommended to improve socio-cultural life. Swimming pools and tennis courts will be built for enhancing the sense of community and a healthier public. All amenities are within a walking distance. All of the designs should either protect or restore at least 75% of the biodiversity and ecology in the area.

Transportation in Eco-tech settlement

4. Minimize the impact of automobile and parking- The trend requiring greater mobility should be reversed. Compact, multi-use streets including pleasant walking areas and bikeways should be designed. Such a design should especially be promoted along arterial and collector roads and should be integrated with transit service through priority lanes. Performance targets include, decreasing the design speed to 40 km/h in the residential and commercial areas to promote safe walking and cycling, hence one parking area for each dwelling would be enough to reduce impervious surfaces. To decrease urban heat island effect, trees should be grown in the parking areas, stormwater should be collected by surface flow drainage elements when possible. Use of energy efficient street lights is required.

In this eco-tech settlement green streets are designed. A ring road with traffic, bicycle and pedestrian lanes shaded by large trees connects living/working areas. Land uses are clustered in walking distances to promote accessibility and reduce transportation demands. The residential area includes a car-free section surrounded by the ring road and supported by public transport vehicles and bicycles. Performance targets are defined to increase the number of kilometers walked and to develop green roads.

5. Use Small and Slow Solutions- Ecological system by pedestrian lanes will be enhanced to provide social interaction. The main pedestrian road will connect the residential clusters to eco-tech center. Pedestrian roads will be increased %100 and complied with the standards for pedestrian, disabled and elder people.

A main pedestrian road about 9 m wide is proposed in Güdül eco-tech site, aimed to connect residential areas to the eco-tech center. Then, other pedestrian roads will connect to this main road. Recycled crushed stone, brick or pavers will be used for pedestrian paths. Performance targets are to increase the number of kilometers walked and develop green roads.

6. Promote bicycle usage- The aim is to promote bicycle usage in small towns and Güdül eco-tech site. Performance targets are: to increase the number of kilometers biked and to decrease impervious surfaces. It is projected that at least half of the residents should use bicycle for transportation.

A bicycle network is proposed for Güdül eco-tech site. There will be two roads next to each other. The cyclist lane will be 3.5m wide and will be separated from the pedestrian lane with a sign and a band painted on the ground. When permitted by the soil, road for cyclists should have permeable pavement. There will be "stop and parking" areas in every 5th km. Another parking area is also designed in eco-tech center. As a performance criterion, the bicycle lanes should be designed in the higher part of the road in order to have dry and safe travel.

7. Recognize connections, locate elements relationally- Every resident will be of a desirable proximity to transit stops (200 to 300 m maximum). The performance targets are: to minimize air pollution, to improve car pooling- at least 10% of the residents, to support alternative fuel cars by building fuel stations (i.e. bio-ethanol etc.)

A car-pooling system can be built in the eco-tech site in order to offer access to the environment. Various stops and parking areas should be determined. Additionally, green buses running by biogas and having stops in every 1 km circulate in the ring road, between the old town, eco-tech center and residential areas.

8. Increase using of alternative cybercars - The main aim is to reduce CO_2 emissions by using alternative fuel, bio-diesel etc. At least 5% of the drivers should use these kinds of vehicles to decrease air pollution and energy footprint to save forests as performance targets.

Alternative fuel cars or solar cars are promoted in Güdül eco-tech site to travel to the villages and environs.

Technology in Eco-tech Settlement

9. Connect and communicate in real time- Life will be facilitated by ICT in flexible spaces to minimize personal, social and ecological impacts of travel and to provide energy saving in 21st century by using computer, intranet, internet, smart-metering etc. Within the eco-tech site the most feasible technological standard available for communications infrastructure will be enhanced to provide a full range of living and working opportunities.

WIMAX technology which serves wireless internet in 50 km radius will be designed as to locate on the highest hill of Güdül to get wireless connection to internet; which will provide e-business, e-learning and e-security. As a performance criterion, every computer, hand devices should support wireless. A touchscreen will be put in the flats to let the inhabitants reserve car from the pooling systems. Every residence will have smart metering to report energy consumption to the resident hourly.

10. Share your geographic data with everyone by GIS- Every municipality should use GIS in urban planning and design, and should be open to public on internet to provide participatory planning. Some kiosks can be put in the streets to provide information about the eco-tech site, tourist points and other facilities. This will lead to make a digital city, as well.

Güdül Municipality should use urban information systems, and produce maps and analyses about the site and develop eco-tech plans and designs with the help of these geographic information technologies. Then they should share this information with the public by discussions and forums on internet. Some kiosks can be installed to the streets to get information about maps, transportation, schedule, sports and cultural activities.

11. Use and Value Renewable Resources and Services- Resources will be used sparingly and effectively. Innovative, efficient and effective methods of energy production should be supported through the incorporation of demonstration projects for alternative energy options, including the investigation and, if feasible, implementation of renewable energy resources and district energy systems.

11.1. Catch and Store Solar Energy- There are many options present for incorporating thermal storage units in conjunction with photovoltaic systems and for using solar panels for water heating as well as energy generation. All the energy will be provided all over the year for an average home by sun collectors and photovoltaic systems (PV).

PV systems are proposed on the roof of commercial and administrative buildings of Güdül eco-tech site, as well as on the parapets of live & work units and other detached houses. PV systems will also be used for street lighting. Moreover, two collective solar gardens are designed for the mixed-use area and residential area, for heating the units with water. Integrated systems with wind turbine and solar energy can be used in autumn and winter for effective use of energy which can be more feasible and Renewable Energy Law should be considered for the standards.

11.2. Promote wind turbines - A wind turbine can prevent the emission of 5000 tons of CO_2 into the atmosphere each year. It would take 500 acres of forest to absorb that much CO_2. Installation of wind turbines will reduce the energy footprint.

A wind turbine about 300-400 kW is proposed in the gardens of the detached houses in Güdül eco-tech site. They are set back from any lot line by "one and one half times" the height of the tower and shall be located at least 40 meters from the nearest exterior wall of a dwelling on an abutting lot. Their heights do not exceed 40 meters. The noise levels generated by a wind turbine shall be limited to 45 db.

11.3. Develop geo-exchange pumps- Geo-exchange systems use the renewable thermal energy found just below the surface of the earth, either underground or underwater. Benefiting from thermal energy for heating is promoted to reduce CO_2 emissions and energy footprint.

A geo-exchange pump is planned in every detached house in Güdül eco-tech site, Çağa thermal springs which are near Güdül can increase the efficiency of the pumps. It can be used for heating and cooling but heating is mostly preferred.

12. Produce energy from bio-diesel and bio-mass - Tractor fuel can be produced from colza oil as bio-diesel

to reduce energy footprint. Waste from kitchen, waste of chicken and other animals and also waste of some agricultural products such as sugar beet can be recycled and turned to biogas which can be used in green buses.

Güdül is an agricultural settlement surrounded by large fields. At least 100 decares of colza is needed to support tractors in this settlement. So, colza should be grown in 6% of the total agricultural fields. A biogas plant is proposed in Güdül to produce energy from waste.

Infrastructure in Eco-tech Settlement

13. Limit or eliminate the use of potable water for landscape irrigation - High efficiency irrigation technology will be used and rain and recycled water will be captured to reduce water consumed for irrigation by 50% over conventional means.

The alternative irrigation technologies such as drip irrigation will be applied in Güdül eco-tech site and nearby fields.

14. Use water conservation appliances- Rain and gray water will be harvested from the house; cisterns are proposed to be developed for use in landscaping and toilet flushing.

Rainwater is collected by roof leaders of detached houses of Güdül eco-tech site with the help of rainbarrels that collect water to use in landscaping and toilet flushing, a biotope pond should be built near Kirmir Valley for irrigation, stormwater that runs off from the road surface should be collected by channels, filtered and reused. The slope of the channels should be between 2% and 7% and these channels will contain stones, perforated pipes etc. Biotope should be emptied ever 48 hours for health and rainbarrels should be cleaned and should not used in hard wintertime conditions.

15. Purify water- Reduction of water consumption about 40-50% is the performance target.

Gray water coming from kitchen and bathroom are collected from residences and commercial buildings of Güdül eco-tech site, treated and reused for irrigation and toilet flushing.

16. Reduce, Reuse and Recycle- Recycling will be provided for reducing the consumption. Vacuum system is encouraged for garbage collection in order to avoid garbage collection vehicles. These systems provide underground piping and directly vacuum the waste to the recycling plant. The purchase of recyclable products should be supported.

Güdül Municipality should build this underground system and recycling plant immediately and put separate waste bins connected to this system for organics, glass, metal and paper.

Building Design in Eco-tech Settlement

17. Build green and smart- Recycled materials will be encouraged, non-toxic green materials and recycled ones are used which do not absorb heat, provide indoor air quality and human health with sustainable resources. The environmental efficiency of the buildings will be measured with assessment methods like LEEDS, CASBEE, BREAM etc. to get the desired scores for eco-buildings. Less building footprint will be provided with small and smart buildings, efficient building units are more affordable as they minimize the costs and save the agricultural land. Big and bulky units will not be supported. Affordable housing should be designed with a variety of housing from small flats to 2, 3 or 4 room units for providing more effective quality of living to minimize operating costs and to provide options for different incomes. All buildings should contain ICT opportunities.

All buildings should be constructed from recycled material and measured in Güdül eco-tech site. Different housing options should be designed for every income.

18. Provide adaptability and flexibility- Modifications and upgrades will be designed which will satisfy the programmatic, spatial and infrastructure needs and which will facilitate flexible occupation throughout the life of the building. Flexible housing allows making necessary changes based on family needs inside the houses. The selected performance targets are: flexible use of houses in different seasons and moods, re-develop building structure and shell; live-work design and modular space understanding are drawn the performance targets.

Live-work units in mixed-use area of Güdül eco-tech site have flexible type of housing including mobile walls. Thus, Güdül old traditional housing typology can be modernized and adapted to the row houses in residential area.

19. Build with green materials- Resources should be conserved by salvaging building materials. Well-isolated, strong, recycled material, local material and certificated and recyclable material should be used.

Detached houses can be built from timber, row houses can be stone, timber, adobe and strawbale and these techniques should be applied and measured by LEEDS etc. in Güdül eco-tech site.

Green areas and Urban Agriculture in Eco-tech Settlement

20. Develop greenways and open and green system- The natural topography of the community and existing natural systems will be preserved where possible. Additional natural systems should be recreated as a part of the public park system. Native vegetation will be used along roadways and other corridors. Ecological corridors and parks will be designed; trees and vegetation are critical for human comfort by balancing the air quality, creating recreation and livability. Rehabilitation of flora and fauna brings the sustainability of those species in the area to enhance local environments.

An open and green system is proposed for the eco-tech community and is composed of: 1) arterial open space which connects and integrates eco-tech community to adjacent neighborhoods; 2) collector open space which links eco-tech site to old town and nearby recreational areas and; 3) local open space which gives opportunity to access collector and arterial open spaces, established in

conjunction with local. Every resident has an access to the open space with a 3-minute walk and fruit trees are planted in all parks.

21. Obtain a Yield- Urban agriculture will be promoted, grass areas will be minimized, permaculture gardens which are productive and provide self sufficiency, will be recommended. Biotope ponds will be used to collect rainwater which will be used to irrigate permaculture gardens.

Local plants will be grown: 1) in the gardens of detached houses in Güdül eco-tech site, for instance, nut, cherry and annual horizontal type plants, altogether, in the context of permaculture; 2) community gardens about 100 m^2 covering 2 ha will be designed for the residents living in mixed-use area next to the residential area; 3) edible trees will be planted in the public spaces and; 4) pilot orchards and vineyards about at least 10 ha will be built in the periphery. All organic products will be green-labeled as performance criteria.

22. Make sustainable planting- Plantings should consist of locally available and propagated, native and, indigenous species. Green ways, local roads, parking areas and other public areas should be planted in order to decrease impervious area, provide biodiversity and to promote edible landscape. CO_2 will be balanced if 5 trees were planted per a motorised vehicle which would improve the air quality, one of the performance targets.

A list is prepared for Güdül eco-tech site including species like yellow and black pine trees, nut, almond, cherry, pistachio and pomegranate trees as local. Green fencing is supported and recycled wood and brick elements are used for barriers for flower beds.

23. Build green roofs- Stormwater runoff from roofs will be reduced by a minimum of 50%. Heat isolation and storage, noise absorption and microclimate improvement are listed as performance targets.

Green roofs will be applied onto the eco-tech center and supermarket in the mixed use area in Güdül eco-tech site.

24. Provide shading and wind breaks- Min. 5^oC will be decreased in urban heat islands and min. 25% of energy saving will be ensured in residences as performance targets. Trees and other appropriate vegetation may be located to reduce direct contact of sun with heat-retaining surfaces, including buildings, streets, stormwater management facilities (i.e. wetlands, stormwater ponds, etc). In addition, trees and vegetation may be located to reduce exposure to prevailing winter winds. The height, shape and persistence of leafs should be taken into consideration to optimize micro-climate of buildings and streets.

In a windy site, a windbreak or shelterbelt planting can account for up to 50% wind reduction with a 20 to 40% reduction in heating fuel consumption. Evergreen conifers are a perfect barrier to winter winds. Windbreaks should be placed at right angles to the prevailing winter wind - typically on the north and west side of the residential area.

The south facades of the buildings, roads and pedestrian lanes and large parking areas should be planted with appropriate shade trees in Güdül eco-tech site. Heat measurements should be made in shaded and non-shaded areas for monitoring as performance criteria. Eco-forest can be built in northern part of the residential area to prevail winter wind, the depth of the forest can be determined due to the wind intensity. When the needle leaf plants have a mature height equivalent to about 1.5 times the height of the house, they can be used for wind barriers, as performance criteria.

6. CONCLUSION

The design strategy package in this research suggests *energy-efficient solutions* which reduce ecological footprint and delay global warming, facilitate tracking and calculating renewable energy resources. The package also provides *ecological solutions* which bring the protection of natural environment, productive areas, biodiversity and *environment-friendly solutions* that improves water resources, agriculture and air quality. 3 'E's (Energy, Ecology and Environment) are incorporated in this study which use technology as an intuitive tool and bring a new vision specifically for Turkey. The research is the first initiative in Turkey, whilst one of the few examples in the world. If eco-tech sites are implemented, there will be a potential to decrease the growth and sprawl of metropolitan cities. A re-migration will start to these small towns and eco-tech communities will emerge toward resilient settlements.

Various thematic maps and 3D models were produced for the case study, which assisted site selection for eco-tech land development in Güdül. These analyses were overlaid to perform the sieve analysis. According to the analysis, south slopes, water drainage areas, windy sites etc. are determined and an area was selected for eco-tech settlement.

Güdül having about 1.8 gha per capita [10] is near to Turkey's ecological footprint (2.1 gha per capita) and increases day-to-day up to world's (2.2 gha per capita) [2]. An eco-tech guide was prepared for reducing these values. The highest savings were obtained in the energy footprint in Güdül. The precautions were created mostly to reduce this footprint. It is forecasted that if the guidelines drawn in this research are implemented, it would be possible to reduce the ecological footprint about 40% to 50% which corresponds to a reasonable ecological improvement in the settlement.

Eco-tech guide consists of scope, performance targets, strategies, methods and criteria under 6 main topics, which are summarized very briefly in this paper. The developed strategy package is an implementation tool and is expected to play an important role in urban planning and design for local authorities. It draws a systematic framework for small towns and supports the development of alternative approaches. It is flexible, updatable and a powerful tool in the process of urban dwellers' awareness on ecological issues. Planners, entrepreneurs, architects, landscape architects, engineers and other stakeholders can be the candidates of user groups of this guide.

Currently there is no direct link with the guidelines and day-to-day development assessment processes in local authorities. Clearly a statutory approach may be beneficial and central to achieving eco-tech design outcomes. However, a statutory approach alone is unlikely to optimize these outcomes – a combination of initiatives is needed including information, guidance and education to build capacity in local authorities' skill sets in order to understand the guidelines and implement appropriate strategies to achieve outcomes. These guidelines are aimed at assisting local authorities to address these gaps. This guideline is friendly for the developers which are interested in initiating a plan in the area as well as for the planning authorities who are in charge of the approval of plans and projects. Although the study targets at the Güdül settlement, the "eco-tech guide" can be adapted to other similar places as well.

However, some barriers still exist against the eco-tech design in Turkey. Currently the building is the only scale at which such developments are rarely occurring. This is due to unfamiliarity, lack of regulation or encouragement through policy and markets, developer reluctance and the sheer enormity of effort involved. Difficulties with planning and administrative systems, legislation and procedures; lack of existing urban design legislation, systems and practice were seen as the other barriers to the achievement of good practices in Turkey, with existing land use and planning processes insensitive to environmental considerations and geared towards aiding the large commercial development process. Policy, funding, educational and marketing mechanisms can be brought into play for the promotion and establishment of eco-tech settlements, such that these become the systemic norm. The barriers can be removed by the collaboration between good management, university, non-governmental organizations and private sectors, hence eco-tech investments can be made rapidly.

Specifically, eco-tech site in Güdül can be developed by local investors (e.g. Güdül Foundation supported by wealthy businessmen born in Güdül), local management (district governorate and municipality) and a technical team (professional engineers, planners and designers). Güdül urban protection site has been greatly funded by Ministry of Culture recently. Ministry of Energy and Ministry of Public Works has also started energy efficiency campaign and published some codes on buildings. These authorities can help and finance a demo eco-tech site for educational purposes as well. The world examples in this paper constitute some models for Güdül. Some design competitions can be made and their results can be applied for buildings and open spaces of the settlement.

In the country scale, Turkey's abundant renewable energy resources such as solar, geothermal, wind potentials can be accomplished through legislative and economic incentives, and community-reliant policies. These incentives can include resource taxes, emission charges, the elimination of subsidies for fossil fuels, billing of consumption, energy efficiency audit programs, efficiency labeling-rating programs, eco-tech building, and recycling. Strong governmental support for research and development in this point is needed to prepare the necessary financial, market, and legal infrastructure of these technologies through fostering a sound partnership among private, public and non-profit organizations.

Furthermore, the share of geographic information by geographical information systems, urban information systems and kiosks described inside the eco-tech design guide can lead the local government to e-municipality and central government to e-government. National urban planning revision program should be held in this way and the program should be enforced with multi-cooperation in eco-tech point of view. Moreover, performance targets and criteria which are stated in eco-tech guide strategically should be drawn in all related law and regulations in Turkey such as Urbanization Law Proposal, Urban Transformation Law etc. And these should be considered in design dimension in the planning hierarchy.

The summary of this study can be examined in Figure 7.

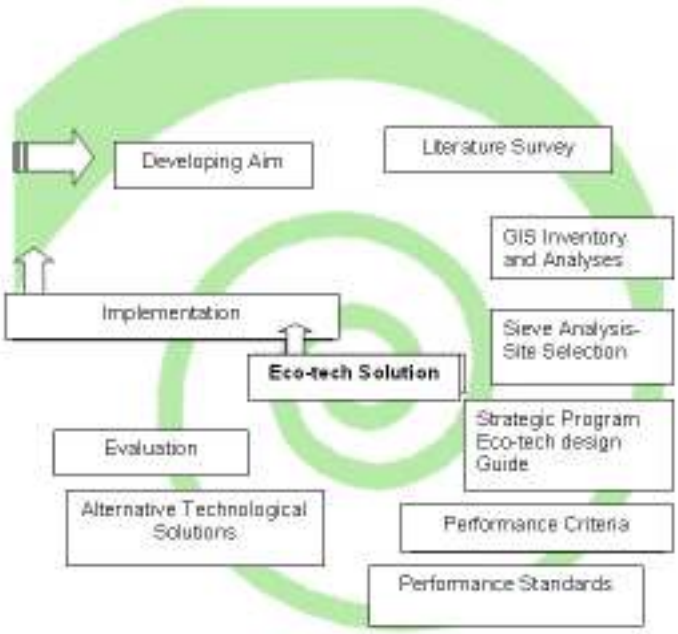

Figure 7 Eco-tech design process

The key of green future of urban planning and urban design is in the hand of technology supporting local applications. If the authorities can apply "Reduce, Reuse and Recycle" and "The Problem is the Solution" principles by the help of designers, the positive developments in city, region and country levels can contribute the solutions of ecological problems in the world in 21st century.

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