DEVELOPMENT OF SUSTAINABLE ENERGY ACTION PLAN FOR THE SELECTED MUNICIPALITY IN ISTANBUL

by

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ABSTRACT

To tackle with the climate change many international organizations are being launched all around the world. One of these formations, “Covenant of Mayors”, is a European Commission initiative which brings Mayors together across European continent. Its main objective is getting commitments of the Municipalities on decreasing the CO_2 e level at least by %20 till 2020, and motivating them to create policies towards sustainable resilience cities. The main objective of this study is to structure energy-oriented strategies, perform tailor-made regional measurements and define main remedies to transform the city to be more sustainable. Within this objective, CO_2 e emission of the region has been calculated for 2010 which is 4.59 CO_2 e / per capita. Following that, the actions are planned under five categories; building, transportation, lighting, renewable energy and awareness. Moreover, measurements targeted 2020 are proposed based on the CO_2 e emission released within the geographical boundaries of the Kadikoy Municipality. The study aims to serve as a model for other municipalities in the region, and a representative approach for improving the regional resource management. It also creates opportunities to further study topics like sustainable city-based transportation, sustainable life-styles for Istanbul City.

ÖZET

İklim değişikliği ile mücadele için bir çok uluslararası örgütler kurulmaktadır. Bu oluşumlardan biri olan "Belediye Başkanları Sözleşmesi", Avrupa Birliği tarafından başlatılan Belediye Başkanları' nı biraraya getiren bir girişimdir. Kurumun temel amacı 2020 yılına kadar % 20 CO_2 e seviyesini düşürmek ilgili Belediyelerin taahhütlerini almak ve onları sürdürülebilir esnek şehirler yaratmaya yönelik politikalar oluşturmak için motive etmektir. Bu tez ile ulaşılmak istenen enerji odaklı stratejiler gerçekleştirerek daha sürdürülebilir bir şehir için eylemler oluşturmaktır. Bu kapsamda, bölgenin CO_2 e emisyonu 2010 yılı için kişi başına / 4.59 CO_2 e olarak hesaplanmış ve bu hesaplamalar ışığında eylemler beş başlık altında toplanmıştır; bina, ulaşım, aydınlatma, yenilenebilir enerji ve farkındalık.. Çalışma bölgedeki diğer belediyeler için bir model ve bölgesel kaynak yönetimini geliştirmek için bir temsilci yaklaşım olarak hizmet vermeyi hedefliyor. Aynı zamanda daha sürdürülebilir şehir bazlı ulaşım, İstanbul City için sürdürülebilir yaşam tarzları gibi konuları incelemek için fırsatlar yaratır. Bu çalışmanın sonuçları diğer belediyelere örnek teşkil edebilir, ve bölgesel kaynak kullanımı yaklaşımları hususunda bir duruş belirtebilir. Ayrıca bu çalışmada ortaya konulan alt yapı ile, sürdürülebilir şehir ulaşımı, sürdürülebilir yaşam alanları yaratma konularında öncü araştırmalar ve tezler yayınlanabilir.

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LIST OF SYMBOLS/ABBREVIATIONS

Symbol	Explanation	Units
CCS	Carbon Capture and Storage	-
CO_2	Carbon Dioxide	Per capita/tonnes
CO_2 e	Carbon Dioxide equivalent	Per capita/tonnes
CoM	Covenant of Mayors	-
CCP	Cities for Climate Protection	-
DIE	State Institute of Statistics	-
ETS	European Trade Scheme	-
GDP	Gross Domestic Product	$
GNP	Gross National Product	-
ICLEI	International Council for Local Environmental Initiatives	-
IPPC	Intergovernmental Panel on Climate Change	-
MW	Megawatts	-
MWh	Megawatthour	-
NACCP	National Climate Change Action Plan	-
WRI	World Resources Institute	-
TPES	Total Primary Energy Supply	-
TUBITAK	Türkiye Bilimsel ve Teknolojik Araştırma Kurumu	-
TWh	Terawatt-hours	-
UNDP	United Nations Development Programme	-
UNFCCC	United Nations Framework Convention on Climate Change	-

1. INTRODUCTION

"Climate is what you expect and Weather is what you get".

- Mark Twain

Mark Twain is one of the most legendary authors lived on earth. He is famous for his book "The Adventures of Tom Sawyer". While we were thrilled with Tom, he was also providing a vision for today's world. Therefore, his expression towards the differentiation of the terms on climate and weather is so effective and eye- opening.

Climate Change has been created by the excessive release of greenhouse gases (GHG) to the atmosphere (Sola, 2013). The main sources of emissions are biological activities and release from energy consumed practices (Covenant of Mayors, 2009). According to United Nations' (UN) research conducted on World Urbanization Prospects, by 2013 almost half of the world was living in urban areas. By 2030, they are expecting this ratio to reach two-third of the world population. The urbanization of the world's populations will create a demand for energy. As a result of it, energy consumption will be ascended and then it is likely to affect the environment (United Nations, 2014).

The threat of disruptive human–caused GHG is an important challenge that municipalities have been trying to be solution partners for years. While they create huge amounts of GHG emissions themselves, municipalities put an effort to GHG emission reductions actions. With this understanding municipalities across the world have initiated climate change policy frameworks to cope with energy use and the increased consumption of energy. Great numbers of administrators start to cooperate with each other and create networks to contribute to the solution (Kern, 2010).

City-based environmental problems are highlighted in the 1990s with the launch of International Council for Local Environmental Initiatives (ICLEI). In year 2008, European Commission established a network under the "Climate and Renewable Energy" package

(European Commission, 2008). Following this development, Covenant of Mayors (CoM) has been launched to encourage local authorities to take action (Covenant of Mayors, 2009).

Realizing and accepting the inevitability of climate change; experts have agreed that adaptation measures will be necessary in order to cope with its consequences. Regional sustainable development and mitigation actions can influence national plans as well. Therefore, researches focus on local can create the effect needed to apply it in global platform.

The aim of this dissertation is therefore to develop Sustainable Energy Action Plan within the scope of Covenant of Mayors in the geographical boundaries of the Kadıköy Municipality. The study focuses on action plan development for the region with aim of reducing 20% CO_2 emission from 2010 levels until 2020.

2. LITERATURE REVIEW

2.1. Turkey's Energy Outlook

Turkey is settled in a wide area, its total land area correspond with 783, 562 km^2. However, it owns relatively small number of natural resources. Therefore, Turkey is dependent to other countries to recover its energy demand. Its economy is in transformation from agriculture based economy to a more diversified economy with an increasingly large and globalized services sector (International Energy Agency, 2014).

Figure 2.1. Map of Turkey Provinces (Travel Planner, 2013).

In 2010, total electricity supply in Turkey reached 194 terawatt-hours (TWh). Natural gas fuelled 49% of power generation, while coal provided 28%, hydropower 19%, oil 3%, and other sources 1%. Electricity demand in Turkey continues at an annual growth rate of between 6.5% and 8% per year (Eurostat, 2013). In 2005, government passed new legislation "Concerning the use of Renewable Energy Resources for the Generation of Electrical Energy Law No. 6094" to encourage investment in the sector. It has been published in the Official Gazette on 18/5/2005. However, this law has been amended in 2010. "Solar energy sources are covered by this law, which decrees that facilities which generate electricity from renewable energy sources will be granted a renewable energy resources certificate (RER Certificate) which will entitle such facilities to benefit from the

incentives provided by the Law" (EPDK, 2010). Turkey is currently undertaking privatization of its electricity distribution. The private sector has responded, adding 6,644 megawatts (MW) of electricity generation capacity since 2009 (US Department of State, 2011).

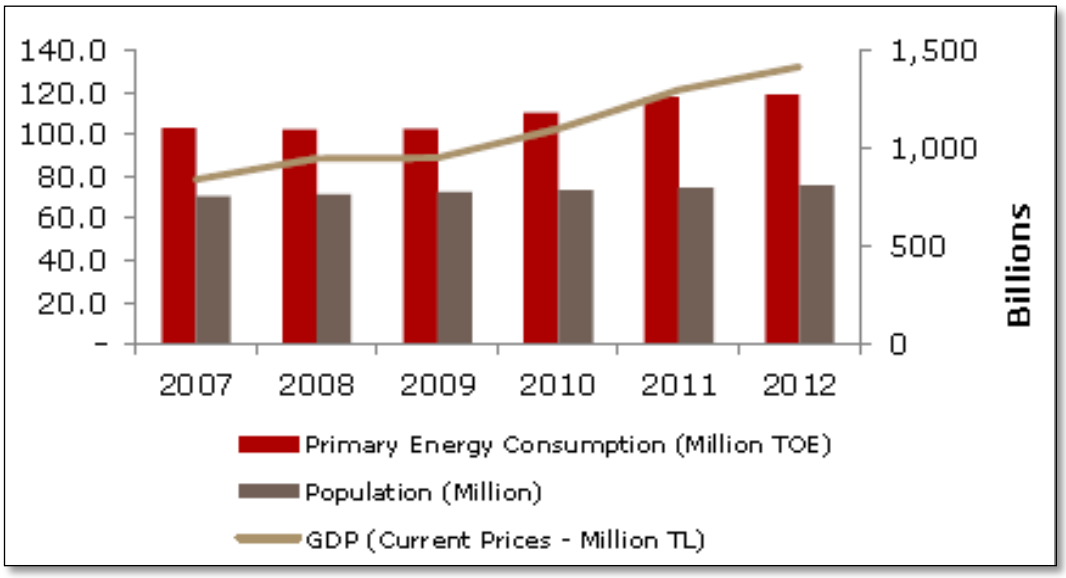

Figure 2.2. Turkey Primary Energy Consumption from 2007 to 2012 (Turkstat, EPDK, 2013).

Over the past decade, demand in the Turkish electricity market has been growing in line with its economic developments, driven by industrialization and urbanization. This situation together with population growth expectations shows great potential for further growth.

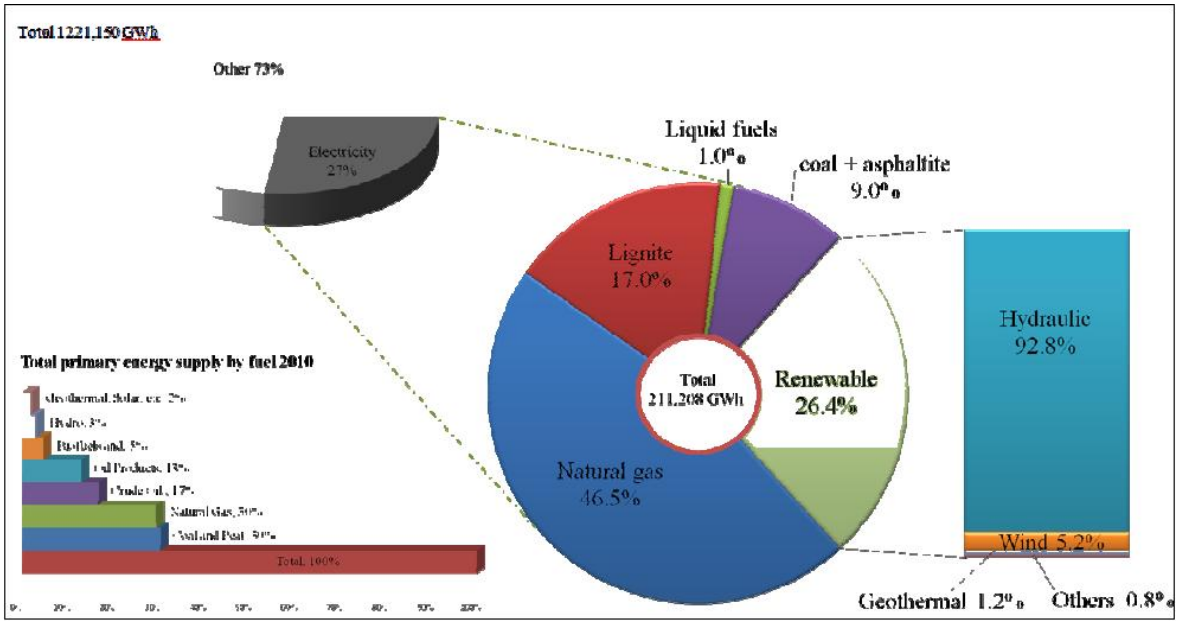

Figure 2.3. Electricity and Fuel Breakdown of the Total Primary Energy Production in 2010 (International Energy Agency, 2011).

Turkey has a high dependency on energy imports. According to the TurkStat (2012a), total energy import reached to 60,112 million USD and it constituted about 25.4 percent of the total in import activities of Turkey in 2012. Due to tremendous energy consumption in the country, in 2010 Turkey GHG emissions have inclined by 115% in last ten years and 85% of emission released from energy sector (TurkStat, 2012b).

Table 2.1. Turkey Overall Energy Variations in Years (Turkish Ministry of Energy and Natural Resources, 2011).

	Turkey's Energy Consumption Increase Rate (from 2000 to 2009) (%)	Turkey's Total Primary Energy Supply in 2011 (%)
Electricity	51	-
Natural Gas	49	31
Coal	28	31
Hydropower	19	11
Oil	3	27
Others	1	-

Table 2.2. Turkey Renewable Energy Sources in 2011 (Kucukali and Baris (2011), TEIAS (2011a), TUREB (2012)).

Type of Energy	Technical Potential (MW)	Economical Potential (MW)	Installed Capacity (MW)
Hydropower	54,000	42,000	17,137
Wind	114,000	20,000	1,806
Geothermal	2,000	600	114.2
Wastes (Biogas+Biomass)	4,000	-	125.7
Solar	56,000	-	-

In Turkey the main energy sources are coal and fuel oil. But in near future nuclear plants are prepared to be built (Barış, K., 2012). However, in near future Turkey has to move to renewable energy sources more precisely. It is obviously understood here that Turkey is not able to generate energy to cover the needs of consumption. This means that Turkey's energy need is corresponded by foreign countries. This brings huge economic liability. If this is the case till 2020 the consumption will increase more as greater population will need more energy sources. To be efficient using renewable energy sources would be beneficial. In below it is clear that consumption of energy will increase and production is predicted to be stable.

Production coming from Renewable sources is predicted to increase. The important generation is provided by hydropower. However, if it is deeply analyzed, it is clear that

total rate of production from Renewable Energy sources are approximately 20% which is quite low. Because domestic production of energy in Turkey is already low, Turkey is dependent to other countries' natural energy sources like natural gas.

Table 2.3. Renewable Energy Share in Total Projected Electricity Generation for 2015 and 2021(TEIAS, 2012).

Renewable Energy (RE) Source	SCENARIO 1				SCENARIO 2			
	Project Production Capacity (GWh)		*Reliable Production Capacity (GWh)*		*Project Production Capacity (GWh)*		*Reliable Production Capacity (GWh)*	
	2015	2021	2015	2021	2015	2021	2015	2021
Hydro	90522	116558	54932	69386	84380	116558	51459	69386
Wind	9208	9208	7644	7644	8790	9208	7288	7644
Biogas+waste	1196	1196	1196	1196	1196	1196	1196	1196
Total	375619	434670	325031	380774	360009	439620	312151	377324
RE Share in Electricity Generation, %	26.8	29.2	19.6	20.5	26.2	28.2	19.2	20.7

To reduce its dependency to imported energy sourced, and prevent the increase in GHG emissions, Turkey is developing scenarios to foster renewable energy sources in long-term. In the Table 2.3., TEIAS, the major electricity distributor in Turkey, has developed two different scenarios for future electricity production of Turkey: High demand and low demand scenarios.

Electricity generation plan for 2012-2021 of TEIAS, includes hydro, wind, biogas and wastes for 2015 and 2021 period. Under Scenario 1, based on project capacity and reliable capacity renewable energy share will be 26.8 % and 19.6 % by 2015, 29.2 % and 20.5 by 2021 respectively. Under Scenario 2, based on project and reliable capacity, renewable energy share will be 26.2 % and 19.2 % by 2015, 28.2 % and 20.7 by 2021 respectively. As seen in the Table 2.3, renewable energy share will be under 30 % by the 2023. According to the TEIAS (2012), there will be a gap in electricity power supply in 2017 and afterwards in Turkey.

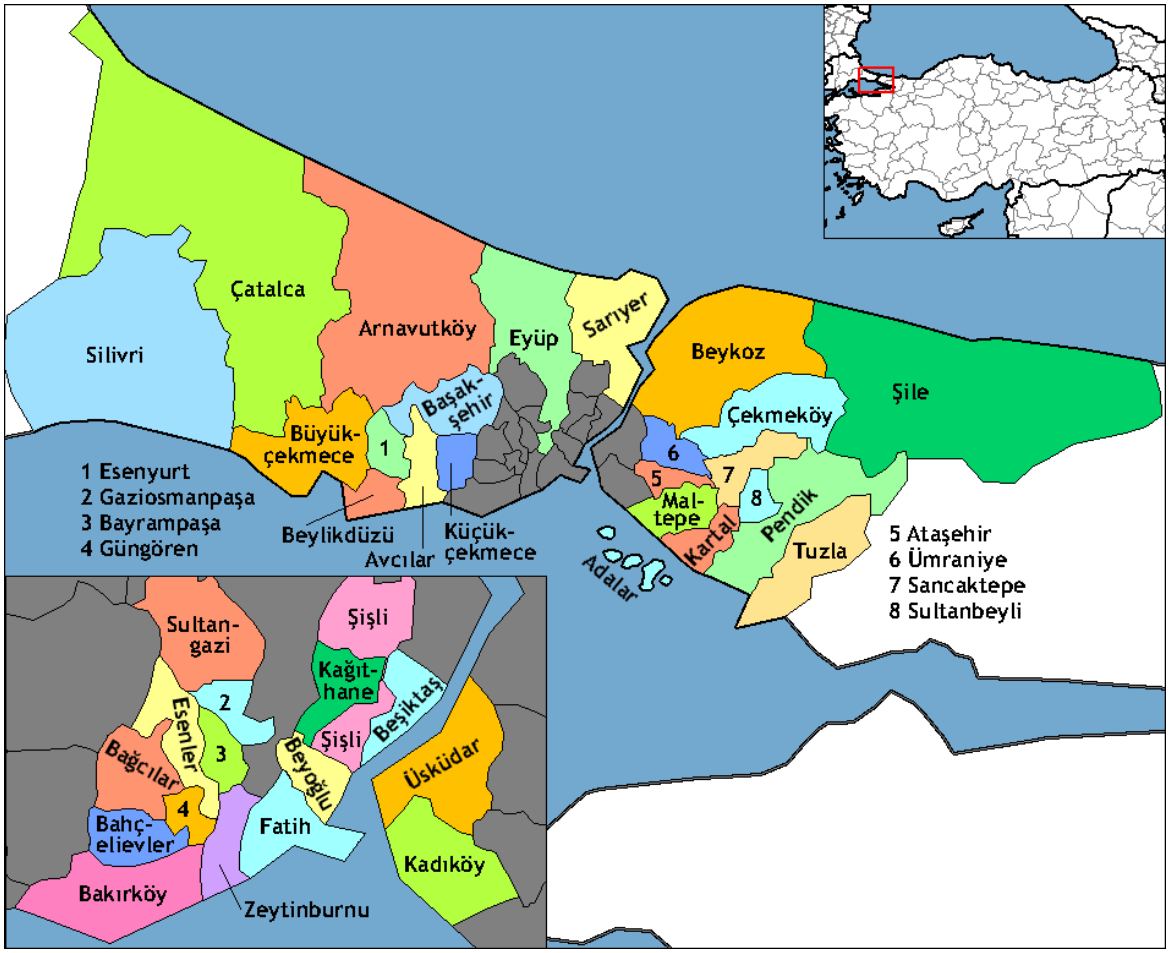

Figure 2.4. Map of Districts of Istanbul (IMM, 2013).

In 2010, Turkey declared 4.47 tonnes/ per capita CO_2 e emissions (Turkstat, 2013) and it was calculated as 3.3 tonnes/ per capita CO_2 e emissions for Istanbul (IMM, 2013). Istanbul is one of the cities has high population density which is 2,725/km^2 in 2010. Kadıköy region which is subject to this research is one of 39 districts of Istanbul Metropolitan, and by voluntarily has signed the agreement with Covenant of Mayors (CoM) to decrease the level of GHG emissions at least 20% till 2020 (IMM, 2014).

Local authorities are ideally placed to tackle climate change as they are seen as trusted sources of information with the ability to engage with individuals, communities and businesses. The initiatives like Covenant of Mayors (CoM) play a key role in success of this global problem. Turkey is not in a leading position in this initiative but, with foreseeing approaches aroused from local governments the numbers of signatories are increasing. In this thesis, we share outcomes of the study about the action plan

development for the Kadıköy. The plan has been developed to display mitigation options that could be applied to a densely- populated region.

Figure 2.5. Kadıköy Districts (Kadıköy Municipality, 2014).

2.2. Turkey's Energy Need

Turkey's energy use and GHG emissions are growing in the same direction. From 1990 to 2010, energy use increased approximately 26%, and GHG emissions accreted 96.0% (UN Statistics, 2014). This is widely acknowledged as a significant threat to ecosystems and the social and economic systems that depend on them (Orr, 2009).

The consumption of energy is rising tremendously due to high population in urban areas and industrial practices. The distribution of the resources and reserves are imbalanced across the world, therefore tension towards creating new resources is very high. Renewable energy applications are counted as one of the best and available technologies in terms of sustainability.

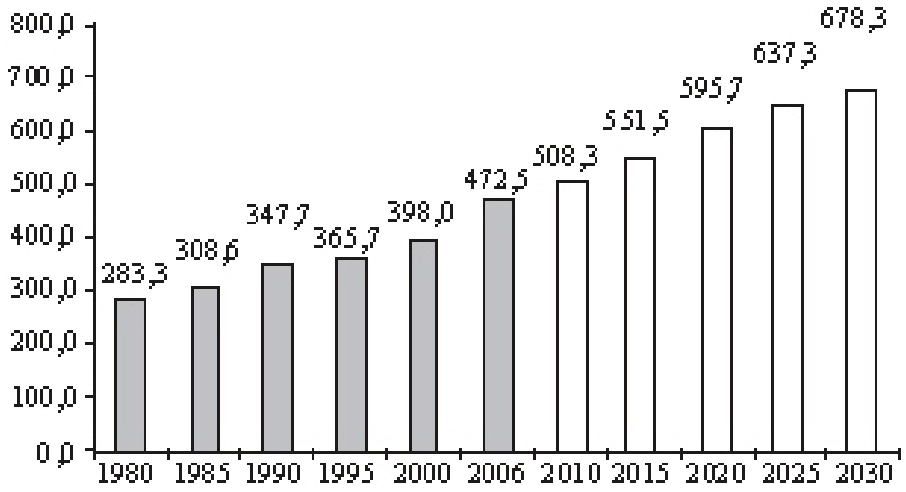

Figure 2.6. Global Energy Consumption, 1980- 2030 (Quadrillion BTU) (EIA, 2006).

The need for energy is increasing day by day. According to the U.S. Energy Information Administration, the world's consumption of marketed energy is forecasted to increase by 44% from 2006 to 2030. In the business as usual scenario, the EIA predicts that the world's energy consumption will rise by an average of 1.5% per year. Therefore, sustainable usage of energies is crucial in any perspective. Developing and integrating new technologies into energy sector will create difference in the long-run. However, just technological improvement is not enough to make a radical movement but also adaptation of the technology into daily-life can lead towards a more sustainable world. Cities are one of the biggest consumers of the energy thus the decision-makers need to display more commitment and should be part of the solution process (EIA, 2006).

2.2.1. Regulations on Energy Issues in Turkey

2.2.1.1. Laws, Regulations and Directives Applied in Turkey

a) *Energy Efficiency Law No. 5627: Adoption Date: 18/04/2007, Published in Official Gazette at 02/05/2007, Issue: 26510*

The purpose of this Law is to increase efficiency in using energy sources and energy in order to use energy effectively, avoid waste, ease the burden of energy costs on the economy and protect environment procedures and principles for promotion of energy efficiency in transportation (Ministry of Energy and Natural Resources, 2007).

b) The Bill on the Endorsement of Turkey's Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) Law No. 5836, Adoption Date 17/2/2009, Published in the Official Gazette, Issue: 27144

As an Annex I party to Convention, Turkey is required to develop annual inventories on emissions and removals of greenhouse gases (GHG) not controlled by the Montreal Protocol using the methodology approved by the UNFCCC (Turkstat, 2010).

c) The Directive on the energy performance of buildings (EPBD) is the directive 2002/91/EC (EPBD, 2003) of the European Parliament and Council on energy efficiency of buildings. The Directive came into force on 4 January 2003.

d) European Parliament and Council Directive 2000/55/EC of the 18 September 2000, on energy efficiency requirements for ballasts for fluorescent lighting [Official Journal L 279 of 01.11.2000].

The purpose of the directive is to achieve cost-effective energy savings in fluorescent lighting, which would not otherwise be achieved with other measures. This directive covers only newly produced ballasts, which are responsible for high energy consumption and offer considerable potential for energy savings (Europa Report, 2006).

e) *Concerning the use of Renewable Energy Resources for the Generation of Electrical Energy Law No. 6094. Adoption Date 18/5/2005, Published in the Official Gazette, Amended: 29/12/2010-6094/Art.*

f) *Electricity Market Law numbered 4628, The Electricity Market Law was enacted in 2001 with the aim to liberalize the electricity market*

g) *Law on utilization of renewable energy sources for the purpose of generating electrical energy Law No. 5346. Adoption Date 10/5/2005, Published in the Official Gazette 18/05/2005*.

The purpose of this law is to expand the utilization of renewable energy sources for generating electric energy, to benefit from these resources in a secure, economic and qualified manner, to increase the diversification of energy resources, to reduce greenhouse gas emissions, to assess waste products, to protect the environment and to develop the related manufacturing industries for realizing these objectives (Emra, 2015).

2.3. Comparison on European Union Vision 2020 and Republic of Turkey Vision 2023 with special interest on Environment and Energy

EU puts three main strategies smart growth, sustainable growth and inclusive growth to reach its goals by 2020. All countries and each government wants to reach economic growth, provide welfare for the citizens, but in order to achieve those targets, they must have stable economy.

EU struggles with the economic crisis for some time, so it needs new ways to generate income. And it is clear in the report that they found the solution in R&D with special interest on Green Technologies and possible new markets for that sector. In European Commission report (2010) the goals are shared with the public.

Turkey, one of the candidate countries for acceptance to the European Union, plans the structure and goals within that perspective. Turkey's strategies and goals on Environmental issues are reported in 2006 by Ministry of Environment and Forestry.

In the Table 2.4., the comparison on Turkish future targets and EU future targets on both environment and energy areas have been displayed. Within the context of the smart growth, EU embraces the fact that planning and developing strategies towards global challenges is an obligatory. They give high importance to energy efficiency programmes and also for resource efficiency they are planning to adopt an action plan. In Turkey, the planned is to implement a national environmental strategy. That can help Turkey to be harmonized with EU Environmental Acquits. Those strategies and plans should be applied in time, therefore policies and directives can be firmed to preserve the natural resources. In addition to all, EU and Turkey are focusing the carbon market. Carbon market can engage finance and innovative solutions. The carbon-sensitive innovative projects not only support the resource efficiency but also can increase the country and personal the savings as a whole.

Table 2.4. Comparison of Energy and Environment Future Targets (European Commission and Tübitak, 2010).

Turkey 2023 Targets in Energy Sector	EU 2020 Targets in Energy Sector
The national environmental strategy and will be implemented as a whole.	To adopt and implement a Revised Energy efficiency Action Plan and promote substantial programme in resource efficiency
The laws and by-laws related to environment will be reviewed and their harmonization with EU Environmental Acquits will be ensured by progressive stages	To complete the internal energy market and implement the strategic energy technologies plan, promoting renewable sources of energy in the single market
The protection/utilization conditions of the natural resources will be determined by considering the requirements of the future generations and the environmental management that will provide fair and equal access for everyone to these resources will be ensured.	To present proposals to modernize and carbonize the transport sector; intelligent traffic management, better logistics, pursuing the reduction of CO_2 emissions for road vehicles
The environmental organization plans that will be prepared throughout the country will be in conformity with the national, regional and lower scale plans.	To present an initiative to upgrade Europe's network, Trans European Energy Networks
Integration of the environmental policies to economic and social policies will be ensured, the necessary incentives will be provided and the economic tools related to protection of environment will be utilized.	Strengthen the economy resilience to climate risks and disaster prevention and response
For an effective environmental management, the experience gained in institutional structures will be used in the most effective manner, also these experiences will be developed according to present conditions and capacities will be strengthened.	To enhance framework for the use of market based instruments (e.g emissions trading, revision of energy taxation, state- aid framework, encouraging wider use of green public procurement)

Environmental information and monitoring systems will be established for the implementation of the environmental norms and standards and for the monitoring of the implementation.	Decreasing the growth rate of Greenhouse gases
Controlling, assessment and reporting system that is required for monitoring of implementation of EU Directives will be established.	To bring in innovative incentive mechanisms linked to the carbon market
Coordination between the institutions in environmental management will be ensured and the cooperation between the stakeholders will be developed.	Investing in cleaner, low carbon technologies and in resource efficient technologies
Financing opportunities of the environmental sector will be developed, the investments required for the infrastructure and other sectors will be realized and environmental protection will be of importance in all the processes from production to consumption.	Reducing the consumption of fuels
Cooperation between the private and the public sector will be developed in meeting, financing and operating of the infrastructure needs.	Clean and efficient energy, £ 60 billion less oil and gas import
In order to minimize the waste water, solid waste and air pollution under economic conditions, technologies those are best suitable for the conditions of the country will be preferred in the construction, maintenance, repairing, and renewal and operating of the environmental infrastructure facilities. Also, these facilities will be generalized in a way that will encourage local administrations where possible and will be ensured to be operated effectively.	Create 600.000 jobs from green sector

Controlled utilization will be provided in management of the chemicals and wastes that may cause risks for human health and environment in the period beginning from production until disposal.	To develop a strategic research agenda focused on challenges such as energy security, transport, climate change, and resource efficiency , environmental- friendly production methods and land management and to enhance join programming with member states and regions

2.4. Local Government Organizations in the Area of Climate Change

As municipalities are one of the important actors in the fight against climate change, their collective actions would create the atmosphere needed. For that reason several regional initiatives has been established. They are apart from national governmental bodies, their motivation gain strength from being volunteer. Those initiatives are formed in two ways; regionally and globally. In global context, ICLEI and C40 are two well-known actors who embody signatories across the world.

The International Council for Local Environmental Initiatives (ICLEI), founded in 1990, is part of the UN and operates worldwide charged with helping to implement the goals of Agenda 21. "Agenda 21 is a non-binding, voluntarily implemented action plan of the United Nations with regard to sustainable development." It has been official in UN Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil, in 1992. It is counted as an action plan for the UN, other multilateral organizations, and individual governments around the world and can be executed at local, national, and global levels. (ICLEI-USA, 2012) It has produced one of the most utilized municipal GHG inventory standards, the *Local Government GHGEmissions Analysis Protocol* (IEAP). The program uses a performance-based model in which members work towards completing five milestones: creating a GHG emissions inventory, setting reduction targets, developing a local action plan; implementing the plan, monitoring progress and reporting results (Oceania, 2008).

In 2011, *The C40 Cities Climate Leadership Group (C40)* and ICLEI signed an MOU to announce that they would partner to develop a Global Standard on Cities Greenhouse Gas Emissions. With this collaboration, sources of these two initiatives have been merged in one pool. In other words, municipalities who have been side of ICLEI or C40 benefit from the actions that have been already actualized (Betsill, 2007).

C40 is a partnership of 40 global cities which works to share best practices and reduce GHG emissions through initiatives and programs. Istanbul Metropolitian Municipality is currently the only member from Turkey to this initiative (C40, 2013). The success of this

initiative has been noticed, and it has quickly become an important international framework and commended the C40s' unique style of 'governance from the middle' as both compelling and practical (Roman, 2010).

Climate Alliance, is also network of local authorities. Its focus is to reduce the GHG emissions. To increase the awareness they have been working with local governments in both Europe and Amazon Basin. Their focus areas climate protection, indigenous peoples, and tropical forest.

Energie Cities' main task is to bring local networks together in the same framework like Climate Alliance or C40, they want to decrease the level of CO_2 emission. Municipalities in the networks share the know-how in projects. This collaboration generates opportunity to be successful in implementation. In the Table 2.5. those initiatives and their characteristics have been shown. They have a common ground to reduce the level of CO_2 emissions; in addition to that, their strategies to reach the target merge in the process. Beyond all that, they have unique aims as well. To illustrate, the Climate Alliance want to preserve tropical rainforests, however for the other networks they do not have that specified target.

Those initiatives have global operations, and they adopt classical public entities into new world arrangements. They embrace the organizational structure and quality all together; therefore they involve stakeholders at various levels into action, smoothly. However, those initiatives are not working solitarily, regional- based organizations support the work with local governmental forces. The best example to this is Covenant of Mayors. CoM's signatories are distributed all over the Europe, and municipalities are developing many projects and actions and implement them to sustain their region.

Table 2.5. Local Government Organizations in the Area of Climate Change.

Name of the Organizations	Founded Year	Area Served	Focus Area	Similarities	Differences
Climate Alliance	1990	Europe and Amazon Basin	Climate protection, indigenous peoples, tropical forest	Network of local authorities Reducing the level of CO_2 emissions	To preserve the tropical rainforests by avoiding the use of tropical timber It does not require a action plan from its members.
Energie Cities	1990	Europe	Building, Energy Efficiency, Renewables, Urbanism, Transport	Network of local authorities Reducing the level of CO_2 emissions	Influence the policies and proposals made by European Union institutions in the fields of energy, environmental protection and urban policy. To develop and transfer know-how in projects. It does not require a action plan from its members.
Climate40 Cities		Global	Sustainability	Reducing the level of CO_2 emissions	Network of the world's megacities It does require a action plan from its members.
International Council for Local Environmental Initiatives	1990	Global	Sustainable Development	Network of local authorities Reducing	It does require an action plan from its members.

(ICLEI)				the level of CO_2 emissions	
Covenant of Mayors (COMs)	2008	Europe	Energy Efficiency	Network of local authorities Reducing the level of CO_2 emissions	It does require an action plan from its members.

2.5. International Protocols and Agreements to Mitigate Climate Change

The Kyoto Protocol was a driving force in this respect, and was an international agreement linked to the United Nations Framework Convention on Climate Change. The major feature of the Kyoto Protocol is that it sets binding targets for 37 industrialized countries and the European Community for reducing GHG emissions. The reduction amount declared is on average five per cent against 1990 levels over the five-year period of 2008-2012. The Kyoto Protocol was adopted in Kyoto, Japan, on 11 December 1997 and became legally binding for signatories on 16 February 2005 (Nordhaus, 2006). In 2012, at the capital city of Qatar, in Doha, the representatives of the countries have met once again to discuss the effects of climate change. As a result of the conference, the Kyoto Protocol has been extended to 2020. The 27-member European Union, Australia, Switzerland and eight other industrialized nations agreed to the binding emission cuts by 2020. Each signatory had already legislated individual targets. The US has refused to ratify Kyoto. The protocol also excludes major developing polluters like China, the nation with the highest rate of pollution, and India (UNFCC, 2015).

In December 2008, EU leaders and the European Parliament agreed on a unilateral commitment to reducing GHG emissions by 20 percent (compared to 1990 emissions) by 2020. The EU has made a commitment to increase this target to 30 percent for the period beyond 2012 if there are comparable targets from other developed countries and adequate action by developing countries. Targets set by the EU are;

- The EU Emissions Trading System (EU ETS) directive is the EU's main policy mechanism for reducing CO_2 e emissions from energy intensive sectors. It will deliver two-thirds of the first 3 UK carbon budgets. This equates to 21% reduction by 2020 compared to the 2005 verified emissions baseline under the EU ETS.

- A GHG Effort Sharing Decision sets targets for reductions in those sectors of member states' economies not covered by the EU ETS – in the most part residential and transport.

- A Renewable Directive sets targets for each member state for the proportion of renewable energy generation by 2020. The EU has a 20% renewable target by 2020. The Renewable Directive also sets every Member State a target of supplying 10% of transport fuel from renewable sources by 2020.

- The Directive on the geological storage of CO_2 e outlines a regulatory framework for the safe capture, transport and storage of carbon dioxide in the EU. Up to 300 million allowances from the new entrants' reserve of the EU ETS will be used to support the demonstration of carbon capture and storage (CCS) and innovative renewable technologies (Europe 2020 Report, 2010).

The EU Covenant of Mayors Initiative on Climate Change-2008; CoM Initiative on Climate Change was established in 2008. The initiative was started at a regional level, voluntarily committing to go beyond set government targets on GHG reduction. By their commitment, Covenant signatories aim to meet and exceed the European Union 20% CO_2 e reduction objective by 2020.

2.5.1. Covenant of Mayors Initiative

Due to rapid growth in the cities, especially metropolitans like Istanbul, the need for governance and management of the urban areas increase. Cities play main role in response to landscaping climate change (Betsill and Bulkeley 2007). Moreover, to create efficient and adequate road maps, some parameters need to be considered. According to those parameters city-based solutions could be developed. Those parameters are generated by working on urban competitiveness, urban GHG emissions inventories and vulnerability to climate change (Rosenzweig et al, 2009). These basic indicators become a base for experts to generate regional action plans. However, experts' involvement is not enough to enhance the process, therefore local authorities' involvement to the process is crucial (Covenant of Mayors, 2013).

The figure below effectively summarizes the pattern. In vertical, the first step constitutes the international agreement with high participation rate. It follows the national governments enthusiasm about the subject and that regional governments should follow the

directives founded in national platform with municipalities. Therefore, as it is explained in the figure the position of municipality is highly beneficial to rule the process comprehensively.

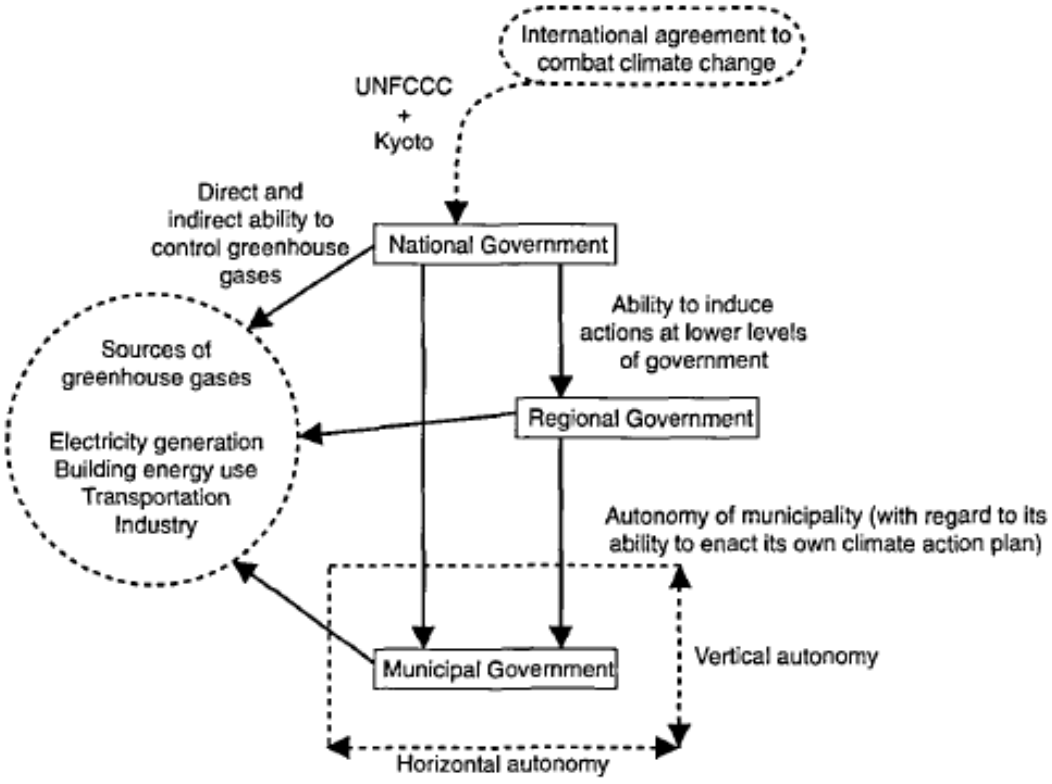

Figure 2.7. Conceptual Framework for Municipal Climate Action (Deangelo et al., 1998).

CoM is an effective organization in order to force municipalities to act in a systematic way. Every city or district municipalities are free to join this network. It invites any party that wants to fight against climate change in EU region or even outside the region. Therefore, it might be predicted that this collaboration may also constitute long-term energy policies for the European Continent or even the World (Covenant of Mayors, 2009).

The CoM initiative has received wide acceptance by communities in Europe. Spain and Italy are leading the EU region by the high number of signatories, which is now up to 800 municipalities, corresponding to millions of citizens from those regions. These countries are followed by France, Germany and Greece. This organization is so important that each day it increases its signatories. This could be a hope to return to90's level of

greenhouse gas release which is 200,720 Gg. CO_2 e (1Gigagram= 1000 tonnes) (DIE, 2005).

In Turkey, several densely populated local governments already became a part of this agreement. Six municipalities in Turkey had already signed the CoM agreement and formally expressed their will to reduce their CO_2 e emissions by at least 20% by 2020. Those cities represent more than 3 million citizens of Turkey. In big picture, it only corresponds close to 4%, but it is a beginning.

Development of the SEAP is a process where volunteer signatures of CoM should embrace the whole process in holistic approach. Getting acceptance from the JRC office who directs the administrative duties of CoM initiative is easy, if you are willing to adopt your organization to low-carbon living style. Firstly, the candidate city officially demonstrates its commitments. Following the signatories' official volunteer commitment, a period of one year to prepare and submit their SEAP is given. In this year, team which includes municipality officers and experts prepare the groundwork. The very first thing is identifying the related stakeholders which can provide the necessary data to reveal the current status of Kadıköy region. The calculation of total GHG emission of the region is realized by those data. In this study, Kadıköy Municipality's 2010 emission inventory has been constructed by applying this process which is displayed in Figure 2.6. That was followed by developing the energy efficient actions with Municipality executives. The SEAP must illustrate the applicable procedures to achieve their targets in CO_2 e emission reductions. Therefore, the selected actions should be approved by the Mayor to actualize. The bureaucratic procedure in CoM is completed when SEAP is approved by the CoM office, and then regular implementation reports must be prepared in order to showcase the progress and results, informing the citizens.

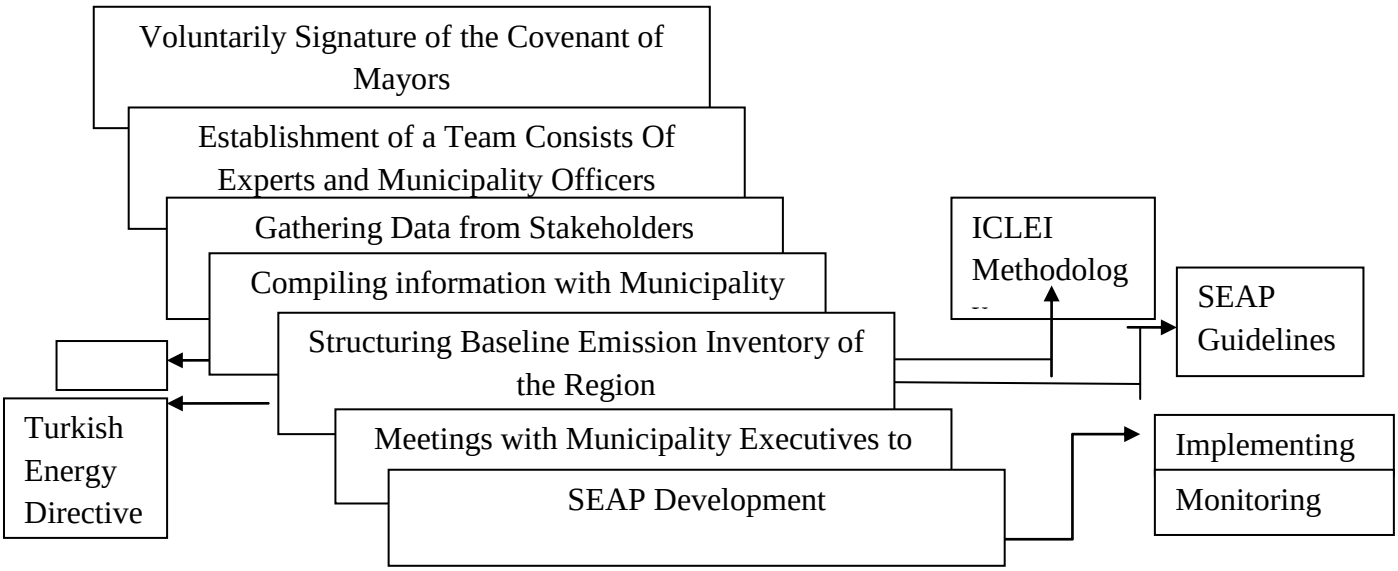

Figure 2.8. Step-by-Step Process to be followed in Development of SEAP.

The most important step towards the development of the SEAP is the compilation of a Baseline Emission Inventory. This inventory should depict the situation concerning the CO_2 e emissions inside the territory of the Covenant signatory at a "baseline" year (SEAP guidelines of CoM, 2013). Therefore, the first workload of the area is generating the "Carbon Foot Print" of the district. The amount of GHG emissions released from a region is a good source in order to predict possible outcomes of that region in theupcoming years.

2.6. Sustainable Energy Action Plans from CoM Signatories

Cities have been appointed by the authorities to overcome the negative effects of the climate change as they contain huge amount of sources which contribute to climate change. In their paper Bassett and Shandas (2010) emphasize that cities are in an advantageous position for applying the actions which produce instant outcomes. However, in the same study it is revealed that there is no set process for developing universal action plans as a plan which works for one city may not work for another. In this chapter, examples of actions from different parts of Europe are displayed. They might not perfectly fit to Turkey but similarities can be observed.

Delft is a university city from Netherlands. It is located in the province of South Holland, north of Rotterdam and south of the The Hague. It is population is 99.737 and its total area is 24.06 km^2. City's population density is 4.371/ km^2. Delft Municipality participated in CoM in 2008 and since then the municipality has been updating its targets and actions with midterm reports. They have chosen the year 2007 for a baseline year, and the calculation of tonnes CO_2 e /capita/year was 4.3.

Their main actions to decrease the level of emissions are focused on buildings renovation; municipality and housing. The municipality committed to decrease 30% till 2020. In line with this goal, they have generated projects on sustainable energy. They were fully aware about the process to accomplish the plan, have reported what should have been done clearly in their report called "3E: Climate Plan 2003-2012", and by following this report they enlarged their activity log.

Firstly, they have defined the committee who works on to complete the actions noted. Secondly, they have pointed out their projects for reduction to reach out their goals. Their best approach in the process is that they have analyzed the cost of the comprehensive plan very detailed and efficiently. The aim of those studies is to influence governmental bodies to develop regulations or standards towards making conditions of the district better than they already are.

Another signatory is from Britain, Cornwall Municipality. Cornwall is a peninsula bordered to the north and west by the Celtic Sea, to the south by the English Channel, and to the east by the county of Devon, over the River Tamar. Cornwall has a population of 536,000 and covers an area of 3,563 km^2 (Watts, 2010). They have developed beneficiary actions. According to the guidelines of the SEAP, they have realized projects under categories; Building and equipment/ facilities, transport, local electricity production, local district heating/ cooling, land use planning, public procurement of products and services, working with citizens and stakeholders.

- Local electricity production through Solar PV, Landfill gas, small hydro and onshore wind and sewage gas

- Green Council, green communities, green economy perspective generation for the region

- Local transport plan to promote sustainable transport; Prioritize investment into walking and cycling route, reduce road building, Support the delivery of electric vehicle, infrastructure, encourage responsible use of our cars, increase investment in drainage solutions

- Superfast broadband for all of Cornwall; install superfast fibre optic broadband throughout Cornwall, with significant investment from the European Regional Development Fund (ERDF) Convergence Programme and BT. Calculation of potential savings is being looked at by the municipality.

- Anaerobic Digestion Project in Looe

- Smart grids project for housing

- Supporting and promoting Marine Energy opportunities

Unlike rural, urban areas possess the effect to reflect as pioneer in the field of sustainable energy action (Rosenzweig et al., 2010). Most of the municipalities in Turkey are not aware of climate change and GHG emission's cause and effect, therefore they do not put any efforts to act. Although this is the situation encountered in Turkey, some municipalities are voluntarily committed to mitigate the emissions released from their region. Kadıköy Municipality is one of them, also from Izmir, Karşıyaka and Bornova Municipalities signed the CoM agreement and published their action plan to fight against climate change.

Bornova Municipality located in Aegean part of Turkey, in one of the biggest cities of Turkey, Izmir. Its population is 418. 837. They have calculated their GHG emission for year 2011 as 1.015.581 tonnes/CO_2 e. As agreed on they have generated actions in order to decrease their level of emissions by 20%. To illustrate some of their actions are;

- Isolation in residential buildings, the aim of this study to prevent the loss of heat and decrease the amount of fuel used for heating purposes.

- Urban Transformation in buildings in accordance with Energy Efficiency

- Transformation of the municipality vehicles into CNG and vehicles that contributes less to GHG

- Motivating the citizen to use public transportation

- To adapt renewable energy sourced illumination; to construct panels into field with aim to generate 50 MV electrical energy into the region

- Waste minimization and development projects

- Awareness raising projects towards extending energy efficient application (Bornova Municipality, 2013)

Karşıyaka Municipality is also located in Izmir. Its' 2009 CO_2 e emission is 589.590 tonnes CO_2 e. To establish actions GHG emission inventory of the city was concluded for 2009. Their target is to reduce the emission by 20% by 2020. Their solutions to decrease the emission are;

Table 2.6. Karşıyaka Municipality GHG emissions by Sector for 2009 (Karşıyaka Municipality, 2013).

Sectors	CO_2 e emission tonnes (2009)	%
Building, equipment and Industrial Facilities	449.076	76
Transportation	140.514	24
TOTAL	589.590	100

In Table 2.7. actions taken to prepare the region for the impacts of climate change has been displayed. In the further steps, the adaptation of these actions and projects are crucial at both local and national level. The building sector and industrial activities in the region hold the biggest portion of inventory. Therefore, in the plan municipality authorities gave the importance to the buildings renovations. However, in delft city they have also prepared business community solutions, thus different stakeholders can involve into process.

Table 2.7. Sustainable Energy Actions from CoM Signatories (CoM, 2013).

City	Country	About City	CO_2 /capita/year	Sustainable Energy Actions
Delft	The Netherlands	Population is 99.737 Total area is 24.06 km^2. City's population density is 4.371/ km^2. Participated in CoM in 2008	4.3	Realizing sustainable energy in dwelling areas Constructing Wind turbines Application of residual heat of Desktop and Server Management (DSM) Business community solutions; sustainable industrial sites, Extended scope and duty of care of the business community Developing internal transport plan for the region Re-structuring energy performance
Cornwall	Britain	Population is 536.000 Total area is 3.563 km^2. City's population density is 151/ km^2. Participated in CoM in 2008	5.8	Waste management; waste water discharge, commercial and industrial landfill, incineration, local authority collected waste to landfill Local electricity production through Solar PV, Landfill gas, small hydro and onshore wind and sewage gas Green Council, green communities, green economy perspective generation for the region Local transport plan to promote sustainable transport; Prioritize investment into walking and cycling route, reduce road building, Support the delivery of electric vehicle, infrastructure, encourage responsible use of our cars, increase investment in drainage solutions

Bornova	Turkey	Population is 418. 837 Total area is 224 km^2. City's population density is 1870/ km^2. Participated in CoMs in 2012	2.42	Isolation in residential buildings, the aim of this study to prevent the loss of heat and decrease the amount of fuel used for heating purposes. Urban Transformation in buildings in accordance with Energy Efficiency Transformation of the municipality vehicles into CNG and vehicles that contributes less to GHG Motivating the citizen to use public transportation To adapt renewable energy sourced illumination; to construct panels into field with aim to generate 50 MV electrical energy into the region
Karşıyaka	Turkey	Population is 325.717 Total area is 102.4 km^2. City's population density is 319/ km^2. Participated in CoMs in 2012	1.9	Energy Monitoring systems adaptation to municipality buildings Smart Municipality Buildings Isolation in residentials Central Cooling and Heating Systems in residentials LED applications Transformation in the energy system –switching to natural gas from fuel oil Building Solar Panels into the field within the capacity of 493 KW

2.7. Kadıköy Municipality

Kadıköy Municipality was established in 1855 as a Sehremaneti. After the foundation of Turkish Republic, in 23 March 1930, the district of Kadıköy is structured, and it still protects its existence in the region.

Table 2.8. Characteristics of Kadıköy Municipality and Turkey (Kadıköy Municipality 2020 Strategic Plan and UN Data Bank, Turkstat, International Energy Agency, 2013).

Characteristics	Kadıköy	Turkey
Total Land Area (km^2)	25	783,562 km^2
Population (inhabitants)	524.373	77,695,904
Population density (residents /km²)	20.975	101
Living space (m²/ capita)	40	10084
Types of housing	Mostly 2 or 3 rooms housing	Mostly 2 or 3 rooms housing
CO_2emissions per capita (t)	4.83	4.47
Energy consumption per capita	7.7 MWh	1304.1 MWh
Percentage of renewable energy consumed	None	10%
Total percentage of citizens walking, cycling or taking public transport to work	No data	No data
GDP per capita	No data	10,482$
Industrial and commercial activity	Negligible	Yes

Due to its visionary perspective Kadıköy Municipality signed CoM agreement in 2012 and become party to its voluntary obligations. That led to formation of SEAP. However, Kadıköy Municipality has already started to develop projects which make the district greener. Predictions point out that urban development plays important role in order to reach the targets. Along with Kadıköy Municipality, Bornova Municipality which is located in Izmir-Turkey calculated their GHG emissions and reported to CoM. When it is compared with Kadıköy they experience advantage of having free land area to construct renewable solar field. In addition to that, due to location Bornova has good weather conditions all year long. This positively affects the fuels used for heating (Bornova SEAP, 2013).

3. MATERIALS AND METHODS

3.1. Methodological Approach

While developing the SEAP baseline emission inventory for year 2010 the principals used are consistent with those used in the finance sector, to ensure accurate accounting andreporting of GHG. There are several standardized documents to be able to generate systematic documents. UK's Carbon Trust standard and International Organization for Standardization (ISO), ISO 14064: Quantification and Reporting of GHG Emissions for Organizations is supported by ISO 14069: Guidance for the Application of ISO 14064 is used by the parties for reporting GHG emission sources of their entities. European Energy Award is also a guide used to develop energy action plans. However, tools and other sources are not publicly available. Therefore, to use that source as a municipality has to be a member of the community. For the climate alliance, the same conditions are valid. As a researcher, conducting the study through these guidelines is not possible.

Table 3.1. Comparison of SEAP development methodologies (Bertoldi et.al, 2012).

SEAP Methodologies	Strengths	Weaknesses
European Energy Award	- Good catalogue of measures with evaluation tool - Numerous tools/best practice examples available in different languages - Existence of a forum where the participating cities are represented and which guarantees the quality management and standardization on European level	- Tools and guidance documents are not publicly available (members only) - Cities have to pay a license fee to participate - The quality of the evaluation strongly depends on the skills of the energy advisors - The availability of some tools/best practice examples may depend on the country/language
Clımate Compass	- The guide developed by CA contains a "compendium of measures" aimed at helping municipalities to make a choice among them and establishing their own level of ambition. This tool can be used by	- The communication and dissemination aspects have not been fully developed. - Some of the information is only available for the members of CLIMATE ALLIANCE.

	expert and nonexpert municipalities as the lowest and highest levels are adapted to both situations.	- Following the available information this methodology seems very focused and detailed on the measures to be implement
ICLEI	- The guidebook contains a very rich collection of previous experiences in diverse sectors that will help municipalities to identify the main barriers to overcome with certain measures. - A large amount of arguments to increase awareness among the stakeholders are proposed at the beginning. - - The method has been used worldwide by ICLEI. - - Numerous references to external resources	- The communication aspect is not dealt in depth. The guide just contains some aspects of it. - Networking and benchmarking have not been included as important point to develop a SEAP.

However, those two are not convenient enough to create community based inventory due to their focus areas. ICLEI which has been adapted by the WRI/WBCSD GHG Protocol Initiative to apply to the accounting and reporting of greenhouse gas emissions is beneficial through its standardization defined particularly for municipalities. There were few numbers of specific methodologies for developing SEAP. The most convenient for the region of Turkey is International Local Government GHG Emissions Analysis Protocol (IEAP) which is generated by ICLEI.

For the Kadıköy region, Global Protocol for Community-Scale Greenhouse Gas Emissions Pilot Version 1.0 and World Resource Institute (WRI)'s guidelines have been considered. Also, the guidelines of constituting baseline emission inventory under CoM which has been written by Joint Research Centre (JRC) are the key elements to provide accountability for the calculations. In the decision phase of the methodology, the availability of tools and guidelines played a significant role.

Defining the boundaries of the working area could be difficult for the municipality employee's to assess the GHG emission releases from the region. In the process almost every municipality had their own methodology. Without standardization the allocation of the resources would be impossible. Under Scope 1, Scope 2, and Scope 3 emission classification is important. To increase the accuracy, the table below should be taken as a guide especially for regional GHG emission calculation.

In order to set the procedure to be followed during the research, four significant items are defined at the beginning of research. They are;

1. Setting Organizational Boundaries; it is used in consolidating GHG emissions and to define operations and units.

2. Setting Operational Boundaries; it helps to identify emissions associated with its operations and categorizing them as direct and indirect emissions, and choosing the scope (Scope 1, Scope 2 and Scope 3) of accounting and reporting for indirect emissions.

3. Setting Geographical Boundaries; within the official border of the region.

4. Identifying and Calculating GHG Emissions; it is usedto identify GHG emissions sources, selecting a GHG emissions calculation approach, collecting Collect activity data, choosing emission factors and making GHG inventory calculations. (IEAP, 2013)

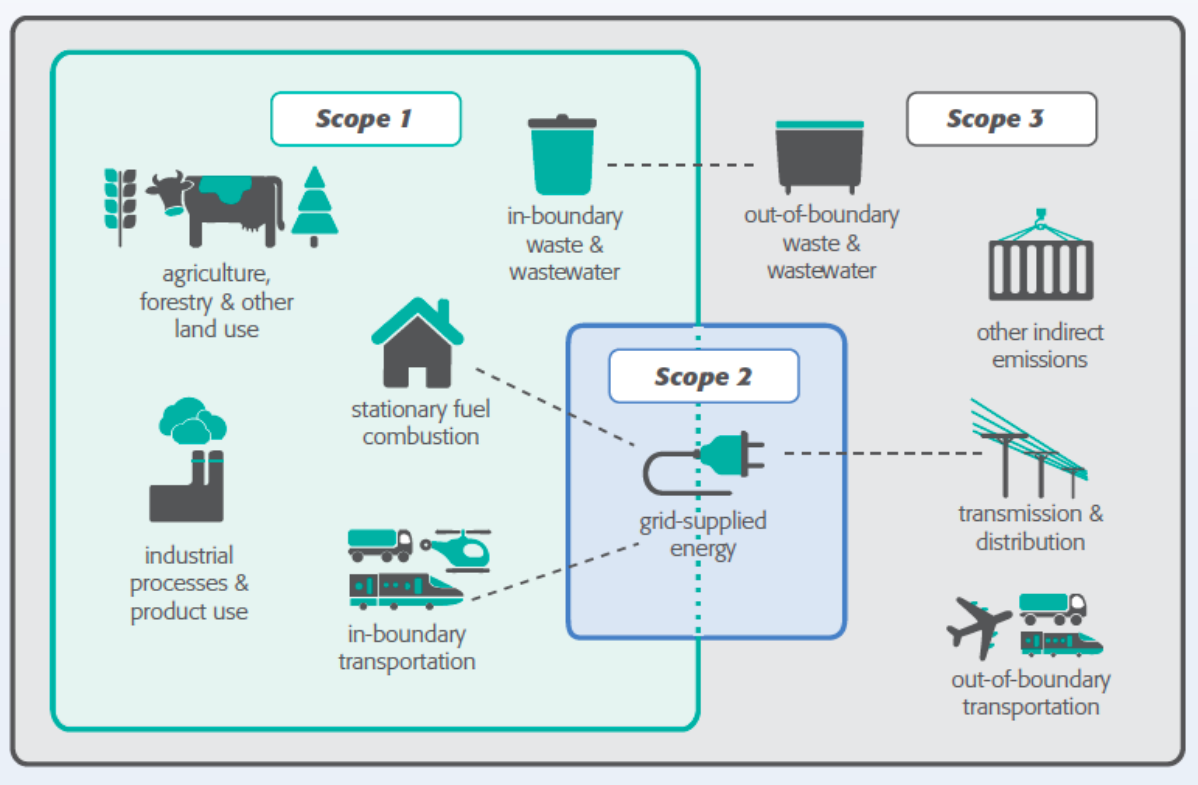

Figure 3.1. Community-scale Scope 1, 2 and 3 classification (ICLEI, 2012)

Classifications of the Scope 1, 2 and 3 in accordance with emission sources;

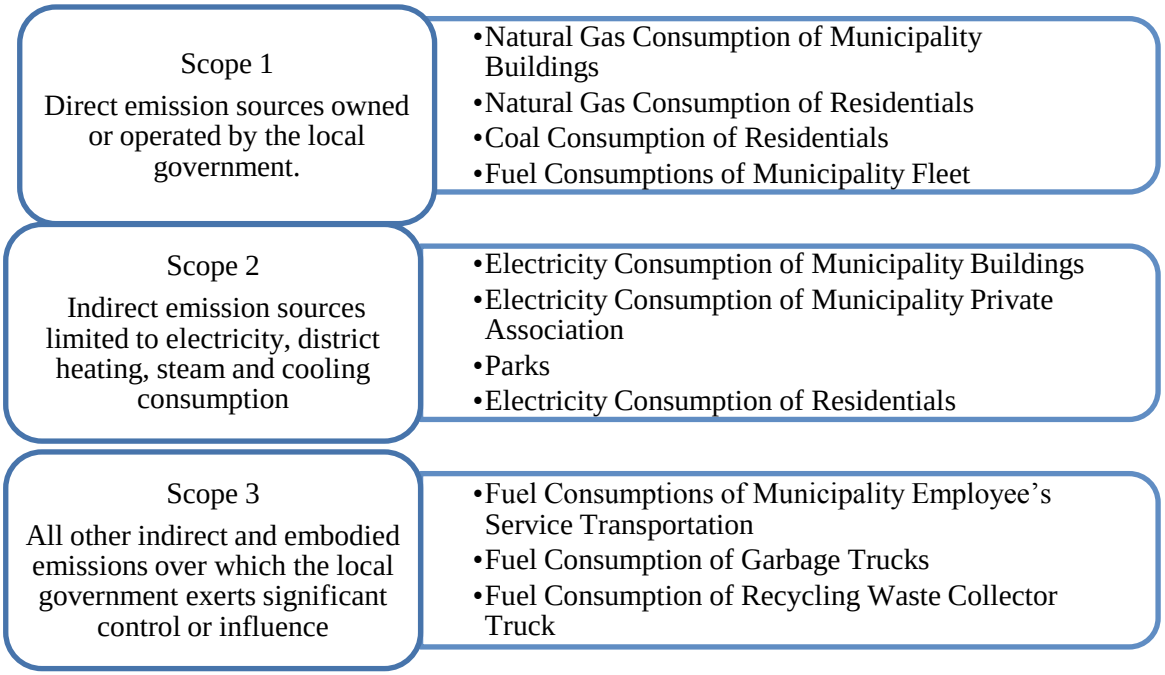

Figure 3.2. Distribution of Kadıköy Municipality (IEAP, 2013)

3.1.1. Method of Calculation

The most recent and convenient approach to calculate GHG is using the information of activity data (AD) and emission factor (EF). Equation 3.1 and 3.2 are used to calculate GHG emissions of Kadıköy district (SEAP, 2013).

Basic GHG Emission Calculation Equation

$$\text{Emissions} = \text{Activitiy Data (AD)} \times \text{Emission Factor (EF)} \quad (3.1)$$

Calculation of activity data

$$\text{Fuel used in road transportation [kWh]} = \text{mileage [km]} \times \text{average consumption [l/km]} \times \text{conversion factor [kWh/l]} \quad (3.2)$$

In constituting the inventory of GHG emissions, activity data under different Scopes have been collected (e.g. consumed natural gas in m^3 or electricity consumption in kWh) and each have been multiplied by their appropriate emission factors (such as kg CO_2/kWh).

On the other hand, to be precise and accurate in the results, national conversion factors have been used. In the Table 3.2. which was taken from a report published by Turkish Ministry of Environment and Urbanization, the emission conversion factors for Turkey is presented. Each type of energy sources' conversion factor has been calculated by considering averages of Turkey.

Table 3.2. Turkey Coefficient Emission Conversion Factors (Ministry of Environment and Urbanization, 2013).

CO_2 e Emission Factors [t CO_2 e/ MWh] in 2010					
Type of Energy Source	**Turkey** (Source: Energy Performance in Buildings Regulation by Environment and Urbanization Ministry, 2009)	**Turkey EBRD** (US Energy Information Administration, 2007)	**The Netherlands** (SEAP Guideline, Annex 3 emission factors, JRC, 2012)	**EU-27** (SEAP Guideline, Annex 3 emission factors, JRC, 2012)	**DEFRA UK** (Department of Environment, Food and Rural Affairs , 2013)
Fuel-Oil	0.330	0.279 (IPCC,2006)	IPCC	IPCC	0.267
Natural Gas	0.234	0.202 (IPCC,2006)	IPCC	IPCC	0.184
Coal (Lignite)	0.433	0.364 (IPCC,2006)	IPCC	IPCC	0.333
Electricity	0.617	0.605	0.435	0.460	0. 499

Table 3.3. Emission Factors for Transportation (IPCC, 2006).

Fuel Type	CO_2 e Emission Factor (t CO_2 e/MWh)
	IPCC
Gas Oil/diesel	0.267
Motor Gasoline	0.249
Liquefied Petroleum Gases	0.227

The calculation of emission factors are done with consideration of several elements. In below equation, emission factor for electricity consumption has been presented. To reach the most appropriate result, the production sources are needed to be classified. According the type of fuel the emission rate can change. Also, national and local emission factors are taken into consideration. In order to find the factor, total electricity consumption should be known as well.

Emission Factor for Electricity Consumption Equation (SEAP, 2013)

$$EFE = [(TCE - LPE - GEP) * NEEFE + CO_2\ LPE + CO_2\ GEP] / (TCE)$$

Where

EFE = local emission factor for electricity [t/MWhe]

TCE = Total electricity consumption in the local authority [MWhe]

LPE = Local electricity production [MWhe]

GEP = Green electricity purchases by the local authority [MWhe]

NEEFE = national or European emission factor for electricity (to be chosen) [t/MWhe]

CO_2LPE = CO_2 emissions due to the local production of electricity [t]

CO_2GEP = CO_2 emissions due to the production of certified green electricity

(3.3)

3.2. Data Collection

The most important step in the development of the SEAP is the compilation of a "Baseline Emission Inventory". This inventory should depict the situation concerning the CO_2 e emissions inside the territory of the Covenant signatory at a baseline year. (SEAP guidelines, 2013) Therefore, the first step in this study was to develop carbon foot printing of the district**.**

In order to make sustainable inferences about the future of the region, defining GHG emissions level of a region constitutes a good infrastructure. "Carbon Foot Printing" is an measure that helps to describe and exemplify the effects of CO_2 e. Definition given by UK Carbon Trust is "the total set of GHG emissions caused by an organization, event, product or person". Moreover, there are different and a complementary definitions which emphasize institutional approaches towards the issue. It can be used for a person, a product, so different things could be compared with help of it.

In the second phase, in accordance with the methodology the boundary of the region is structured. There are two approaches to display the boundaries of a district under calculation of the GHG emissions. Firstly, organizational boundary consists of functions that are directly under the control of the local government. Secondly, geopolitical boundary includes the physical area or region over which local government has jurisdictional authority (GHG Protocol, 2010). Those concepts are appointed with collaboration of municipality officers.

After the decision given through the authorities of the municipality, the calculation of baseline emission inventory for year 2010 has been conducted. The base year has been chosen due to accurate data reasons.

The carbon emission per person for year 2010 was structured by expressing the methodology of ICLEI and calculated by considering the municipality emission sources owned by the Kadıköy Municipality. In calculation, the GHG emissions of the region have been converted into carbon dioxide equivalent (CO_2 e) to come up with a single number that represents the total amount of GHG being released from Kadıköy.

Data required for this research has been gathered from the local government officials and stakeholders who represent the district. To collect the required data a datasheet has been created. This datasheet has been distributed among stakeholders. The important part of data collection is reaching accurate and reliable output, therefore the regional authorities' involvement to the process increased efficiency of clustering data.

In order to calculate the reliable carbon emission inventory of the district the year 2010 is chosen as a base year. For the previous years, we could not reach accurate data due to poor archiving.

The data is taken from several sources. For the building sector the required data has been gathered from Municipality own database called UKBS (Borough Info System), the same data source also has been used while calculating the municipality emissions, natural gas data has been requested from Istanbul Gaz Dağıtım a.ş. (IGDAS) which is the main natural gas distribution company, consumption of electricity for the year 2010 has taken from local stakeholder Istanbul Anadolu Yakası Elektrik Dağıtım a.ş. (AYEDAS), main electricity distributor of Kadıköy, and to calculate the amount of emissions released from transportation sector, necessary information was taken from Istanbul Metropolitan Municipality (IMM).

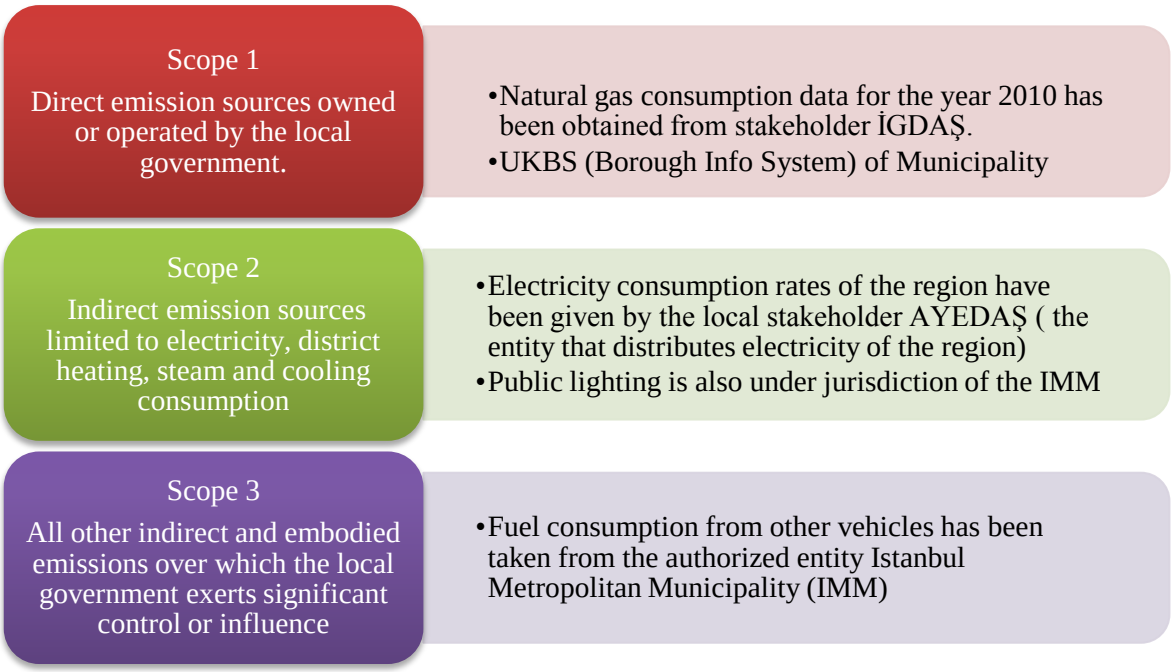

Figure 3.3. Kadıköy Municipalities' Scope 1, 2 and 3.

GHG profile of the region has been carried out with the help of guidelines provided by Joint Research Centre and ICLEI (SEAP, 2013) According to those guidelines, data collection strategy and hot spots are decided by municipality administrates and university.

The limitations experienced during the research period are:

1. Stakeholder involvement has become big concern regarding managerial structure of the region.

2. Data verification was required to avoid double-counting therefore researcher had experienced time constraint on data collection and information gathering.

After data collection was completed, the general portrait of the Kadıköy district was drawn. In light of information gathered, the total consumption of natural gas, electricity of the Kadıköy calculated. In addition to that, total energy consumption of transportation in the boundaries of the Kadıköy has been formed.

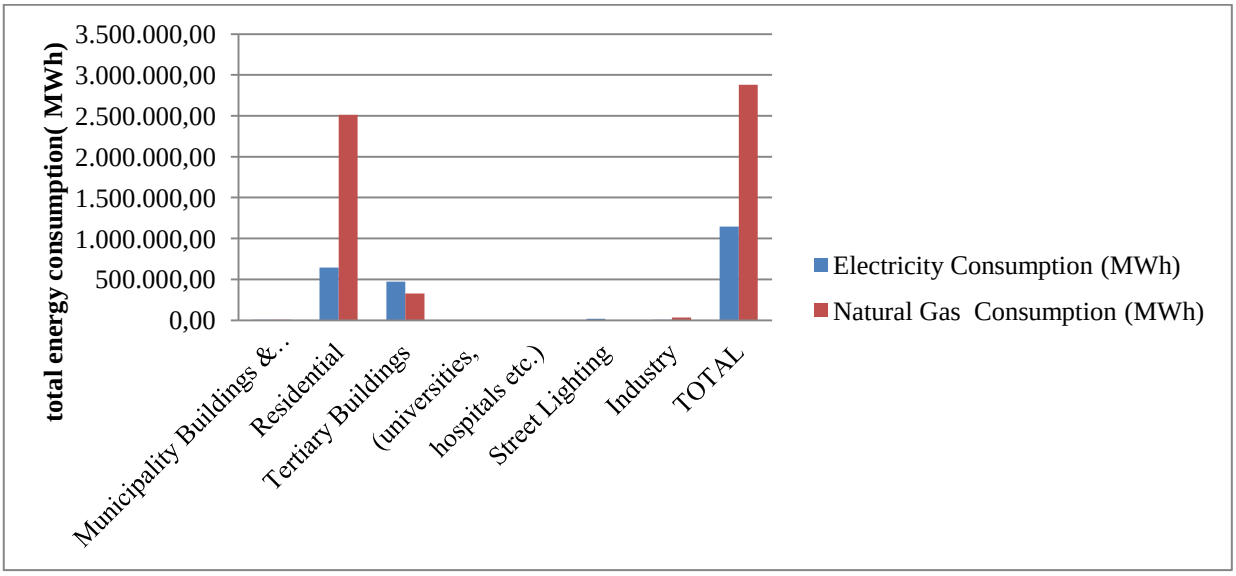

Figure 3.4. Kadıköy Region's Natural Gas and Electricity Consumption in 2010 (AYEDAS and IGDAS, 2010).

In the base year, Kadıköy's total energy consumption is 3.710.545, 963 MWh. Figure 3.5. summarizes the aggregate emissions by sector for the Kadıköy district in geographical boundaries. Majority of consumption is from residential buildings and tertiary buildings which are followed by industries and municipal operations. Because of the 87% of consumption rate in total, in the action plan, reduction targets are settled on energy efficiency practices for buildings. In addition to that, tertiary buildings and municipality sources are key indicators to create a distinctive carbon management in this district.

In Figure 3.6. total energy consumption from transportation has been displayed. It is so clear that personal and commercial cars are emitting 87% of the total CO_2 e emissions. This calculation has been done in accordance with the result of the study which has conducted by IMM (IMM, 2010).

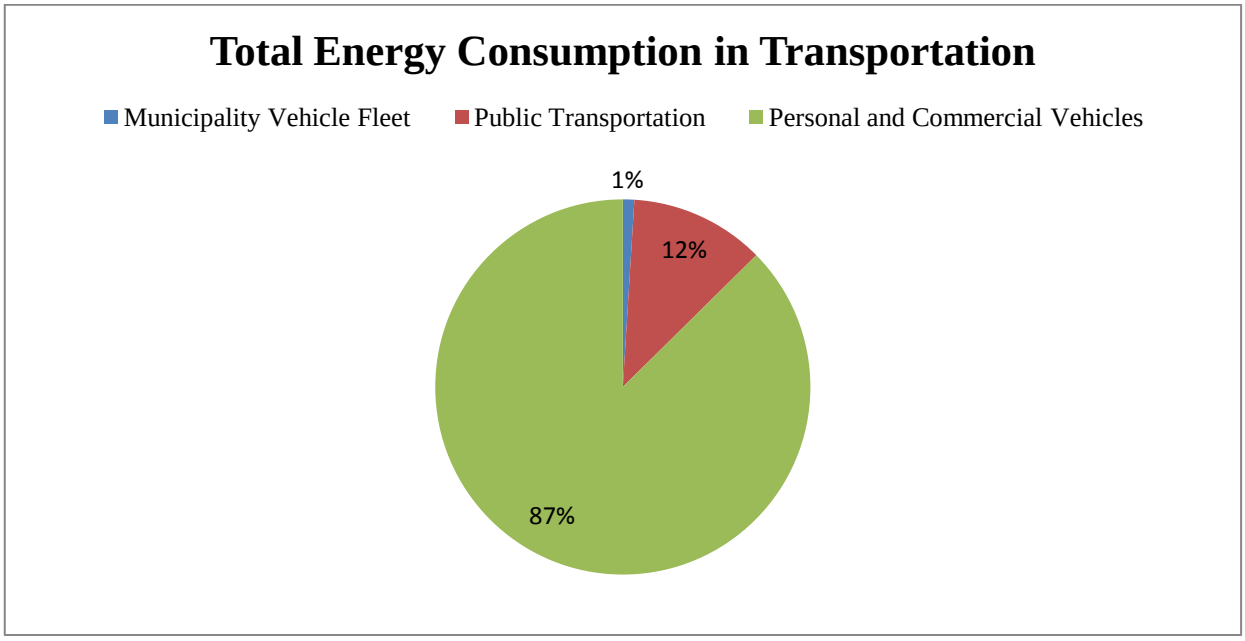

Figure 3.5. Total Energy Consumption of Kadıköy District from Transportation (UKBS and IMM, 2010).

4. RESULTS AND DISCUSSION

4.1. Emission Inventory Assessment

Climate change is an internationally recognized problem. In time, overall climate might shift to extreme weather conditions. Therefore, eventually people will need to change their daily life styles (Ivanova, 2014). Also, the paper written by Nicholls in 1995 explains that coastal megacities, like Istanbul, are in danger of unexpected global sea-level rise and other coastal implications of climate change (Nicholss, 1995). For that reason, mitigation and adaptation actions in community level will be helpful to identify possible impacts of released emission in the specific region. In the study, as the very first step baseline emission inventory of the selected area has been developed for the evaluation of the current situation and then tailor-made solutions/actions for the region has been detected to decrease the level of GHG emissions.

Istanbul is the largest city in Turkey, represents the country's economic, cultural, and historical heart. In addition to that, with a population of 14.1 millions, the city forms the largest urban agglomeration in Europe, second largest in the Middle East and the fifth-largest city in the world (UN, 2014). Kadıköy which has been selected to conduct the study is one of the districts in the city which has 524.373 citizens.

In development of SEAP for the district as first step, the GHG emission inventory of Kadıköy has been generated for year 2010. The results of the inventory are presented in Table 4.1. In this Table, the right column shows the total emissions for all categories for selected year and in the left column sectors in defining the regional emission inventory have been presented.

Table 4.1. Total CO_2 e Emission of the Kadıköy District for 2010.

Sectors	**%**
Municipality Buildings & Parks	18
Residential	41
Tertiary Buildings	15
Street Lighting	0.4
Industry	0.4
Municipality Vehicle Fleet	0.2
Public Transportation	3
Personal and Commercial Vehicles	22
TOTAL	**100%**

Kadıköy's per capita CO_2 e emission for baseline year 2010 has been calculated as 4, 59 per capita/ CO_2 e (public transportation and personal car fuel consumption is included). Total emission is almost 2.5 million tonnes of CO_2 e. As it is displayed in the Table 4.1 the biggest emission is caused by residential and it is followed by personal and commercial vehicles.

Local government emissions are about 2 to 5 percent of overall community emissions. As a minor contributor to total emissions, actions to reduce municipal energy use may have a limited impact on Kadıköy's overall community emission levels.

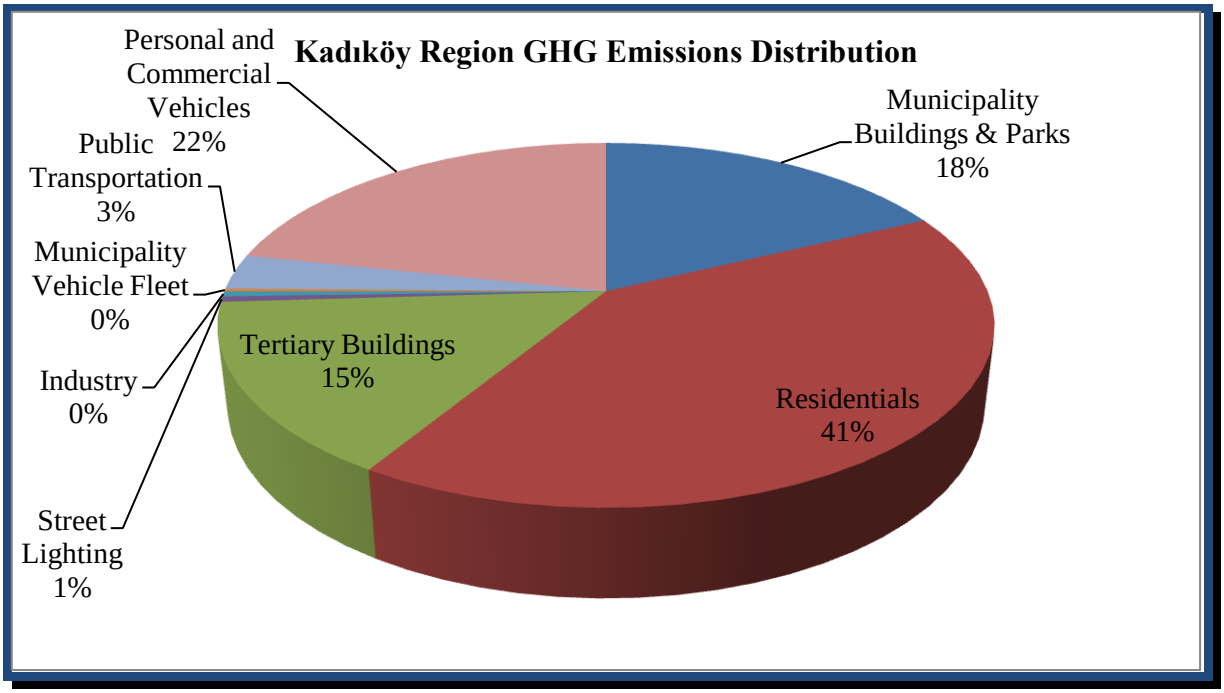

Figure 4.1. Total GHG Emission Distribution for 2010.

According to the Figure 4.1., most of the release in the district is from residential buildings with 41% of total emissions. Second biggest emission source is private car owners and other type of vehicles used for trading purposes which is 22%. Thirdly, 15% of emissions have been released from activities occurred in tertiary buildings. One another interesting observation on this pie chart is that municipality own buildings and other facilities emissions represent almost 1 percent of total release from the district. Therefore, it would not be surprising while action plans are designed, the building-oriented actions will take the lead in order to reduce the total emissions in selected municipality.

In this part of the thesis, municipality owned sources are classified and explained under Scope 1, 2 and 3 and for the baseline year the results of the calculation is evaluated. Table 4.2 presents the overall emission sources of the region.

Table 4.2. Scope 1, Scope 2 and Scope 3 Emissions of the Kadıköy District.

Scope 1	**CO_2 e Emission %**	**Scope 2**	**CO_2 e Emission %**	**Scope 3**	**CO_2 e Emission %**
Municipality Buildings Natural Gas Consumption	0.6	Municipality Buildings Electricity Consumption	0.8	Municipality Employee's Service Transportation Fuel Consumptions	0.1
Residentials Natural Gas Consumption	98	Municipality Private Association Electricity Consumption	0.1	Garbage Trucks Consumption	0.4
Residentials Coal Consumption	0.4	Parks	0.1	Packaging Waste Collector Truck Fuel Consumption	0.2
Municipality Fleet	1	Residential Electricity Consumption	98	Public Transportation	93
TOTAL	**100**	**TOTAL**	**100**	**TOTAL**	**100**

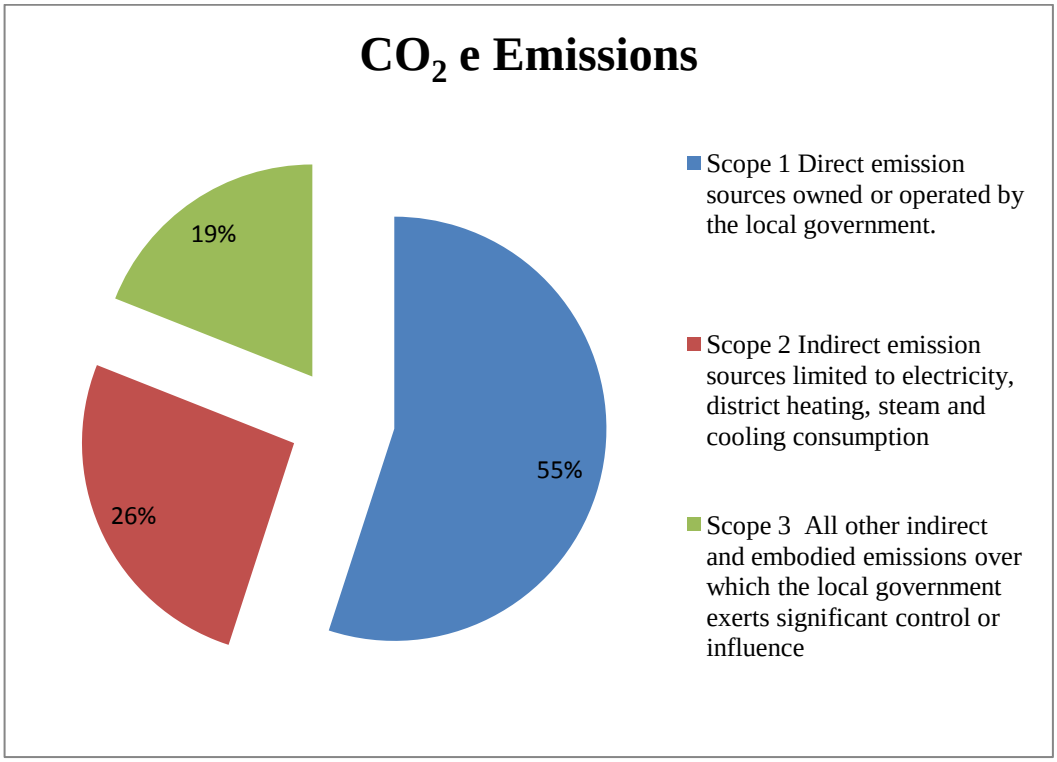

Figure 4.2. Scope 1, 2, and 3.

In Scope 1, direct emissions that the Municipality owned are included into the calculation. In 2010, at Kadıköy for heating purposes natural gas has been consumed. It corresponds almost 99% of the total emission under Scope 1. However, in Fikirtepe neighborhood some residential's coal use has been detected. (Fikirtepe region is chosen by central government for "Urban Transformation". That area will be replaced with new, energy-saving oriented buildings. At the end of 2012, locals of that region have migrated to other parts of the city. Therefore, Kadıköy municipalities population has changed over years. Moreover, with new residential movement that area is expected to attract new people to settle down) Another sector in Scope 1 is the Municipality owned vehicles. These are in use for serving to citizens. Fleet consists garbage trucks, cars, business machines etc. In total, they represent 1% of emissions.

Under Scope 2, electricity consumption coming from municipality buildings, municipalities' private associations' consumptions (café and restaurants run by municipality), and electricity used to illuminate green parks and residential consumption from 19 neighborhood have been observed. As a result, the largest proportion of

consumption was found out in residential sector with 98%. Raising awareness towards energy-saving in residences will be one of the crucial actions to decrease the level of consumption. If the way of living can be affected by the campaigns about energy-efficiency, this can help to achieve the targets. For instance, people can switch to led technology; prefer A++ durable goods etc. In this way, a targeted decrease in overall GHG emissions can be sustained.

In Scope 3, the Municipalities' indirect emissions are taken under assessment. Public transportation which includes different types of vehicles is releasing the biggest portion of CO_2 e in that region. Thus, actions developed for that specific sector plays a key role in achievement of the overall plan. However, there is an important legal discrepancy for Istanbul. Istanbul's whole transportation plan has been made by Ulaşım A.Ş. which is controlled by IMM. Kadıköy local Municipality can develop projects about public transportation for their regions of interest, however approval and application decision of those belongs to the IMM administration.

Table 4.3. Comparison of CO_2 e/ per capita Emissions in Kadıköy, Istanbul and Turkey.

CO_2 e Emissions / per person (in tonnes)	
KADIKÖY	2,05*
ISTANBUL	3,33
TURKEY	4,47

*This 2.05 tonnes/ per capita represents the emission amount of Kadıköy Municipality which the Municipality is responsible to reduce, it does not represent the whole emission rate released from the district (This calculation is free from public transportation). When all the sectors included into calculation per person emission released from Kadıköy equals to 4.59 tonnes/per capita. In Table 4.3. presents the the emissions per capita releases from the Kadıköy, Istanbul and Turkey.

According to the Turkstat, Turkey's 2010 per capita emission is 4.47 tonnes/per capita and Istanbul's per capita carbon emission 3.3 data tonnes/per capita which has taken from IMM. As it is seen Kadıköy's overall per capita emission is higher than Turkey's and Istanbul's per capita emissions. The reason behind this is Kadıköy's high population density and high electricity and natural gas consumption. Also, according to the officers in municipality, that is related with average income level of citizens. We can assume that for general, there is a linear relationship between life-style and consumption amount of natural gas or electricity. Luxury increases the level of consumption.

In order to reach the target of at least 20% reduction from base year 2010 carbon emission which is 1 million tonnes, precautions need to be structured effectively.While applying the SEAP steps another important item is to share the information with your stakeholders. Within that purpose, a workshop was organized in Kadıköy. The workshop was organized in the Kozzy AVM on 10th of May 2015. It was an open meeting; therefore interested parties from different sectors have attended to the workshop. Participants have been asked to find solutions to reduce the CO_2 emission level. Outputs of this workshop have been used in development of SEAP.

4.2. Sustainable Energy Actions in Kadıköy towards 2020

Rapid urbanization and rise in the population will cause GHG emissions to increase tremendously. In the first scenario "Business as Usual", projection of ten years between 2010 and 2020 has been done. The conclusion is when everything stays same on all sectors with the population growth rate 1.3%, emissions tend to rise. It is expected to be almost ten times higher than baseline year emissions (Marmara Belediyeler Birliği, 2013).

It is known that the basic objective of all global initiatives is to decrease the level of GHG emission till 2020. Appropriate measurements for the area should be defined by the stakeholders. In our case, Kadıköy Municipality and its solution partners should develop projects which will help to decrease the level of emission released from region.

In Delft city case, not just municipality but also universities joined to the process to apply the plan to the district. In addition to that, national government supported the plan

via national action plans which proposes a complete solution in collaboration with local administrations.

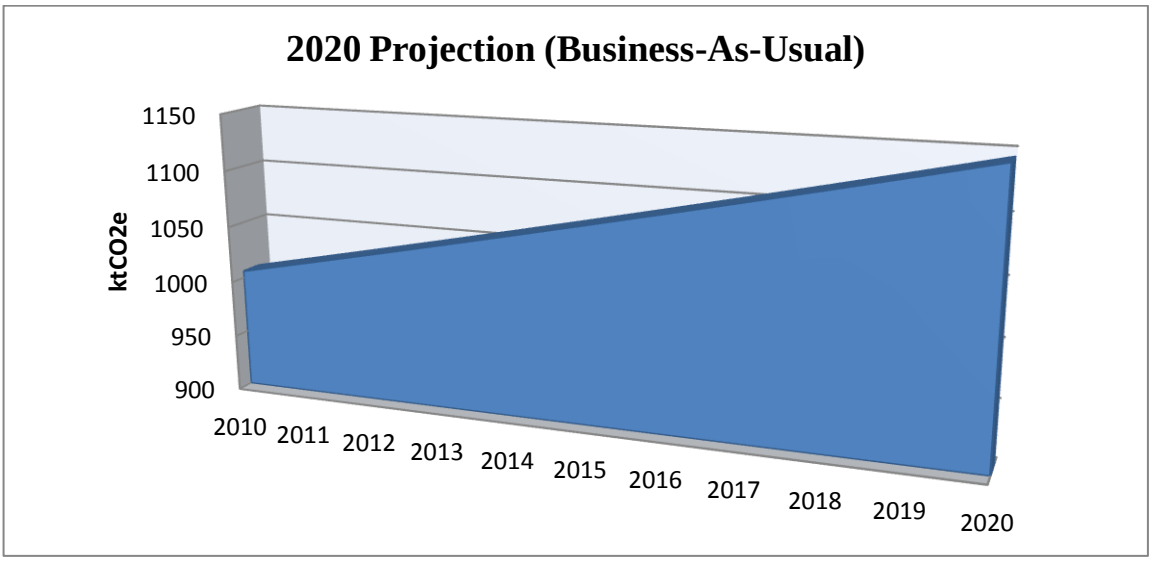

Figure 4.3. Kadıköy District CO_2 e emissions' 2020 Projection (in total).

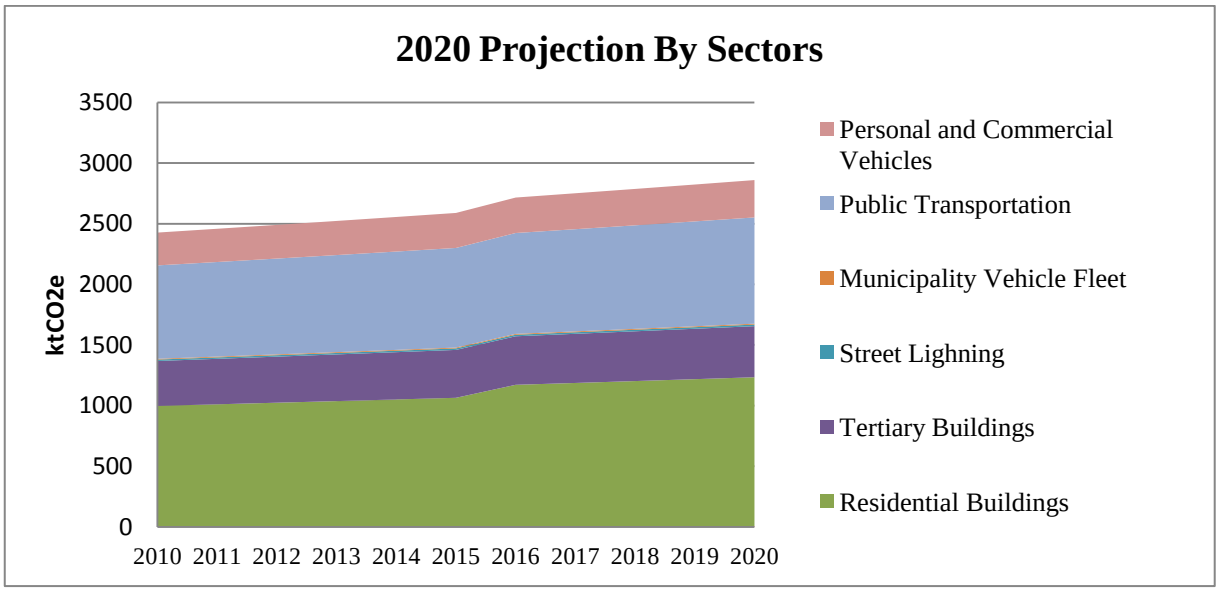

Figure 4.4. Kadıköy District CO_2 e emissions' 2020 Projection by Sector.

Second projection which presents sectored based changes over ten years is an effective diagram to observe the consequences of daily activities. Due to Kadıköy is an urban area of Istanbul, building density in the region is quite high. In 2020, with high probability the dwellings will still be representing the biggest portion of CO_2 e emission of the district. If things continue as it is, in other words no change has done, than the level of emission will continue to increase. In 2020 the released emission amount from Kadıköy is expected to be 150.000 tonnes more than 2010. Uncontrolled raise in business activities, no energy saving, less renewable energy source usage and many other facts will turn BAU scenario into a reality. Municipality owned emissions are not in big amounts like public transportation or residential, therefore its position in 2020 is not easily seen at above figure.

Within the enlightenment of these projections the measurements to decrease the per capita emission of the district has been generated by researcher and the municipality's department of Climate Change and Energy Efficiency.

4.2.1. Building Sector

World's biggest share of total end use of energy derived from buildings depletion of energy (IEA, 2014). It corresponds to 40% of total end use of energy which includes only residential and commercial purposed use facilities. Development in technology and change in way of living increased the use of energy therefore contribution to decrease the energy consumption in buildings is an essential to achieve the goals.

In Kadıköy, most of the GHG emissions released to the atmosphere from buildings. In order to analyze the effects of the different stakeholders, buildings are divided into sub-categories as residential, tertiary and municipality. Municipality owned buildings are obligatory field to generate action to decrease the level of emissions while developing SEAPs. They are presented in Scope 1 and 2. Until 2017 Kadıköy region is supposed to renovate existing building stock with new energy efficient buildings, and it is supported with a law published by the Ministry of Environment which is "Energy Efficiency Law No. 5627". According to the law "Energy Performance of Buildings" which is applied across Turkey, old buildings will be under investigation of Ministry and Natural Resources. Thus, buildings in each category will be evaluated for their energy efficiency performance. Referring to whole Turkey, between 1.5 % and 3% of the building stock is renovated each year (Izoder, 2010). When the law is applied effectively, energy performance of buildings expected to enhance. Existing buildings consumption of energy can be declined by upgrading the windows (e.g. using double or triple glazed technology), adding internal or external insulation (if feasible) to walls during renovations, upgrading the heating and cooling systems, insulating the roofs and reducing the air leakage of the building envelope and ductwork (Gabrielaitiene, 2013).

Until 2017 building stock of Turkey is expected to amended or reconstructed. As being the signatory of the CoM, Kadıköy municipality gives priority to energy efficiency projects with special interest on building sector. In Kadıköy, there are 28.885 buildings. It includes historic, commercial, governmental and residential textures. Renovation facilities target 16.694 building in the district. The main actions will be reconstruction of old (over 35 years) and high energy consumed buildings and developing energy efficiency renovations for the existing building stock. According to forecasts done by researcher,

costs and savings from CO_2 e for building sector have been actualized. In Table 4.5., the calculations are based on the change in average energy consumptions in buildings from 2010 to 2020, and the daily prices of energies applied in Turkey.

- Reconstruction of old buildings (over 35 years) will save 128.000 tonnes /CO_2 e; also the overall cost has calculated as 85 million euro. It corresponds to 12% reduction in overall which is presented in Table 4.4.

- The insulation practices will save 68.350 tonnes/CO_2 e emission and forecasted cost is 40 million euro. The data for calculation taken from municipality own resources. It corresponds to 7% reduction in overall.

- Also, Kadıköy municipality is constructing a Green Kinder garden in Table 4.6. details showed which saves 105 tonnes/CO_2 e and has supported by sponsors, so that no cost has calculated. The project has developed by the "Project Development Department" of the Municipality. It corresponds to less than 1 % reduction in overall reduction targets presented in SEAP.

The environmental and economic feasibility evaluations that have been carried out for the options have not been prioritized by the municipality. Developed projects presented here in the tables aims to give clear vision to the Municipality for its future actions, and provide help in monitoring and implementing stages of SEAP.

Table 4.4. Planned Action 1- Existing Building Reconstruction.

Action 1	Existing Buildings Reconstruction
Project Description	Reconstructions of existing buildings will create a positive impact towards reduction from base year emissions. It is also supported with the new legislations. By that, citizens will be motivated for change.
Project Benefits	Financial Savings: 18,6 million € *Carbon Emission Reduction Target: 128.000 tonnes/ CO_2* *12 % reduction*
Funding&Resources	Project Cost : ~10,8 million € (estimated), all stakeholders are expected to involve in process
Roadmap to reach the target	Stakeholder's involvement to the process is the key. Contractors and government agencies collaboration creates the necessary environment to renovation.
Measuring	Annual update of carbon emissions baseline
Duration	2010- 2017
Comments	Energy saving provided from 10.659 buildings in the region is 546.968,4 (MWh). They are all expected to be rebuilt till 2020. When they are all renewed 55% of energy saving will be provided. It is equal to 128.000 tonnes of CO_2e. 36% of buildings stock of the region has been considered to be rebuilt.

Table 4.5. Planned Action 2- Existing Building Insulation.

Action 2	Existing Buildings Insulation
Project Description	Within the scope of the "Buildings Energy Efficiency Directives" of Turkey, all buildings have to be renovated and insulated. Under these circumstances almost 50 % of the building stock of the borough (includes residential and tertiary buildings) is supposed to be in the project concept.
Project Benefits	*Carbon Emission Reduction Target: 68350 tonnes/ CO_2* *7 % reduction from total $CO_2 e$*
Funding&Resources	Project Cost : ~ 16,8 million € (estimated), all stakeholders are expected to be involved in the process
Roadmap to reach the target	Stakeholder involvement to the process is the key. Contractors' and government agencies' collaboration creates the necessary environment for renovation.
Measuring	Annual update of carbon emissions baseline
Duration	2012- 2017
Comments	Energy saving provided from 6035 buildings in the region is 292.094 (MWh). They are all expected to be insulated until 2020. When they are all renewed 55% of energy saving is expected. It is close to 68350 tonnes of CO_2 e.

Table 4.6. Planned Action 3- Green Nursery House.

Action 3	Bahriye Üçok - Green Nursery House Project
Project Description	Increasing the attention towards green buildings. Healthy Learning Spaces Teaching Healthy Spaces Saving Money Practical Training Nature-Friendly
Project Benefits	*Carbon Emission Reduction Target: 105 tonnes/* CO_2
Funding&Resources	Sponsors & Volunteers
Duration	2012- 2014
Comments	The total construction area is 1107 m², basement and ground floors of the building of the kindergarten; • Ground Floor; welcome, waiting for the administrative staff areas, service areas, 5 classrooms for different age groups and the common play area • In the basement, dining room and kitchen, the technical departments, service areas, a sleeping room, business class and science in every class.

4.2.2. Transportation Sector

The management of the public transportation is under jurisdiction of the Metropolitan Municipality; therefore regional municipalities like Kadıköy cannot take measurements for overall transportation mechanisms to decrease the GHG originating from that particular district. They can manage municipality owned vehicles. Measurements taken for the transportation are listed below.

- Electrical Car Charging Stations are planned to be placed to the main points of the Kadıköy, with this project forecasted saving is 44 tonnes/ CO_2 and it costs 12.000 euro.

- Transformation of municipality's Service Vehicles to Electrical Vehicles; total saving is 1670 tonnes/ CO_2 and cost is 160.000 euro which has been displayed in the Table 4.8.

- Waste collection with Hybrid Vehicles will generate 271, 3 tonnes/ CO_2 saving and cost 95.000 euro, in the Table 4.9.

For public transportation, 76.462 tonnes/ CO_2 e reductions have been estimated by the municipality management through the transportation by Metro, Metrobus, Avrasia Tunnel etc. by 2020. Under the Table 4.7. Reductions are provided under four implementations; Park Et Devam Et, Metrobus, Marmaray, Avrasia Tunnel.

All these transportation systems are under control of IMM except "Park Et Devam Et". It is a project developed by municipality to motivate the citizens to use less their personal cars, and to prevent the traffic which is a big problem in Istanbul especially in rush hours. The municipality aims with this project to save in total 524.000 liter fuel and 1.409,93 tonnes/ CO_2 e emission till 2020.

Metrobus is a bus line serving long-distance transportation from Sogutlucesme to Beylikdüzü. It is more than 50 km. Kadıköy's citizens are using this line very actively according to survey done by IMM in year 2010. In a day, almost 3 million people are using

that vehicle for daily transportation. It is widely used to reach works and schools. According to estimations done by municipality, emission saving comes from Metrobus corresponds to 15.972,00 tonnes/ CO_2 e.

Marmaray is an underground transportation opened to serve in 2014. This is very recent development for Istanbul. In addition to that, it is very beneficial because of the length of line and destinations. It goes under the Bosphorus. It is for people who live in Kadıköy as it is an effective way to reach European side. The total expected reduction with this new line is 14.040, 62 tonnes/ CO_2 e.

Eurasia tunnel is basically designed for private cars, a tunnel connect Anatolia to European side, a highway. Due to traffic in rush hours two bridges are not enough for now, a third one is being built in this process. Because of 17 million population in total, that is also not enough therefore this tunnel is expected to bring a fruitful solution. According to assumptions, estimated reduction from tunnel for the region is 20.951, 15 tonnes/ CO_2 e. Data needed for calculations has been gathered from the Kadıköy Municipality department of Environmental Protection.

Table 4.7. Estimated Savings for Public Transportation till 2020.

Mode of Transport	**Total Emission Saving (tonnes/ $CO_{2)}$**	**Coordinators**
Park Et Devam Et	1.409,93	Kadıköy Municipality
Metrobus	15.972,00	IMM
Marmaray	14.040 ,62	IMM
Avrasia Tunnel	20.951, 15	IMM

Table 4.8. Planned Action 4- Electrical Car Charging Stations.

Action 4	Electrical Car Charging Stations
Project Description	To the district several charging stations will be set up. The aim of this activity is to drag the attention to electric cars, so to decrease the fuel consumption from public transportation and personal cars.
Project Benefits	Financial Savings: • According to the recent studies in per mile (1,6 km) electrical vehicles save 0,12 dollar, so for a year 75 $ saving occurs for ten cars. *Carbon Emission Reduction Target: up to 44 tonnes CO_2*
Funding&Resources	Project Cost : • One average residential type electrical charging cost is 1200 € • For this project 10 charging station is planned to be set up Total Cost: 12000 €
Measurement	Annual update of carbon emissions baseline
Duration	2015-…
Comments	Approx. 750 employee of the municipality use their own cars to reach to their offices. They mostly own diesel cars. For the 2020 targets, motivating the staff to use electrical cars by providing free charging stations nearby is a solution to decrease the level of greenhouse gas emissions

Table 4.9. Planned Action 5- Reorganizing Municipality Employee's Travel Choices.

Action 5	Reorganizing Municipality Employee's Travel Choices
Project Description	A number of initiatives are planned to reduce staff business travel by 2020 and encourage staff to use sustainable modes of transport whilst at work. However, the majority of these initiatives also encourage sustainable commuting, yet this is not included in the 10% reduction target as accurate figures are not yet known for commuting. These initiatives include: A review of essential car user status and parking permits
Project Benefits	Carbon Emission Reduction Target: 745 tonnes CO_2
Funding&Resources	Project Cost : 40.000 €
Measurement	Annual update of carbon emissions baseline
Duration	2013- 2015

4.2.3. Lighting Sector

In lighting sector, at Table 4.10. actions are mostly focused on replacing old-fashioned illuminations with new energy-saving alternatives. Generated projects regarding illumination for municipality buildings and parks are efficient lighting projects for recreation areas which help to save 213, 2 tonnes/ CO_2 e and estimated cost has been calculated as 103.500 euros.

Table 4.10. Planned Action 6- Outdoor Illumination switch to LED.

Action 10	Zübeyde Hanım Social Hall & Municipality Building Outdoor Illumination Substitution to LED
Project Description	Outdoor illuminations under the control of municipality are changed with more energy efficient ones.
Project Benefits	Financial Savings: 6.000 € (annually) • 3.800 € (5 m. lighting fixture poles) • 1.200 € (3,5 m. lighting fixture poles) • 1.200 € (Recessed armature) *Carbon Emission Reduction Target: 45.3 tonnes CO_2 87.6 MWh/ year* • The annual 16200 KWh electricity consumption is planned to decrease to 3888 KWh.
Funding&Resources	Project Cost : ~ 36.000 €
Measurement	Annual update of carbon emissions baseline

4.3.4. Renewable Energy Sector Developments

This sector consists not only renewable energy treatments but also building and lighting treatments or innovations which uses renewable energy sources. Five different implementation areas have been selected and with specific examples possible savings and estimated cost of the applications has been practiced and displayed in Table 4.11, Table 4.12, Table 4.13. and Table 4.14.

Table 4.11. Renewable Energy Applications in Kadıköy District.

Applications	**Total Savings (tonnes/ CO_2)**	**Estimated Cost (Euro)**
Kadıköy Youth and Sports Center Solar Panel	54,4	127.000
Kalamış Atatürk Park Solar Panel	3,5	12.000
Zübeyde Hanım –Wedding Hall Solar Panel	54,4	134.000
Renewable Energy for Building	426,48	16 M

Table 4.12. Action 11- Khalkedon-Kalamış ParkingSolar Panel Application.

Action 11	Khalkedon-Kalamış Parking Solar Panel Application
Project Description	Several charging stations will be set up to the district. The aim of this activity is to drag the attention to electric cars, to decrease the fuel consumption from public transportation and personal used cars.
Project Benefits	Financial Savings: 2400 € *Carbon Emission Reduction Target: 972 tonnes CO_2* *1577 KWh/per year (Saving)*
Funding&Resources	Project Cost : 120.000 €
Measurement	Annual update of carbon emissions baseline
Duration	2013- 2014
Comments	With technological improvements an average parking can produce 2000 KWh electricity per year

Table 4.13. Action 12- Kalamış Atatürk Park Solar Panel Application.

Action 12	Kalamış Atatürk Park Solar Panel Application
Project Description	Setting up the 8 LED illumination poles (Energy Source: Solar Panels)
Project Benefits	Financial Savings: *Carbon Emission Reduction Target: 100 tonnes CO_2*
Funding&Resources	Project Cost : 5.800 €
Measurement	Annual update of carbon emissions baseline
Project Timing	2014- 2015

Table 4.14. Action 13- Zübeyde Hanım –Municipality Building Solar Panel Application.

Action 13	Zübeyde Hanım –Municipality Building Solar Panel Application
Project Description	Increasing the renewable energy sources in the municipality buildings, 20%-30% saving in electricity consumption
Project Benefits	Financial Savings: 18.600 € /per year (based on average energy costs) *Carbon Emission Reduction Target: 79 tonnes CO_2* • Saving 129 MWh/ per year
Funding&Resources	Project Cost : 40.000 €
Measurement	Annual update of carbon emissions baseline
Comments	The efficiency rate of the Solar panels are quiet high, however their economic life is approximately 25 years

4.3.5. Awareness Oriented Sector

Besides all technological developments and innovation, the biggest contribution to reach the targeted emission level comes from locals of the region. Therefore, increasing awareness can help to decrease the end use of energy and fuel consumption etc. Within that purpose several reduction targets are set which have been presented in the Table 4.15.

- Launch an overall awareness campaign covering all aspects of carbon reduction. Plan to carry out awareness campaigns at regular intervals to increase effectiveness.

- Altering from inefficient household appliances to efficient household appliances (refrigerators, washing machines, air conditioner, and light bulbs) in our homes. Total carbon emission reduction target is forecasted to be 11.904 tonnes yet the cost cannot be calculated because of the high diversity of the sources.

- To share the result of the calculation of CO_2 e emission of the district, a workshop has been organized on 10^{th} of May, 2013. The stakeholders of the region and the potential contributors to the action plan have been invited. There was a high attendance from different parties. The group was colorful with academicians, public sector representatives, private sector representatives and volunteers.

- After the brief introductory presentations of the project, representatives of different parties came together to share their knowledge and experiences in the concept of sustainable cities. Four different headlines are defined by project teams which are building isolation systems, renewable energy applications, transportation alternatives, awareness and training concept for sustainable cities. According to those titles, participators are motivated to find solutions or possible way-outs to decrease the emissions of the Kadıköy district. Some of the outcomes of this fruitful workshop are included to the thesis.

- Launch a top-down and bottom-up awareness practices covering all aspects of carbon reduction. Those practices are expected to increase effectiveness in long-term.

Municipality's employees are also important assets to sustain SEAP. Therefore, actions towards them are forecasted to form requested background to realize the projects created to achieve the goals presented in this thesis.

- Development of a network includes NGOs, and environmental agencies
- Organizing trainings for employees about environment and energy efficiency
- Including environmental and energy-efficient practices into new job descriptions
- Discouraging unnecessary travel
- Raising awareness and encouraging staff to recycle batteries using containers provided
- Increasing awareness on Regulations such as " Building Energy Control" and "Energy Efficiency Performance in Buildings"
- Publishing quarterly energy consumption figures and carbon emissions on Municipality web page.

Another important thing is transportation motivation. Citizens in the region can be encouraged to use the bicycle in some parts of the region. In the Table 4.16. possible outcomes and ways to use are summarized.

Energy Efficient plans are for Kadıköy region are described and exemplified in the Table 4.17., Table 4.18., Table 4.19., and Table 4.20. In accordance with the measurements

developed an overall emission reduction target has been formed. Total Carbon emission reduction target for that sector is forecasted 745 tonnes and cost is 40.000 e euros.

Table 4.15. Action 14- Awareness Raising & Training.

Action 14	Awareness Raising& Training
Project Description	Launch an top-down and bottom-up awareness practices covering all aspects of carbon reduction.
Project Benefits	Financial Savings: 130.000 € *Carbon Emission Reduction Target: 745 tonnes CO_2*
Measurement	Annual update of carbon emissions baseline
Duration	2014- 2020
Comments	Emissions reduction calculations based on achieving a 5% municipality sourced emission reduction in building consumption (public buildings, schools, housing) as a result of the awareness campaign. Financial savings based on energy costs (approx 2/3 gas @ 0,085 tl/kWh, 1/3electricity @0,358tl/kWh)

Table 4.16. Action 14- To Encourage Use of Bicycles.

Action 15	To Encourage Use of Bicycles
Project Description	Promote the use of bicycles, healthy and clean public transport drivers to steer the implementation of the project is considered, within the boundaries of District vehicles leave the parking areas located on the access roads, will be created in these areas to be supplied with the bike rental stations using alternative routes, metro-Metrobus-train and so on. be able to reach the public transportation centers. On a pilot basis; 8 lock, 2, and 10 bike stations shown on the use of bicycles, the user web site and so on. with the hardware features of the project, a source of renewable energy from the sun energy will be required for the rental station.
Project Benefits	*Carbon Emission Reduction Target: 1440 tonnes CO_2*
Funding&Resources	Project Cost: 34.800 €

Table 4.17. Action 16- Creating an Ecological Park.

Action 16	Creating an Ecological Park
Project Description	Ecological Park, the Council carried out the work on climate change and energy efficiency, announced to the public, to raise awareness about the existing and / or new to do with the preparation of this theme park will be created. Water efficiency, energy efficiency and sustainable transport for the (bike training area) portable visuals and activities will take place in the park. Also, the park will be designed to use as an exhibition area for the ecological projects.
Project Benefits	*Carbon Emission Reduction Target: 100 tonnes CO_2 (estimated)*
Project Cost	80.000 €
Measurement	Annual update of carbon emissions baseline

Table 4.18. Action 17-“Step by Step” Energy Efficiency.

Action 17	“Step by Step” Energy Efficiency
Project Description	Step by step, which will be implemented as a social responsibility project with Energy Efficiency Project for students in primary and secondary schools, education schools prepared and selected neighborhoods within the scope of energy efficiency and combating climate change will be transferred to technical information. Thus, awareness will be transferred from students to families.
Project Benefits	Financial Savings: 6.100 € (annually) *Carbon Emission Reduction Target: 45.3 tonnes CO_2*
Funding	Project Cost : ~ 20.000 €
Measurement	Annual update of carbon emissions baseline
Duration	2014- 2016

Table 4.19. Action 18- Municipality's Service Vehicles Transformation to Electrical Vehicles.

Action 18	Municipality's Service Vehicles Transformation to Electrical Vehicles
Project Description	Service vehicles consume electricity as a source
Project Benefits	Financial Savings: 64.300 € (annually) *Carbon Emission Reduction Target: 1670 tonnes CO_2*
Funding&Resources	Municipality Budget, 160.000 €
Roadmap to reach the target	Charging equipment to be fitted with a power consumption of letting electricity meters measured, the current use and the same distance, which means that by comparison, the efficiency of the project will be checked
Measuring	Annual update of carbon emissions baseline
Project Timing	2012-2016

Table 4.20. Action 19- Waste Collection Services with Hybrid Vehicles.

Action 19	Waste Collection Services with Hybrid Vehicles
Project Description	Hybrid cars will be added to the fleet.
Project Benefits	*Carbon Emission Reduction Target: 271,3 tonnes CO_2*
Funding&Resources	Municipality Budget
Roadmap to reach the target	Points placed in the charging stations will store the electrical energy output of vehicles attached to the counter, the measurements carried out on a monthly basis and the amount of monthly consumption, saving rates will be determined and will be followed.
Measurement	Annual update of carbon emissions baseline
Duration	2012-2016

All projects that have been developed for the Kadıköy municipality have been presented in table 4.21. Their contribution to overall emission savings has been given in percentages. Highest contribution to the overall emission is from the building's reconstruction and insulation projects, respectively 12% and 7%. Following sectors are under 1%, however when the whole table have completed, the overall reduction would reach to 20%. The main aim of the municipality and this research is to emerge the possible projects for the region which will help to incline the level of emission by 20% from baseline year (2010) emissions.

Table 4.21. Actions Developed for the Kadıköy Municipality.

Project	CO_2 e Reduction (tonnes)	Reduction target %
Zübeyde Hanım Social Hall & Municipality Building Outdoor Illumination Replacement to LED	45.3	less than 1%
Electrical Car Charging Stations	44	less than 1%
Khalkedon-Kalamış Parking Solar Panel Application	972	less than 1%
Kalamış Atatürk Park Solar Panel Application	100	less than 1%
Zübeyde Hanım –Municipality building Solar Panel Application	79	less than 1%
Awareness Raising& Training	745	less than 1%
Reorganizing Municipality Employee's Travel Choices	745	less than 1%
Existing Buildings Reconstruction	128000	12%
Existing Buildings Insulation	68350	7%
To Encourage Use of Bicycles	1440	less than 1%
Ecological Park	100	less than 1%
"Step by Step" Energy Efficiency	45.3	less than 1%
Green Nursery House	105	less than 1%
Municipality's Service Vehicles Transformation to Electrical Vehicles	1670	less than 1%
Waste Collection Services (with Hybrid Vehicles)	271,3	less than 1%
TOTAL	**202711,9**	**20%**

5. CONCLUSION AND RECOMMENDATIONS

In this dissertation during the research and calculation process of the baseline emission inventory of Kadıköy there were several things identified that need to further studies on. Initiatives who tackle climate change and energy efficiency problems are widely developed in Europe and United States, however in Turkey there is no official initiative who brings related parties together. In Turkey, municipalities such as Kadıköy and Karşıyaka have been part of one of the global initiatives which called as CoM. This initiative's guidelines and related documents are generated for their needs. Thus, a local initiative for Turkey which concerns climate change effects can create a harmony between municipalities in Turkey. In addition to that, they can generate tailor-made guidelines to incorporate plans. Secondly, adaptation and monitoring phases of the plan is also very crucial. That could be the most sensitive spot for all action plans in the world. Therefore, a platform that municipalities could share their experiences can increase the efficiency of the plans. In this research while developing the action plan for Kadıköy Municipality, CoM's guidelines are taken as a base. However, adaptation of the guidelines to Turkish Municipalities can enhance and accelerate the process of implementation.

Regarding CO_2 e Kadıköy's responsibility is approximately 11 kg/ CO_2 e/ m^2. Yet, that is an overall result which includes public transportation and private cars emissions. When it is compared with other CoM signatories, their contribution cannot be discarded. To illustrate, Barcelona owns 40 kg/ CO_2 e/ m^2 emissions. Its emissions are triples the Kadıköy's CO_2 e, their motivation and studies to decrease the level of emission will help to reach international goals.

The case study, Kadıköy, presented several characteristics that were expected based on the academic literature. For example, districts/towns wants apparent results, so visible actions like increasing green areas, building bike paths, building insulations are observed (Bassett & Shandas, 2010). In addition to that, municipalities are giving credits for awareness raising in both citizen level and for the employees. Kadıköy Municipality gives importance to awareness, so they organized a workshop with stakeholders to share the current status of the region. Also, municipality created bike paths in several main points to

encourage bike usage. However, those projects needs more technical development in city-based.

Another fact encountered in the research and the developing plan is that commitment level of the municipalities to the energy saving is important. Raising funds for the project, assigning capable employee in adequate numbers to the projects will increase the level of success. Giving high importance to this issue in Kadıköy Municipality's strategic plan can create an impact in long-term.

Data collection process was so crucial for this thesis, and it was difficult to reach an accurate data, that consumed a lot of time, but at the end most accurate data from stakeholders were gathered.

To increase the level of success in developing and application stages of the SEAP, I defined some elements as a recommendation to Kadıköy Municipality.

- Establishing goals and objectives, with measurable targets, in energy use and GHG emissions.

- Implementing regulations that support the plan and encourage citizens to act greener.

- Public participation on the decision-making phase will increase the interest to the project, and responsibility level will rise.

The work in this thesis could be expanded through future research in several areas. First, it would be useful to expand this case to other cities in Turkey. Second, for the selected region to develop more actions, studies can be done. For instance, buildings are the largest consumer of energy, in order to decrease it strategies could be developed, it could motivate to invent new technologies. Third, it would be useful to have research on conversion factors for calculation of emissions. In CoM guidelines, they propose to use EU-27 averages, but they also emphasize that using country based conversion factors could be more accurate. This conflict could be clarified with further researches on that subject.

All of these need to be done in a way which incorporates the values and input of the community at large.

This research has aspired to assess municipal action to mitigate climate change's reactions through reductions in Kadıköy district's GHG emissions. To evaluate the municipal response to mitigating GHG emissions, a plan has designed within the guidelines of the CoM provided and IEAP. According to that plan, Kadıköy districts's total emission inventory for year 2010 has been detected. To decrease the emission level by 20% till 2020 necessary actions has been generated within the valuable contribution of municipality officers and managers. Actions are in compliance with the literature and Turkish laws and policies which are in full force and effect. However, the expected regulations are also taken into consideration to be efficient and to be up to date. In addition to that, other signatory municipalities' actions are also analyzed and appropriate ones have been considered as possible actions for Kadıköy. This research is compiled to display the cities consumption attitude and propose actions towards the problem within universal aims.

The study asserts that central and local governments should make policies to hamper negative effects of climate change on societies. In other words, reports could be used as a base for further developments in regulation side. The further research would increase the knowledge about municipalities' attitudes, improve upon existing indicators. Also, it would motivate other municipalities to take actions.

Another positive effect of the action plan is that it creates opportunity for entrepreneurs. Renewable energy is still a developing sector in Turkey, those initiatives will encourage the parties who want to be involved and that will increase competition. This study also explains that technological development in urban level is highly demanded especially in transportation and building sector. That can hopefully trigger further researches in this field.

6. REFERENCES

Adger, W.N., 1999.Social vulnerability to climate change and extremes in coastal Vietnam. World Development V. 27, 249-269.

Apak, G., Ubay, B., 2007. Türkiye İklim Değişikliği Birinci Ulusal Bildirimi, Date of access: February 22, 2013, www.meteor.gov.tr.

Bankoff, G., Frerks G., Hilhorst G., 2003. Mapping Vulnerability: Disasters, Development and People. ISBN 1-85383-964-7.

Baris, K., Kucukali, S., 2012. Availability of renewable energy sources in Turkey: Current situation, potential, government policies and the EU perspective. Energy Policy, 42, 377-391.

Bassett, E., & Shandas, V., 2010. Innovation and climate action planning: perspectives from municipal plans. Journal of the American Planning Association 76(4), 435- 450.

Bertoldi, P., Cayuela, D., Monni S., Raveschoot R., 2013. Methodologies and Tools for the Development and Implementation of SEAPs, JRC under European Comission, Brussels.

Betsill, M., & Bulkeley, H., 2007. Looking back and thinking ahead: a decade of cities and climate change research. Local Environment, 12(5), 447-456.

Bornova Municipality, 2013. Sustainable Energy Action Plan. Bornova Büyükşehir Belediyesi, İzmir, Turkey.

Carbon Trust, 2006. The Carbon Emissions Generated in All That We Consume. Carbon Trust, London, UK.

Climate40 (C40), 2013. Date of access: February 02, 2013, www.c40.org

Covenant of Mayors, 2009. The Covenant step-by-step. Date of access: November 11, 2013, www.covenantofmayors.eu

Department of Environment, Food and Rural Affairs, 2013. Report on UK Emission Factors.

Delft Municipality, 2003. 3E: Delft Climate Plan 2003-2012.

DeAngelo, B. and Harvey, L. D., 1998. The jurisdictional framework for municipal action to reduce greenhouse gas emissions: Case studies from Canada, USA and Germany. Local Environment, 3 (2), 111–136.

EBRD, 2014. Report on Energy Statistics.

Energy Market Regulatory Board (Emra), 2015 Date of access: May 22, 2015, emra.org.tr

Energy Information Administration (EIA), 2006. Turkey country analysis brief, Europa Summaries of EU Legislation. Date of access: June 03, 2014, www.eia.doe.gov.

Enerji Piyasaları Düzenleme Kurulu (EPDK), 2010. EPDK regulation on Concerning the use of Renewable Energy Resources for the Generation of Electrical Energy Law No. 6094, Ankara.

EPBD, 2003. The Directive on the energy performance of buildings (EPBD) is the directive 2002/91/EC, European Parliament and Council, Brussels.

European Commission, 2010. Energy 2020: A strategy for competitive, sustainable and secure energy, Brussels-Belgium.

Eurostat, 2013. Statistics on Turkey's Energy. Date of access: 13 December 2013, http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=ei_lmhr_m&lang=en

Gabrielaitiene, I., Melica, G. Economidou, M., and Bertoldi, P., 2013. Part III Techical Measures for Energy Efficiency and Renewables , JRC Science and Policy Reports, Brussels.

ICLEI-USA, 2012. What is Agenda 21, 2012. Date of access: April 16, 2013, www.iclei-usa.org/Reports.

IEAP, 2012. International Local Government Greenhouse Gas Emissions Analysis Protocol, ICLEI.

Istanbul Metropolitian Municipality, 2013. Date of access November 30, 2014, www.ibb.gov.tr

International Energy Agency (IEA), 2011. Key World Energy Statistics, Turkey Chapter, OECD/IEA 2011, France.

International Energy Agency (IEA), 2014. Key World Energy Statistics, Turkey Chapter, OECD/ IEA 2014, France.

IPCC, 2006. Guidelines for National Greenhouse Gas Inventories, Volumes 1 - 5 http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

IPCC, 2007. Glossary J-P. In (book section): Annex I. In: Climate Change 2007: M Report of the Intergovernmental Panel on Climate Change (B. Metz et al. Eds.), Cambridge University.

IPCC, 2007. Solomon, S.; Qin, D.; Manning, M.; Chen, Z.; Marquis, M.; Averyt, K.B.; Tignor, M.; and Miller, H.L., ed., Climate Change 2007: The Physical Science Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, ISBN 978- 0-521-88009-1 (pb: 978-0-521-705967). Date of access: November 27, 2013, www.ipcc.ch/pdf/assessment-report/ar4/wg1/ar4-wg1-spm.pdf

Ivanova, A., & Bermudez-Contreras, A., 2014. Climate Action Plan for the City of La Paz, BCS, Mexico: A Tool for Public Policy in a Coastal City. Current Urban Studies, 2(03), 249.

Izoder, 2010. Dünyada Binalarda Enerji Verimliliği Stratejisi ve Türkiye'de Yapılması Gerekenler, 2010-2023 Isı Yalıtımı Planlama Raporu.

Joint Research Committee, 2013. SEAP Guideline Baseline Emission Inventory, Brussel.

Joint Research Committee, 2013. SEAP Guideline on Technical measures for energy efficiency and renewable energy, Brussel.

Joint Research Committee, 2013. SEAP Guideline on the SEAP process, step-by-step towards the -20 % target by 2020, Brussel.

Kadıköy Municipality, 2014. Date of access: January 01, 2014. www.kadikoy.bel.tr

Karşıyaka Municipality, 2013. Sustainable Energy Action Plan.

Kern, K., 2010. Climate Governance in the EU Multi-level System: The Role of Cities. 21. Porto, Portugal.

Marmara Belediyeler Birliği, 2013. Annual Report 2013.

Meffe, G., Nielsen, L., knight, R., & Schenborn, D., 2002. Getting a grip on ecosystem management. In Ecosystem management: adaptive, community based conservation, pp. 57-78, Washington, DC: Island Press.

Ministry of Environment and Urbanization of Republic of Turkey, 2012. National Climate Change Action Plan of Turkey Report, Ankara.

Ministry of Environment and Urbanization of Republic of Turkey, 2012, Annual Report, Ankara.

Ministry of Energy and Natural Resources, 2012. Annual Report, Ankara.

Ministry of Energy and Natural Resources, 2009. Annual Reports Official Gazette. Date of access: May 18, 2014.

NASA, 2008. World Book at NASA: Weather. Date of access: January 10, 2013

Natural Resources Canada, 2004. Climate Change Impacts and Adaptation: A Canadian Perspective. Ottawa, Canada.

Netherlands Environment Agency, 2008. EU-25 Energy Consumptions and Predictions 1990-2030.

Nicholls, R. J., 1995. Coastal megacities and climate change. GeoJournal, 37(3), 369-379.

Nordaus, W. (2006) "After Kyoto: Alternative Mechanisms to Control Global Warming", The American Economic Review, Vol. 96, No. 2, pp. 31-34

Oceania, ICLEI, 2008. Local government climate change adaptation toolkit.

Orr, D, 2009. Down to the wire: Confronting climate collapse. New York: Oxford University press.

Pumpim De Oliviera, J., 2013. Learning how to align climate, environmental and development objectives in cities: lessons from the implementation of climate co-benefits initiatives in urban Asia, Journal of Cleaner Production 58 (2013) 7-14, July 2013.

Román, M., 2010. Governing from the middle: the C40 Cities Leadership Group. Corporate Governance, 10(1), 73-84.

Rosenzweig, C., Solecki, W, Hammer, S., Mehrotra, S., 2011. Cities lead the way in climate-change action: scientists should do the research to help mayors prepare for a warming world. Nature 467.7318: 909.

Sola, J., Armero, M., Foix, B., Rieradevall, J., 2013. Energy and environmental evaluation of municipal facilities: Case study in the province of Barcelona, Energy Policy 62, 920-930.

State Institute of Statistics (DIE), 2005. Statistic yearbook of Turkey in 2004, Prime Ministry, Republic of Turkey, Ankara.

TEIAS, 2001. Electricity Production and Transmission Statistics in Turkey. Date of access: December 24, 2014, http://www.teias.gov.tr/istatistikler/I.htm

TEIAS, 2011a. Turkish Electricity Production and Transmission Statistics 2011. Date of access: December 24, 2014, www.teias.gov.tr.

TEIAS, 2011b. Electricity Power Production Projection for Turkish Electrcity Energy 2011-2020. Date of access: December 24, 2014, www.teias.gov.tr.

The Met. Office, 1998. Climate change and its impacts: some highlights from the ongoing UK research programme: a first look at results from the Hadley centre's new climate model.

Travel Planner, 2013. Date of access December 23, 2013. www. travelplanner.com.tr

Tubitak, 2010. Turkey 2023 Targets Report, Ankara.

Turkstat, 2013. Turkey Greenhouse Gas Inventory, 1990 to 2011, National Inventory Report, Ankara.

TurkStat, 2012a.Foreign Trade by Standard International Trade Classification. Date of access: December 24, 2014, www.tuik.gov.tr

TurkStat, 2012b. Greenhouse Gases Emission Inventory Period 1990-2011.

United Nations, 2014. Statistics for Regions, retrieved from: data.un.org. Date of access November 23, 2013.

United Nations Framework Convention on Climate Change, 2015. The status of Doha Amendment. Date of access: May 22, 2015. www.unfcc.int

U.S. Department of State, 2011. Bureau of European and Eurasian Affairs, background note: Turkey. Date of access October 26, 2013, http://www.state.gov/r/pa/ei/bgn/3432.htm.

Watts, V., 2010. The Cambridge Dictionary of English Place-names (1st paperback ed.). Cambridge University Press. p. 158. ISBN 978-0-521-16855-7.

Welfens, P. et al., 2011. Global Economic Sustainability Indicator: Analysis and Policy Options for the Copenhagen Process, International Economics of Resource Efficiency, Springer, pp 19-50.

Wesselink, L. G., Eerens, H., Vis, J., & Natuurplanbureau, M. E., 2008. EU 2020 climate target: 20% reduction requires five-fold increase in impact of CO2 policies. MNP report, (500094007), 90.