ENERGY INDICATORS FOR SUSTAINABLE DEVELOPMENT: COMPARISON OF TURKEY AND SELECTED EUROPEAN UNION COUNTRIES

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

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ABSTRACT

ENERGY INDICATORS FOR SUSTAINABLE DEVELOPMENT: COMPARISON OF TURKEY AND SELECTED EUROPEAN COUNTRIES

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The aim of this study is to compare the sustainable development perspective of Turkey with selected European Union countries in terms of Energy Indicators for Sustainable Energy between 1980-2008. The study is conducted in a comparative and descriptive way by using energy indicators. The common energy policy priorities of Turkey and European Union are determined in the light of recent literature. An energy indicator set is constructed according to energy priorities, namely, energy efficiency and energy intensity; energy security and fuel mix; and environmental concerns. The analysis of relevant indicators demonstrates that Turkey does not meet the sustainability criteria in terms of energy use. In general, findings of the study indicate that Turkey does not use energy efficiently and energy intensities in the economy do not decrease except for the industry sector, for the period 1980-2008. Import dependency has increased and fuel mix of energy sources is dominantly carbon based. Expectations about increasing renewable energy share do not exhibit a significant trend thus energy security and fuel mix are still important issues for Turkey. Lastly, environmental protection in terms of decreasing GHG emissions, air pollution and deforestation could not be achieved as GHG emissions, air pollution and deforestation have increased in Turkey during 1980-2008 period.

Keywords: Energy Indicators, Sustainable Energy, Turkey and EU, Sustainable Development

ÖZ

SÜRDÜRÜLEBİLİR KALKINMA İÇİN ENERJİ GÖSTERGELERİ ÇERÇEVESİNDE TÜRKİYE VE SEÇİLMİŞ AVRUPA BİRLİĞİ ÜYE ÜLKELERİNİN KARŞILAŞTIRILMASI

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Bu tezin amacı 1980-2008 tarihleri arasında Türkiye'nin sürdürülebilir kalkınma perspektifini sürdürülebilir enerji başlığı altında ilgili iktisat yazını ve seçilmiş enerji göstergelerini kullanarak incelemek ve bazı Avrupa Birliği ülkeleri ile karşılaştırmaktır. Türkiye ve Avrupa Birliği'nin üç ortak enerji politika önceliği vardır. Bunlar: enerji verimliliği ve enerji yoğunlukları; enerji güvenliği ve enerji çeşitliliği; ve çevre duyarlılığıdır. Bu üç ana enerji politika önceliğine uygun olarak seçilen sürdürülebilir kalkınma için enerji göstergeleri, 1980-2008 aralığında hem Türkiye hem de seçilmiş Avrupa Birliği üye ülkeleri için hesaplanmıştır. Bu çalışmanın bulguları, Türkiye'nin gerek enerji verimliliği ve gerek enerji yoğunluklarında, sanayi sektöründeki enerji yoğunluğu azalışı hariç, başarılı bir performans gösteremediğine işaret etmektedir. Türkiye'nin artan enerji ithalat bağımlılığı, enerji kaynaklarının çoğunlukla karbon bazlı kaynaklar olması ve yenilenebilir enerji kullanımında istenen başarıyı gösterememesi, enerji güvenliğinde de beklenen performansı gösteremediğini

kanıtlar niteliktedir. Son olarak çevre konusunda da Türkiye, artan sera gazı emisyonları, hava kirliliği ve ormansızlaşma oranı göz önüne alındığında başarılı olamamıştır.

Anahtar Kelimeler: Enerji Göstergeleri, Sürdürülebilir Enerji, Türkiye ve Avrupa Birliği, Sürdürülebilir Kalkınma

To my mother, Barış and Onur

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CCS: Carbon Capture and Storage

CSD: Commission on Sustainable Development

EC: European Commission

EEA: European Energy Agency

EIA: Energy Information Administration

EISD: Energy Indicators for Sustainable Development

EMRA: Energy Market Regulatory Authority

EPA: Environmental Protection Agency

EU 15: The European Union of 15 member states

EU 27: The European Union of 27 member states

EU-ETS Scheme: European Emissions Trading Scheme

FAOSTAT: Food and Agriculture Organization of the United Nations

GHG: Greenhouse Gas Emissions

HDI: Human Development Index

IAEA: International Atomic Energy Agency

IEA: International Energy Agency

INOGATE: Interstate Oil and Gas Transport to Europe

ISED: Indicators for Sustainable Energy Development

ISEW: Index for Sustainable Economic Welfare

JPOI: Johannesburg Plan of implementation

MENR: Ministry of Energy and Natural Resources

NAP: National Allocation Plan

RES: Renewable Energy Sources

SEW: Sustainable Energy Watch

SPO: State Planning Organization

TFC: Total Final Consumption

TFF: Total Forest Fellings

TEAS: Turkish Electricity Generation and Transmission Corporation

TENs: Trans- European Networks

TPES: Total Primary Energy Supply

TRACECA: Transport Corridor Europe- Caucasus- Asia

TRD: Total Rate of Deforestation

UN: United Nations

UNDESA: United Nations Department of Economic and Social Affairs

UNDP: United Nations Development Program

UNFCCC: United Nations Framework Convention on Climate Change

WCED: World Commission on Environment and Development

WEC: World Energy Council

WSSD: World Summit on Sustainable Development

AT: Austria

BE: Belgium

CZ: Czech Republic

DE: Germany

DK: Denmark

EL: Greece

ES: Spain

FI: Finland

FR: France

HU: Hungary

IE: Ireland

IT: Italy

LU: Luxembourg

PL: Poland

PT: Portugal

SE: Sweden

SK: Slovakia

TR: Turkey

UK: United Kingdom

CHAPTER 1

INTRODUCTION

Can sustainable development solve the problems the world encounters with such as global warming, depletion of resources, continuing poverty and inequity? Meeting the needs of the present without compromising the ability of future generations to meet their own needs is a dream or not? The answers to these questions will remain ambiguous until we understand sustainable development and achieve its goals. Sustainable development is devoted to solve problems related to energy use, stagnation, poverty, hunger, illness, environmental degradation and globalization (Munasinghe, 2004). In this study, sustainable energy will be our main concern as it is a crucial part of sustainable development.

Without a doubt, energy is an essential tool to attain sustainable development goals. Here the question is whether the energy is sustainable or not. The efficient use of energy resources, the accessibility of energy with affordable cost and in a secure and environmentally friendly manner, decreasing poverty, improving human welfare and raising the living standards are all regarded as sustainable energy objectives. Therefore, achieving sustainable development goals cannot be considered without sustainable energy. Sustainable energy targets to reduce the use of fossil fuel use, to avoid using nuclear energy, to improve energy efficiency and to increase the amount of energy obtained from renewable resources (Stanford, 1997).

The measurement and assessment of sustainable energy is not an easy task. As an essential part of sustainability, measurement and assessment of sustainable energy will be our concern. In this study, we aim to assess the current condition of sustainable energy indicators for Turkey and selected European Union[1] countries. We will search whether Turkey achieves sustainability goals in terms of sustainable energy by comparing our findings with other countries. Our aim is to detect past and current implications of energy policies, to determine energy policy priorities and to monitor the progress of sustainable energy goals of Turkey and selected European Union countries between 1980 and 2008 by implementing Energy Indicators for Sustainable Development (EISD). We use such a tool because it enables us to sort out disaggregated data about sustainable energy and to make inter-country comparisons in terms of the indicators calculated by using the same indicator set.

EISD is developed by five international institutions namely IAEA, DESA, IEA, Eurostat and EEA. EISD is consistent with international commitments and global policy initiatives, such as, the United Nations Conference on Environment and Development or Earth Summit (Rio de Janeiro, 1992); the Millennium Declaration and the Millennium Development Goals, adopted by the United Nations (New York, 2000); the OECD Environmental Strategy for the First Decade of the 21st Century, adopted by the OECD Environment Ministers (Paris, 2001); and the World Summit on Sustainable Development, its political declaration and particularly the Plan of Implementation (Johannesburg, 2002) (Ross, et.al., 2005). Thus, EISD can be accepted as a worldwide known comprehensive indicator set in order to assess Turkish and European energy sectors in terms of their sustainability. Moreover, there are successful studies implementing EISD to countries such as Brazil (Schaeffer et al., 2005), Cuba (Perez D. et al., 2005), Lithuania (Streimikiene, D., 2005), Mexico (Ross et al., 2005), Russia (Aslanyan et al., 2005), Slovakia (IAEA, 2005) and Thailand (Todoc et al., 2005)[2]. There has not been any study done for Turkey using EISD framework. Therefore, our study will be the first to implement this indicator set to Turkey. Moreover, all country studies mentioned above are done individually. In other words these countries were not

[1] Countries that are both members of EU and IEA.

[2] The results of these studies are discussed in the second chapter.

compared to any other country. Thus, our study is pioneering the comparison of multiple countries using the same indicator set, to be specific, the comparison of Turkey and European Union countries.

EISD, published in 2005, is comprised of three main themes; social, economic and environmental. Each theme is then divided into sub-themes; i.e., social theme has four, economic theme has sixteen and environmental theme has ten sub-themes. The detailed definitions, required data to calculate the indicators, the relevance to sustainable development, the data resources and the international agreements relevant to the indicator are all available in the EISD publication (IAEA et.al., 2005). The selection criteria for indicators are identified according to country specific conditions such as energy policy priorities, economic structure and defined goals about sustainability. EISD is an effective tool to compare and point out the linkages between countries. The relevant indicators are calculated for each country. Nevertheless, there is not any standard stating the numerical results of these indicators as good or bad. The only way to understand whether a country's progress towards sustainability is satisfactory or not is to compare it with the findings for the other countries using the same indicator set.

We aim to compare Turkey with selected European Union countries, because of several reasons. To begin with, Turkey is a candidate country whose accession process to EU is continuing. Turkey is modifying its regulations and legislation according to EU standards and energy is an important title in these attempts. The findings of this study may provide a snapshot of both Turkey and European Union countries. Moreover, it may be useful to point out areas that Turkey should pay more attention to catch up with European Union in terms of sustainable energy progress. In addition, energy is an especially important title for EU. The accession process of Turkey is regarded as crucial because of her role as an energy corridor for EU. Many publications like Green Paper and White Paper stressed the role of Turkey as an energy corridor considering the security of the energy supply (Green Paper, 2001; White Paper, 2009). Second reason why we compare EU with Turkey is the willingness and ambition of EU about achieving goals of sustainable development and sustainable energy. As it will be discussed in the following chapters in detail, both current implications, regulations and legislations put into action show how EU has devoted itself to achieve sustainable development and sustainable energy goals. Therefore, to assess Turkey's energy performance in terms of sustainable development and compare the results with selected European Union countries, EU is a convenient threshold for Turkey. European Union itself has introduced many legislation and held many conferences regarding sustainable energy. Almost all countries are trying to achieve energy efficiency, improve the use of renewable energy, decrease atmospheric pollution and achieve greenhouse gas mitigation (Streimikiene and Sivickas, 2008). When we evaluate the energy policies of EU and Turkey, we come up with three main energy priorities: energy security and energy mix; energy efficiency and energy intensity; and environmental protection. As it will be discussed in detail in the third chapter, we constructed our indicator set according to common energy priorities of Turkey and European Union and the interpretation of the results which take place in the fifth chapter are also consistent with those priorities.

In the Second Chapter, we present a literature review about definition of sustainable development and sustainable energy. As the definition of sustainable development has evolved through time; the emergence and evolution of the concept is discussed in detail. Likewise, the definition of sustainable energy and the evolution of this concept take place in the second chapter. The relationship between sustainable development and sustainable energy is stressed and lastly the sustainable energy indicators are analyzed and country case studies that used EISD framework are summarized briefly.

In the Third Chapter, we review energy policies of Turkey and European Union since 1960s. Looking into the development plans of Turkey, energy policy is discussed in terms of issues such as type of energy sources (commercial, non- commercial, nuclear, hydro), privatization, energy security and demand, EU accession process and sustainable development concept. We try to analyze these issues for the European Union and lastly we briefly discuss the relationship between Turkey and the European Union in terms of energy.

The Fourth Chapter is the data and methodology chapter. In this chapter, we provide detailed information about EISD framework, country and time selection criteria, the selected EISD framework, terms and explanations of the indicators and databases that are used.

In the Fifth Chapter, we analyze every selected indicator under three main titles (i.e energy security and fuel mix; energy efficiency and energy intensity; and environmental protection) and discuss them in terms of definition, calculation, relevance to sustainable development, interpretations according to sustainable energy concept and point out the regulations or legislations if there exists. There is a brief discussion about the findings at the end of this chapter.

Lastly, Chapter Six concludes the study.

CHAPTER 2

LITERATURE REVIEW

This chapter provides a brief literature review about the definition of sustainable development, emergence and evolution of sustainable development concept, methods of assessing sustainable development, definition of sustainable energy, emergence and evolution of sustainable energy concept, the relation between sustainable development and sustainable energy, sustainable energy indicators and country studies related to the concept of sustainable energy.

2.1. Definition of Sustainable Development

There has not been an intact definition of sustainable development yet. However, the literature accepts the Brundtland Commission's definition as a starting point. Most authors emphasize their own priorities and definitions regarding the definition that sustainable development is '...development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987).

For instance, according to Kerk and Manuel (2008), sustainability[3] is composed of three elements: depletion of resources, environmental and ecological aspects and quality of life. Sustainability is inherent in sustainable society and the authors modified the definition in Brundtland Report and define a sustainable society as 'a society that meets the needs of the present generation, that does not compromise the ability of future generations to meet their own needs, in which each human being has the opportunity to develop itself in freedom, within a well-balanced society and in harmony with its surroundings' (Kerk and Manuel, 2008). Sustainable development is expected to enable

[3] The terms sustainability and sustainable development can be used interchangeably (Leach, and Scones, 2003).

both generations to live in a clean and healthy environment, to take into account the future generation's rights and to ensure human well-being. The definitions of sustainable development by the International Union for Conservation and Nature (IUCN) and United Nations of Environment Program (UNEP) are shaped according to those elements mentioned and it is defined as 'improving the quality of life of humans while living within the carrying capacity of supporting ecosystems' (Kerk and Manuel, 2008). Quality of life concept is especially important for developing countries.

Neumayer (2004) also changed the Brundtland definition and briefly described sustainability as 'the requirement to maintain the capacity to provide non-declining well-being over time.' It is the manufactured, human, natural, and social capital that should be kept non-declining. Economists claim that the mission to maintain the value of total capital intact, which is composed of manufactured capital, human capital, natural capital and social capital, makes sustainable development concept to be a future oriented one. When we mention manufactured capital, it is the capital that consists of factories, machineries, and infrastructure. Human capital is consisted of human skills and knowledge. Natural capital is the everything in the nature that provides human beings with well-being. Lastly, social capital is the will of individuals to cooperate, extent of social network and 'civic engagement' in social groups (Neumayer, 2004). Likewise, at World Summit in 2002, improvement of human, social and natural capital was emphasized. At the World Summit, it is stressed that to attain sustainable development there must be improvements in human capital, social capital and natural capital (World Summit, 2002).

Sustainable development is regarded as a vector which increases monotonically over time and has the following elements that should be satisfied: 'increases in real income per capita, improvements in health status, educational achievement, a fairer distribution of income and increases in basic freedoms' (Pearce and Atkinson, 1992). Lastly, sustainable development can be defined as '...a pattern of social and structural economic transformations which optimizes the economic and societal benefits available in the present, without jeopardizing the likely potential for similar benefits in the future. A primary goal of sustainable development is to achieve a reasonable and equitably distributed level of economic well-being that can be perpetuated continually for many human generations' (Goodland and Ledec, 1986).

As previously mentioned it is difficult to find a world-wide accepted definition for sustainable development. The Brundtland definition is widely accepted because it mainly focuses on two important aspects of sustainability, needs and limitations. The needs of the poor and limitations in technology and environmental opportunities are the main concerns of sustainability concept.

There are mainly three pillars of sustainable development accepted in the literature (UNDESA, 2002; Munasinghe, 2004; Kettner, et al., 2006). Namely these are social, economic and environmental dimensions of sustainability. Social dimension focuses mainly on human beings and care for empowerment of the people, participation, social mobility, social cohesion, cultural identity and institutional development. Economic sustainability is simply defined as the maintenance of capital stock and it focuses on economic growth, distributive justice and efficiency. Environmental dimension, on the other hand, cares for the protection of the integrity of the ecological subsystems and its pillars are ecosystem integrity, carrying capacity, biodiversity and global issues like global warming (Kettner, et al., 2006). Likewise, UNDESA (2002) accepts that sustainable development is comprised of economic growth, social equity and protection of the environment (UNDESA, 2002). Munasinghe (2004), similarly, defines sustainable development as 'a process for improving the range of opportunities that will enable individual humans and communities to achieve their aspirations and full potential over a sustained period of time while maintaining the resilience of economic, social and environmental systems'. According to Munasinghe's categorization, economic aspect focuses on increased consumption and increased human welfare, social aspect focuses on human relations, attaining individual and group targets and strengthening the values and institutions while environmental aspect focuses on protecting ecological system (Munasinghe, 2004). The same three pillars approach have been adopted by Hughes and Johnston (2005), stating that the three pillars of sustainable development are economic growth and human development; protection of social capital regarding social equity; and protection of natural resources (Hughes and Johnston, 2005). The important point is to maximize the social welfare and satisfy the needs of the poor through the optimal and efficient use of natural resources. The term 'needs' refers to basic needs of the poor and the poor should be given the priority. Social dimension includes the satisfaction of basic health and education services that maintain the security and human rights and thus improve the welfare of people. Social equity that is the distribution of benefits and access to resources completes the social dimension of sustainable development. Environmental dimension includes the conservation and enhancement of physical and biological resource base and ecosystems (UNDESA, 2002). Although the Brundtland definition includes the three pillars of sustainable development, there is a single pillar concept claiming that sustainability is a long-term ecological compatibility and thus social and economic dimensions come only after ecological conservation (Gallego and Mack, 2010). Nevertheless, the three pillar approach is dominantly accepted in the literature. Apart from these, there are some other categorizations composed of four or five pillars of sustainable development including the dimensions of culture and institutional stability (Gallego and Mack, 2010).

As a relatively new concept, sustainable development concept is still discussed and definitions and dimensions of sustainable development vary from one author to another. We accept the definition of Brundtland report and categorize the dimensions of sustainable development as social, economic and environmental. The following part is a brief summary of the evolution of sustainable development concept.

2.2. Emergence and evolution of the concept of 'Sustainable Development'

In the past, there were important conferences and commissions held about sustainable development and they all contributed to shape today's sustainable development perspective: 1972 Stockholm Conference, 1987 Brundtland Commission, 1992 Earth Summit and 2002 World Summit. In 2012 there will be Rio+20 conference. These can be regarded as milestones in the evolution of sustainable development concept.

2.2.1. 1972 - Stockholm Conference

The sustainable development concept was flourished in Stockholm Declaration being significantly different from today's perception. In the conference, an internationally accepted environmental law was tried to be established stating that economic activity should be constrained due to environmental problems. It was perceived as 'opposing sides in a zero-sum game' that there is a trade-off between economic efficiency and ecological integrity (Pearce and Atkinson, n.d.). Therefore, the developing country leaders objected the debate as it would constrain the economic development of developing countries and they rejected low or no growth scenarios. The prioritization of ecology over development was conceived as a potential restriction on developing countries' development aspirations that resulted in disputes among country leaders. Developing country leaders objected to put ecological concerns before economic growth targets. Due to mentioned reasons, the concept was extended to include rural poverty and its solutions in developing countries. The Stockholm Conference is important because at the conference, poverty was accepted as a reason of environmental degradation and the content of sustainable development and economy-environment interaction was revised to include this dimension. Moreover, a mutual outlook and resource exploitation for development and environmental protection were accepted (Mehta, 2009).

2.2.2. 1987 - United Nations World Commission on Environment and Development Brundtland Commission

World Commission on Environment and Development (WCED) was created in 1983 and it was asked to prepare a report about on global agenda for change (United Nations Conference on Sustainable Development, 2011). 'Our Common Future' also named as Brundtland Report was published in 1987 by WCED and it is accepted as the starting point for the concept 'sustainable development'. Population, food security, extinction of species, ecological problems, energy, industrial development and urbanization were regarded as world's common challenges and they were discussed at the conference. The purpose is to achieve economic development and use world's natural resources in a sustainable way since they are not limitless and as human-beings we have to preserve them for the future (Mehta, 2009). In 'Our Common Future' report, the tension occurred in Stockholm Conference between developed and developing countries (or North and South) was reconciled by taking proactive measures and the need to cooperate internationally in order to overcome the mentioned problems were emphasized (Meadowcroft, 2000). Considering the objections coming from developing countries, 're-conceptualising the environment as an economic rather than an ecological problem' was attained. Brundtland report is important because it managed to integrate environmental problems with economic growth and integrate present and future generations emphasizing the need for equity and poverty eradication. The core idea is that economic growth is consistent with environmental goals. It is a kind of bridge that connects all different interests in a common agenda yet there were still some ambiguities that would be totally removed in Earth Summit (Pearce and Atkinson, n.d.).

2.2.3. 1992 - Earth Summit

Earth Summit held in Rio de Janeiro in 1992, was an initial attempt to construct national sustainable development strategies for countries. As a result of this summit, Agenda 21 was published. It was a four part report which includes; social and economic dimension (combating poverty, changing consumption patterns, promoting health, changing population and sustainable settlement); conservation and management of resources for development (atmospheric protection, combating deforestation, protecting fragile environment, biodiversity and control of pollution); strengthening the role of major groups (roles of children and youth, women, local authorities, business and workers); and means of implementation (science, technology, education, international institutions and financial mechanisms) (UN, 1992). In addition, sustainable energy concept was discussed in this conference. The main idea promoted in that report is that ‘a healthy environment is central to securing continued economic growth in such a way that growth is central to securing a healthy environment. Where sustainable development once implied ecological sustainability, it was now commonly promoted as economic sustainability: sustaining the growth in material consumption’ (Lele, S. M, 1991).

In Brundtland report it is emphasized that economic growth is consistent with environmental protection while Agenda 21 makes economic growth the means for achieving it. In Agenda 21, the distinction between sustainable development and sustained economic growth disappeared. It solved the problems about distributional conflicts, offered equity for future generations, took the attention from over consumption in the North and assured compatibility between environmental preservation and maximization of growth (Pearce and Atkinson, 1992).

2.2.4. 2002 - World Summit on Sustainable Development (WSSD)

The Johannesburg WSSD held in 2002, published a report called Johannesburg Declaration. It was a declaration that promised to achieve sustainable development at the national, regional and global levels and stressed the social and economic development and the regulation of corporate activities (Schwartz, 2009). Again it was confirmed as in Rio that economic growth is the important for environmental development. According to Hughes and Johnston (2005), in WSDD, sustainable development is related more with social equity, efficient resource use and conservation of natural resources. Moreover, WSDD is crucial because energy sustainability was discussed and it was put on the agenda stressing that concrete measures should be taken and promotion of sustainable energy should be implemented (Tsai, 2010). The main message coming from Johannesburg Declaration was that industrialized countries should open their markets, increase development aid, and leave private enterprises free in order to achieve sustainable development (Pearce and Atkinson, 1992).

2.2.5. 2012 UNCSD - Rio+20

United Nations Conference on Sustainable Development (UNCSD), which is also called Rio +20, will be held in 2012. The UN General Assembly adopted a resolution (A/RES/64/236) in 2009, and it agreed to hold the United Nations Conference on Sustainable Development (UNCSD) in 2012. Rio +20 has three main objectives namely; to secure political commitment about sustainable development, to assess the progress and implementation gaps in meeting already agreed commitments, and addressing new and emerging challenges. There will be two themes in Rio+ 20 that are green economy in terms of sustainable development and poverty reduction and institutional framework for sustainable development.

2.3. Sustainable Development Indicators

A difficulty about sustainable development is to measure it by regarding not only the environmental aspects but also considering its social and economic aspects that are discussed in the previous section. It is a challenge to measure sustainable development by regarding its economic, social and environmental aspects (UNDESA, 2002). For instance Hales et al., (2002) claimed that to achieve a sustainable way of living in this planet, sustainable development should be defined with its components in measurable terms and the progress of assessments about sustainability should be performed concretely. This need brings about many definitions and many different frameworks of sustainable development indices (Kerk and Manuel, 2008). Kerk and Manuel (2008) listed these indices as Human Development Index (HDI), Environmental Sustainability Index (ESI-2005), Environmental Performance Index (EPI-2006), Commitment to Development Index (CDI-2006), Index for Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), Ecological Footprint, Wellbeing of Nations, Millennium Development Indicators, and Commission on Sustainable Development (CSD) Indicators. In addition to those, there are other efforts to characterize and measure sustainable development such as: Consultative Group on Sustainable Development Indicators, Global Scenario Group, U.S. Interagency Working Group on Sustainable Development Indicators, Costa Rica System of Indicators for Sustainable Development, Boston Indicators Project, State Failure Task Force and Global Reporting Initiative. Indicators are useful to show us the progress towards or away from the defined goals and to advise the public, decision makers and managers about the results of sustainability scenarios (Parris and Kates, 2003). Similar to the need to measure/assess sustainable development, in the following part, we use an indicator set for analyzing sustainable energy. The detailed information is given in section 2.7.

2.4. Definition of Sustainable Energy

After discussing sustainable development concept, this part will define sustainable energy and its objectives. 'Sustainable energy is the production and use of energy resources in ways that promote or at least are compatible with long-term human well-being and ecological balance' (UNDP, 2000). Sustainable energy objectives are mainly energy security, natural resource management and environmental protection (Stanford, 1997). Sustainable energy has five targets to reach: zero net emissions of carbon dioxide, no significant environmental impacts, improving the security of energy supply, reducing the cost of energy supply and improving the use of renewable energy sources. To begin with, although nature can tolerate small amounts of increases in carbon dioxide, larger levels of carbon dioxide emission lead to global warming problem. Thus, low carbon energy supply is a concern of sustainable energy. Sustainable energy aims to manage 'flows of energy and associated material streams such as fuel and waste within the carrying capacity of ecosystems'. Also, security of energy supply has a social dimension as energy is used in everyday life and access to energy is a sign of well-being of a society. Depending on political stability, weather, natural disasters or technological factors, energy security can be at risk. Cost of energy is another concern both for industrial and household uses. The accessibility to energy sources is a basic human right and technological improvements can easily reduce the cost of energy. Lastly, as understood from its definition, a finite energy resource is not sustainable. Thus to increase renewable energy use is an essential target for sustainable energy (Acres, 2007). In addition, Stanford (1997) and Jefferson (2006) claim that in order to achieve a sustainable energy system[4] increasing the energy efficiency and promotion of renewable energy should be attained (Stanford (1997); Jefferson (2006)).

Similar to 'sustainable development' concept, in the following part we provide a brief summary of the evolution of sustainable energy concept.

2.5. Emergence and Evolution of Sustainable Energy

Sustainable energy was for the first time on the agenda in 1997 at UN General Assembly as a need to create a common approach towards sustainable energy use patterns. The '2000 World Energy Assessment Report' detailed the subject and analyzed the relations between energy, environment, health and social issues. Energy security, resource availability, end use efficiency, renewable and advanced technologies and rural energy in developing countries were discussed. Both in the Ninth Session of the Commission on Sustainable Development (CSD-9) held in 2001 and WSSD in 2002, sustainable patterns of energy use, production and distribution were discussed.

[4] A sustainable energy system is the system that uses sustainable energy resources and processes, stores, transports and utilizes those sustainable energy resources sustainably (Toklu, et. al. 2010).

CSD-9 is important because it prepared a basis for WSSD and Johannesburg Plan of Implementation (JPOI). To achieve the Millennium Development Goal that is to halve the proportion of people living in poverty by 2015, sustainable energy is a necessity regarding the role of energy in eradication of poverty and changing consumption and production patterns (Fecher et. al., 2005; Vera and Langlois, 2007).

2.6. The Relationship between Sustainable Development and Sustainable Energy

Sustainable development and sustainable energy are closely linked to each other. Considering the definition of Brundtland report this relationship has two important features. First is the adequate energy service for improving social welfare and achieving economic development or in other words defining 'energy as a source of prosperity' (WSSD, 2002). Second is the preservation of the quality of life of current and future generations and keeping the carrying capacity of ecosystems during energy production and use. Considering economic, social and environmental dimensions of sustainable development, each of them is known to be closely linked to sustainable energy. Energy is a major tool for meeting the needs and maintaining a sustainable future (UNDP, 2000). According to social and economic development requirements, the adequate, reliable and affordable energy in an environmentally benign manner is the primary goal of sustainable development. It is the energy that eradicates poverty and raises the living conditions and social welfare (Vera and Langlois, 2007).

Economic dimension of sustainable development includes economic growth and it stimulates energy demand. Energy production and energy use are inevitable elements for economic growth. Energy is a human need that affects the social dimension of sustainable development that focuses on equity and the needs of the poor. It is essential for social development because energy is the key for heating, cooling, cooking, lighting and transportation (Unander, 2005). Accessibility of energy at an affordable cost in a secure and sustainable way is a complementary part of sustainable development goals.

Lastly energy use and production are also linked to environmental dimension of sustainable development that energy use and production cause environmental degradation at local, national and global levels. Depletion of natural resources, deforestation, water and air pollution and land disturbance are all energy-environment related problems that the world is facing with (Unander, 2005). Therefore, achieving sustainable energy is becoming more and more important for sustainable development goals.

Like sustainable development, we can talk about three dimensions of sustainable energy: economic, social and environmental[5]. Economic aspect of sustainable energy proposes to maintain adequate and reliable energy supply, to reduce energy intensity during economic growth and to increase access to modern energy forms. Achieving these goals would attract private investments, facilitate industrialization, improve trade and competition and ease the access to global markets. Social aspect of sustainable energy proposes to reduce the reliance on firewood and charcoal for cooking, avoid noisy, polluting and expensive cooling devices and thus improve the public services such as health and education. Environmental aspect deals with energy security and reduction of carbon intensities, improvements in renewable energy and also improvements at innovative technology (Schwartz, 2009).

The sustainable energy policies/options simply aim to reduce fossil fuel based energy system, to maintain adequate and reliable energy supply, to reduce energy intensity and to increase energy efficiency especially in buildings, electric appliances, vehicles and production processes, to increase the access to modern energy forms, to increase reliance on renewable energy sources, to develop fossil fuel technologies that reduce harmful emissions, to widen access to reliable and affordable energy and to reduce negative environmental impacts of energy use (Schwartz, 2009; UNDP, 2000).

[5] Economic, social and environmental dimensions of sustainable energy will be explained in detail in Chapter 4.

To alleviate poverty, promote economic growth and improve social development, energy plays a crucial role. Sustainable energy use with minimal adverse effects on environment is one of the goals of sustainable development. Sustainable energy was on the agenda at Rio Conference on Environment and Development (1992). Since then energy issues and environmental concerns, actions and precautions have been considered at regional and national levels. After Rio Conference, both at United Nations Commission on Sustainable Development (CSD-9) in 2001, World Summit on Sustainable Development in 2002 and in the Millennium Development Goal of halving the proportion of people living in poverty by 2015, sustainable energy issue has been discussed extensively. The Johannesburg Plan of implementation (JPOI) claimed its concern about increasing poverty and stressed some issues like energy efficiency, renewable energy and necessity of utilizing modern energy services to alleviate the poverty. Energy in the context of sustainable development was also discussed in both United Nations 2005 Summit, 14^{th} session of the United Nations Commission on Sustainable Development in 2006 and 15^{th} session of the Commission in 2007 (IAEA, 2005). All these reconfirmed that 'the provision of adequate and reliable energy services at an affordable cost, in a secure and environmentally benign manner and in conformity with social and economic development needs is an essential element of sustainable development' (Vera et. al, 2005).

2.7. Sustainable Energy Indicators

Like sustainability indicators, energy indicators are useful to monitor the evolution of policies, to guide decision making processes and to define energy policies accordingly. They are different from energy statistics as energy indicators act as connectors that highlight the linkages between environmental, social and economic aspects of a whole energy system. The evaluation of indicators over time points out the trends, progresses or deficiencies of an energy related issue or policy. Indicators are also essential to assess the strategies of sustainable development in the energy area and guide countries about their energy policies. Indicators are useful while analyzing a country's energy policy, strategies and goals to achieve sustainable development or to monitor the progress of past policies and trends. Moreover, energy indicators are useful tools for 'communicating data relating to energy and sustainable development issues to policy makers and to the public, and for promoting institutional dialogue' (Vera et al., 2005). To sum up, energy indicators are crucial to provide a way to structure and clarify a large number of disaggregated data to give better insight about the factors that affect energy, environment, economics and social well-being and to understand how these factors might be influenced and trends might be improved (Vera et al., 2005; Unander, 2005). Moreover, indicators allow us to define the impacts of behavioral and structural changes on energy use. Energy use is shaped by economic, technical, environmental and social factors such as economic growth, energy prices, new technologies and carbon dioxide emissions (Unander, 2005). Also indicators give information about the energy market and assessment of past policies and future policy actions.

The international institutions have been researching to construct a comprehensive indicator framework for sustainable energy. To begin with Organization for Economic Co-operation and Development (OECD) has developed the following indicator sets: Core Environmental Indicators (CEI), Sectored Environmental Indicators (SEI), Environmental Accounting Indicators and Decoupling Environmental Indicators (DEI). International Energy Agency (IEA) developed an indicator set to focus on energy use and efficiency. United Nations (UN) developed indicators that cover the economic, social, environmental and institutional aspects of energy under the name of Indicators of Sustainable Development Program. International Atomic Energy Agency (IAEA) constructed Energy Indicators for Sustainable Development (EISD) and lastly The Asia Pacific Energy Research Center (APERC) created an indicator set to measure energy efficiency.

HELIO international has developed 'Sustainable Energy Watch (SEW)' which is a set of indicators to calculate and interpret the progress or no progress about energy sustainability. The indicators have four aspects: environmental aspect (carbon dioxide emissions per capita and ambient energy related emissions), social aspect (guaranteed access to electricity and investments in clean energy), economic aspect (energy resilience and burden of public energy investments) and technological aspect (energy intensity and renewable energy deployment). In this indicator set, there is a formula based on comparing the value of a country by an average value of all countries or world. The interpretation depends on whether the result is above or below the expected value (HELIO International, 2011).

International Energy Agency (IEA) has developed the Energy Development Index (EDI) to understand the role of energy in human development. There are three indicators that are calculated: share of biomass in residential energy demand (%); electrification rate (%) and per capita electricity generation (kWh). To construct EDI, 'a separate index was created for each indicator, using the actual maximum and minimum values for the countries covered. Performance is expressed as a value between 0 and 1, using the following the formula:

$$Dimension\ index = \frac{actual\ value - minimum\ value}{maximum\ value - minimum\ value}$$

After that the index is calculated as the arithmetic average of the three values (indicators) for each country (IEA, 2011). The main purpose is to increase consciousness in international community about energy-poverty issues and to guide countries to monitor their progress towards energy access.

Apart from the studies done by institutions, there are some other studies done by researchers to evaluate sustainable energy. For example, Howarth et al. (1993) calculated intensity of final energy demand for countries and concluded that changes in the economy may lead to changes in energy intensity ratio but this ratio may be unrelated with changes in technical efficiency. In addition, energy indicators for linking energy use and emissions were developed by Schipper and Haas in 1997. In order to compare differences between countries, under IEA institution the decomposition method 'mine-yours' was developed by Schipper, Unander and Lilliu in 1999. The study was done to emphasize how indicators may link energy with human and economic activity (Schipper et. al., 2000). Lastly, Unander et.al., (2004) used a decomposition approach called 'mine-yours' adapted from IEA for calculating residential energy use in Scandinavian countries. The residential energy intensities are compared for Norway, Sweden and Denmark (Unander et. al., 2004).

Energy Indicators for Sustainable Development (EISD), which is used as the tool of analysis in this study has evolved through time. To begin with, United Nations Commission on Sustainable Development (CSD) and Chapter 40 of Agenda 21 brought about the issue to develop an overall set of sustainable development indicators (ISD) which was achieved by the United Nations Department of Economic and Social Affairs (UNDESA) in 1995. Among those indicators only three of them were energy related. Therefore, another attempt came from the International Atomic Energy Agency (IAEA). It initiated a long term program to develop energy related indicators and cooperated with other institutions. Indicators for Sustainable Energy Development (ISED) flourished by this way. After three years of study and cooperation of International Atomic Energy Agency (IAEA), the United Nations Department of Economic and Social Affairs (UNDESA), the International Energy Agency (IEA), Eurostat and the European Environment Agency (EEA), Indicators for Sustainable Energy Development (ISED) was completed. This program had two phases: first phase (1999-2001) and second phase which started in 2002. During the first phase, Indicators for Sustainable Energy Development (ISED) was developed and applied to 15 countries[6]. The aim is to assess the applicability of the indicator set and to evaluate national energy systems for each country. The results were presented in CSD-9 in April 2001 and second phase

[6] The case studies of countries are discussed in detail in section 2.8.

started in 2002. During the second phase, based on data availability and results of these countries, the indicator set was refined by reducing the number of indicators from 41 to 30. In other words, ISED is the initial form of EISD published in 2005. The mentioned studies were done according to ISED framework. EISD can be defined as the modified and improved version of ISED. A number of indicators were redefined and merged and institutional dimension was dropped leaving social, economic and environmental dimensions. Nevertheless, ISED is consistent with EISD and EISD is improved according to the results and recommendation of these country case studies. The name Indicators for sustainable development (ISED) is modified to Energy indicators for sustainable development (EISD) to emphasize not only renewable energy but also the broader spectrum of energy choices (Vera et. al., 2005). The final set EISD is composed of three sub-sections: social (4 indicators), economic (16 indicators) and environmental (10 indicators) dimension with themes and sub themes.

All these attempts were done to construct an indicator set that would guide countries in terms of sustainable energy and sustainable development policies and monitor the efficiency of implementations and policies. The goals of using EISD are to integrate energy projections by a statistical analysis of past and future trends and to monitor whether the energy system is improving or not. The mentioned energy indicators (EISD) are consistent with international commitments and global policy initiatives, such as the United Nations Conference on Environment and Development or Earth Summit (Rio de Janeiro, 1992); the Millennium Declaration and the Millennium Development Goals adopted by the United Nations (New York, 2000); the OECD Environmental Strategy for the First Decade of the 21st Century, adopted by the OECD Environment Ministers (Paris, 2001); and the World Summit on Sustainable Development, its political declaration and particularly the Plan of Implementation (Johannesburg, 2002) (Ross, et. al. 2005).

We prefer to use EISD framework in this study. The main difference between EISD and other relevant studies is that apart from other indicator sets, EISD is an indicator set that aggregates all dimensions of sustainable energy at a time. EISD both includes social, economic and environmental dimensions and relate each indicator to another in a consistent and comprehensive way. EISD not only evaluates each indicator individually but also guides us to see the overall situation of a country.

We apply EISD to Turkey and selected European Union (EU) countries to compare and contrast the results regarding sustainable energy policies of Turkey and EU. Relevant indicators are selected according to energy policy and its priorities, the structure of the economy and sustainable development and sustainable energy targets of Turkey and other selected countries.

2.8. Case Studies of Sustainable Energy Concept

As previously mentioned although there is a standard framework for sustainable energy indicators, the selection and interpretation of these indicators differ from country to country. After identifying the conceptual framework and classifying indicators, ISED are tested for seven countries. In this section we briefly discuss the implementation of ISED to Brazil, Cuba, Lithuania, Mexico, Russia, Slovakia and Thailand. These are the first applications of the indicators. It is aimed to achieve an indicator set that is both comprehensive, flexible and to be used for the long term. For each country case, the selection of indicators are based on that country's economic situation, energy policies and strategies and data availability. We summarize the energy priorities, selected indicators and interpretation for each country. These case studies might be helpful to compare the results of other countries with Turkey since EISD has not been tested for Turkey yet. Therefore, our study is pioneering the evaluation of energy indicators for sustainable development in Turkey.

The fuel mix of Brazil is dominated by non-carbon energy sources such as hydroelectricity, ethanol, wind power, sugarcane and combined heat and power plants (CHP). Brazil claimed policy options as 'diversifying the energy mix, while achieving sustainable development and promoting energy efficiency, whilst reducing regional energy use disparities and improving energy affordability' (Schaffer et. al. 2005). The policy recommendations are to use ethanol automotive fuel and sugarcane bagasse cogeneration, non combustible new renewable energy sources for power generation; to expand utility investments in end use energy efficiency; to save fossil fuel; to improve the efficiency of passenger transport; and to adopt industrial energy intensity reduction targets and protocols (IAEA, 2005).

Cuba aims to reduce energy import dependency, increase the share of renewables and improve energy efficiency (IAEA, 2005). Some of the recommended policies are to determine the potential for wind and nuclear power; to expand usage of LPG; to increase electricity cogeneration; and to enhance energy efficiency (Perez et. al., 2005).

In the analysis for Lithuania, the ageing nuclear power plant and limited indigenous energy sources are remarkable (IAEA, 2005). Recommended policies are to reduce energy intensity; to increase end use efficiency; to increase security of supply; to balance affordability with efficiency; and to develop GHG mitigation policies (Streimikiene, 2005).

Demographic and economic growth, energy security, increasing energy efficiency and the share of renewable energy and protection of the environment are emphasized as energy policy priorities for Mexico (IAEA, 2005). According to Ross et al. (2005), there have been improvements in energy intensity and atmospheric emissions; and the import dependency has been increasing for gasoline, natural gas and secondary energy sources.

Mexico on the other hand, has increased the amount of export of crude oil and the increase in renewable energy use is not significant enough. Also, the study revealed that better data and statistical support are required for Mexico (Ross et. al., 2005).

Russian Federation's energy priorities are 'securing a stable and uninterrupted energy supply; reducing energy intensity and improving energy efficiency; developing the domestic energy resource base; reducing negative environmental impacts; and ensuring affordable energy for the poorer segments of the population' (Aslanyan et. al. 2005). As an important result of the study attention should be devoted to environmental impacts and the needs of the poor are important results of the study. In addition, measures about transport sector and energy efficiency should be taken into account (IAEA, 2005).

Slovakia is analyzed before joining the European Union and after becoming a EU country. The policies suggest Slovakia to improve energy pricing policies, to reduce energy intensity and to maintain the energy security (IAEA, 2005).

Lastly, Thailand focused on energy affordability, accessibility, efficiency and environmental protection. Energy intensity indicators showed continuously increasing trend for energy consumption compared to the level of economic activity (Todoc et al. 2005). Apart from that there has been a significant progress in extending the electricity grid and encouraging efficient cooking stoves (IAEA, 2005).

As it can be seen from the case studies above, each country used the same framework but calculated different set of indicators and came up with different results that are consistent with each country's specific conditions. Similarly, Turkey is studied in terms of her economic, social and environmental conditions and selected indicators are analyzed accordingly in Chapter Five. Our literature review revealed that there is not any study that used EISD framework for Turkey and compared her with European Union countries regarding sustainable energy policies. We expect our study to contribute to evaluation of Turkey in terms of her energy policies, sustainable energy goals and outcomes of current and past energy policies by comparing her with European Union countries. Moreover, EISD was applied to countries individually and those countries were not compared to each other. In our study, we try to compare countries to each other by using the same indicator set and taking into account energy policies and energy priorities of each country. For this purpose the next chapter investigates the energy policy priorities both for Turkey and European Union countries.

CHAPTER 3

ENERGY POLICIES OF TURKEY AND EUROPEAN UNION

3.1. Overview of Turkish Energy Policy

This chapter aims to present a brief summary of Turkish energy policy mainly by considering the development plans since the beginning of 1960s. We look into the main objectives of energy policy, energy sources, privatization, energy security, EU accession process and international participants and evolution of sustainable development concept in Turkey.

The function of development plans has changed since 1980s. There has been a transition from detailed plans that formulate each sector and each step one by one to strategic plans that redefine the role of state and let the market to operate more liberally. Also approaches towards energy supply and environment have been obviously changing in development plans throughout the years. As Turkey is taking a larger part in international platforms and becoming members of international bodies, the responsibilities and the need of fulfilling the requirements lead to a change in economy and energy policies. Therefore, both the structure, function and the content of plans have changed in a way being consistent with a more liberal approach and the role of the state has been reduced through time.

Here, we discuss the objective and general structure of all development plans and we assess how priorities and aspects of development plans in relation to energy issues have changed through time. The main objective of all five year development plans covering the period from 1963 to 2013 is to supply energy in a reliable and continuous manner with high quality and minimum cost according to the needs of economic growth and social welfare of the country. The utilization of energy in an effective and efficient manner via setting the energy prices according to the availability of resources, reducing the loss of energy and supplying energy to everyone on time are major concerns of all development plans. Although the aim of all plans seems to be more or less the same there is a little nuance difference between the first three development plans and the rest. For instance the first three plans aimed to reduce unemployment, accelerate economic growth and meet energy demand regardless of sustainable development approach or environmental concerns. To supply energy at a minimum cost and continuously are aimed to increase the economic growth and achieve development goals as soon as possible. Especially in the third plan the priority was explicitly given to industrialization and it was declared that Turkey would not accept any restrictive measures taken due to environmental concerns during its industrialization process. On the other hand, after the fourth development plan, the environmental consciousness and international commitments were taking place in the plans. In the sixth development plan, the objectives were based on the protection of environment and preserving resources. Considering environmental problems, these objectives remained the same although the reasons behind them were changing. In order to achieve the goals in the first three plans, the most efficient and effective way of supplying energy would be applied and indirectly environmental problems would be minimized by this way. Here the minimization of environmental problems is not the main concern rather they are indirect positive results of any action done for industrialization. On the contrary, the last three (7-9) plans stressed that achieving economic growth and caring for the environment are of equal importance. We can clearly observe this tendency especially in the last two development plans that stated as "energy consumption and consequently energy supply at minimum amount and cost shall be the main objective, within the approach of a sustainable development that shall support economic and social development and shall have destructive effect on the environment at the minimum level" (SPO, 2001). We can infer that there is a slight trade-off between the priority choices of the plans.

Namely, plans up to 1990s focused primarily on economic growth and accepted environmental concerns that were consistent with industrialization process while plans after 1990s aimed to achieve economic growth and to protect the environment simultaneously.

There are certain types of energy sources that take place dominantly in all development plans. Thus, next part is a summary of these sources and their importance in Turkish energy policy. We categorize them as commercial and non-commercial, nuclear and hydropower.

3.1.1. Commercial and non-commercial energy sources

The consumption of commercial and non-commercial energy sources is an important issue for a developing country like Turkey. According to the third development plan; coal, hard coal, petroleum products and hydropower are classified as commercial energy sources whereas wood and dung are non-commercial. All these energy types plus geothermal, nuclear and natural gas count as primary energy sources whereas electricity and coke gas are secondary energy resources. Non-commercial sources i.e. wood, crop residues and dung were extensively used in the 1960s. The first plan pointed out that the use of non-commercial sources led to social and economic problems. Effective measures should be taken to prevent misuse of these items and government should provide clean and cheap fuels. In the first plan period 54% of energy was supplied from non-commercial fuels and this harmed the economy in terms of optimum allocation of resources. In other words wood, crop residues and dung should not be used as energy sources but allocated for different purposes. The plan aimed to reduce the use of dung and crop residues and preferred to use primary commercial sources instead.

In the second plan period we observed that the share of commercial fuels in total energy consumption increased without decreasing the absolute amount of non-commercial sources. Again reducing the amount of non-commercial fuels and increasing the commercial fuels were one of the main objectives of energy policy but it failed in the first four plans. The substitution of non-commercial fuels by commercial fuels could not be achieved sufficiently. It was planned that 85.4% of total energy production to be supplied from commercial fuels in the fourth plan period whereas this ratio was proposed to be between 77.8% and 85% for the fifth plan period and it was 90% for the sixth plan period. Therefore, the policy proposal was the reduction of non-commercial energy resources extensively. This objective was realized in the last two plans meaning that non-commercial energy consumption has been reduced extensively. According to the eighth plan, 'while the share of hydro energy and natural gas within primary energy consumption displayed an increase, the shares of petroleum products and non-commercial energy displayed a downward trend.' By the year 1999, the share of commercial resources within overall primary energy consumption exceeded 90%. Last development plans pointed out the fact that inevitable increase of in population; urbanization, industrialization and economic growth have led energy demand to increase. Therefore, it is essential to provide energy in a rational, economical and environmentally friendly manner. In other words supply of energy is a high cost issue in terms of high cost investments, long term constructions, efficient processing and finite resource utilizations. In terms of the energy policy we can conclude that the main objective that is to substitute commercial energy for non-commercial energy, has been achieved throughout the plan period.

3.1.2. Nuclear Energy

The first attempt about to make use of nuclear energy resources was initiated by the second development plan. According to this plan to overcome the bottleneck of energy demand, the potential of nuclear energy resources and the feasibility of constructing a nuclear power plant would be investigated. Similarly third development plan pointed out the wide use of nuclear energy in other countries and planned to benefit from nuclear energy as primary energy source[7] in the near future. In the third plan as a policy target, it was aimed to embark the nuclear energy technology as soon as possible and to supply electricity from nuclear energy in case of inadequate production from petroleum and hydropower generation (SPO, 1973). There has been an ongoing intention of building nuclear power plants since the 4th development plan period. Almost all development plans stress the need for nuclear energy without considering its negative effects on the environment. Nuclear energy is considered to be a part of creating a better diversification of sources of electricity supply for the country, yet it needs specific attention about storage, waste management and informing the public to minimize the negative effects on the environment. The last development plan considers these issues as a part of future energy policy of Turkey.

Recently, nuclear energy is seen as an alternative energy source to respond to the increased electricity demand and to help reducing energy import dependency by the government. Therefore, 'The Law on Construction and Operation of Nuclear Power Plants and Energy Sale' (no. 5710) has been enacted on 21 November 2007. Turkey aims to supply 5-6% of her total electricity generation from nuclear energy (Republic of Turkish Ministry of Foreign Affairs, 2009). But, nuclear energy is a complex issue regarding its hazardous effects on the environment and human beings. Therefore, it should be carefully analyzed whether nuclear energy policy is convenient for Turkey or not.

3.1.3. Hydro Power Energy

Hydropower is a primary energy source. As a renewable energy it is one of the key elements of sustainable development. Since the beginning it has been a preferred energy alternative in Turkish energy policy. In the first development plan, high potential of hydropower resources were stressed. To benefit from this potential some measures

[7] It is not clear whether nuclear energy is a primary energy or secondary since some nuclear fuels are not found in nature.

were taken so as to increase the efficiency and to reduce the waste of idle water resources. Although the prospect of giving the priority to water resources in case of meeting the energy demand of Turkey was taking place in the second plan, it is observed that in the following plan period the share of hydropower in the total production of energy decreased. In the third development plan it was planned to explore the potential of water resources and to construct hydropower plants to satisfy the future energy demand. Although during the third plan period it was proposed to enhance the hydropower investments in order to satisfy the increasing demand of energy, we can see from the fourth development plan that these targets could not be realized sufficiently. Keban hydroelectric power station was put into use in 1974 and the share of hydro energy displayed an increase but without satisfying the expectations. Almost all development plans aim to utilize the potential of water resources, ease the energy bottleneck and increase the investments in hydro energy but the proposed targets could not be accomplished fully.

In the sixth plan, not only the importance of hydro energy potential was stressed but also the possible negative environmental effects were discussed. It proposed to investigate any negative social, environmental or economic effects due to hydropower generation. In terms of neoliberal economic policies, the latest development plans revealed the fact that the governments were ready to support and encourage private sector to invest more in hydro energy in order to satisfy the energy demand in Turkey. Especially after the sixth plan period, governments want private sector to dominate the energy market. Yet, there has not been an increasing trend in the share of hydropower in terms of total energy supply.

3.2. Determinants of Turkish Energy Policy Priorities

After analyzing the general overview and essential energy sources of Turkish energy policy, in this part, we discuss four main issues: privatization, energy security and dema demand, European Union accession process and sustainable development concept. Discussing these issues guides us to determine the energy priorities of Turkey.

3.2.1. Privatization

The increasing oil prices and thus energy costs in the world market, fast industrialization and urbanization leading to increasing energy demand for both consumers and producers, and the introduction of neoliberal economic policies all together resulted in an excessive burden on the state and privatization appeared as an alternative.

Starting with the 4th plan (1979-83) privatization was on the agenda of the development plans. Since 1984, arrangements about electricity generation were done in favor of the private sector. Before that there was not any significant attempt that encouraged the privatization of energy sector. Before 1980, the first four development plans revealed the fact that energy investments that required high amounts of capital and profits in the long term, were realized dominantly by state. Thus, the share of private sector remained limited during 1960-1980 (Yılmaz and Uslu, 2007). After 1980, due to liberal policies the share of state was cut down. State controlled economy was replaced with liberal economy where the role of state has declined. Nevertheless, the privatization attempts between 1985-1998 were not successful enough in terms of the transfer of public enterprises to the private sector. Privatization was accelerated when Justice and Development Party (AKP) came to power. The large-scale state-owned enterprises[8] were privatized in 2000s (Angın, 2010). The government introduced legal arrangements that were consistent with liberal economy aspect, and encouraged private sector to contribute more to energy sector. Many instruments such as ‘transfer of operation rights’, ‘sale of property’, ‘build-operate’ and ‘build-operate-transfer’ have been

[8] The large-scale enterprises are TÜPRAŞ, PETKÌM, ERDEMÌR, Petrol Ofisi and Türk Telekom.

introduced for participation of private enterprises in energy sector (Yılmaz and Uslu, 2007).

In the fifth development plan, utilization of private sector and foreign capital instead of public capital for the search of energy resources and energy production was encouraged explicitly. The sixth development plan proposed a new structure that enabled private sector and public sector to work together in energy projects. Moreover, the privatization of electricity sub-sector should be continued and private sector should be encouraged to take part in energy sector extensively in order to reduce the burden of the public sector.

The fifth and eighth development plans claim the importance of directing domestic and foreign private investments towards electricity sector since it would be beyond the scope of public financing opportunities to implement both production, transmission and distribution of electricity. On the other hand, seventh development plan stated the problems about this policy. First of all, there was still uncertainty about how perfect competition and a liberal energy market would be set up while government was still determining the energy price and guaranteeing the purchases. Second, it was not clear that who would be responsible for the project and how to implement it in case of a new investment. There were still public sector activities in some areas, which were actually assigned to private sector such as thermal power plants (SPO, 1985; SPO, 2001).

The seventh plan is important, because for the first time in 1999, privatization concept was incorporated into the Constitution. Moreover, in this plan period liberalization of the public capital and encouragement of private sector participation in the energy sector were discussed. Management right transfer, build-operate and build-operate-transfer methods were continued to be used. However, the expected participation of private sector could not be observed since the private investments in energy sector were still at unsatisfactory levels.

There were also some attempts like structural arrangements and introduction of regulatory boards that would be provided to set up a competitive market and to protect the rights and interests of consumers (SPO, 2001).

As previously mentioned, all development plans aim to supply energy in a continuous, secure manner and at minimum costs. By the changing role of governments after 1980s, globalization and regionalization trends and growing economy led the privatization to become a crucial issue. Especially the last three development plans strongly emphasized the importance and necessity of privatization. Structures of electricity and natural gas sub-sectors were modified accordingly in order to let private sector to take larger part in. Legal and institutional arrangements were done according to production, transportation and consumption technologies that would be productive, economical and environmentally friendly (SPO, 2001).

As proposed in the seventh development plan a structural institution that would regulate the market, the Energy Market Regulatory Authority (EMRA) was established in the eighth plan period. Transforming the publicly dominated energy sector into a competitive market, withdrawal of government from the market eventually and ensuring supply security were main drivers of privatization process. It is claimed that EMRA would regulate, direct, monitor and supervise activities in a transparent, equitable and stable way (SPO, 2007). EMRA is located as a control mechanism aimed to determine energy prices, distribution and investment polices by considering fundamental Turkish energy policy priorities. Turkey has experienced a transition process from a state-owned economy to a liberal one since 1980s. Regarding the need of integration with the world economy, Turkey adjusts its economic policies in a more liberal sense. The main priorities of the privatization policies are as follows:

- Elimination of state`s active role in energy sector,
- Privatization of facilities that are under state`s responsibility and reducing the

financial burden of state,

- Ensuring supply security via related institutions that would monitor, regulate and direct the market accordingly,

- Constructing a competitive market that protects both producers' and consumers' rights,
- Maximizing the share of domestic and renewable energy investments with the lowest costs and in the fastest manner,
- Constructing required institutional structures that will operate in energy market (SPO, 2007).

In order to integrate private sector in R&D activities, Turkish parliament approved a law that benefits the private sector with tax break[9] and social security payments. Moreover, Ministry of Energy and Natural Resources encourages private-public partnerships on energy R&D in priority areas of energy policy and support independent research companies about their R&D expenses. All these efforts are done to increase the R&D in energy. Another attempt is the privatization of electricity market to ensure an efficient and cost effective supply of electricity. Current energy policy aims to integrate private sector into electricity market with a limited market share of 20% by privatizing a remarkable share of state-owned assets. The only state-owned company will be TETAȘ with a 43% market share in electricity market and other private companies will have control over generation and distribution of electricity (IEA, 2009).

To sum up, currently, privatization trend is also on the agenda of the energy sector. Neoliberal policies support the withdrawal of state from energy sector by only leaving the regulative responsibility to it. Turkish Parliament ratified many amendments to privatize state enterprises. These regulations aimed to 'give permission to settle arguments by national or international arbitration, including international arbitration to

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[9] Tax break can be implemented by tax exemptions, tax reductions or tax credit.

be used for arguments including a foreign entity', and these aimed to limit Danıştay to participate in contracting. Lately, important amounts of privatization have taken place in Turkish energy sector. For instance, Turkish Electricity Generation and Transmission Corporation (TEAŞ) was split into four state owned companies. The privatization of electricity sector is also on the agenda (Kılıç and Kaya, 2007). Electricity Distribution Company (TEDAŞ) has been privatized since 2009. Electricity Generation Company (EUAŞ) and Başkent Natural Gas Distribution Company have also been privatized since May 2010 (Prime Ministry Privatization Administration, 2010).

3.2.2 Energy Security and Energy Demand

Economic growth of Turkey throughout the years has brought about an increasing demand and consumption of energy. It is clearly observed in every plan period that both consumption and production of energy have been increasing. In the fourth plan period due to lack of adequate energy supply, the demand for energy was suppressed and the balance between demand and supply could not be attained. Particularly crude oil imports increased in this period because of inadequate and inefficient oil production. Increasing domestic demand for oil, inefficient domestic production and increasing oil prices in 1970s had a negative effect on Turkish economy through balance of payments. Crude oil has been imported since 1963 due to inadequate supply. Energy policy gave the priority to utilize the domestic energy resources rather than importing energy but the discrepancy between the supply and demand led to energy import. The proposed investments and planned production targets could not be realized on time for the first four plan periods. Only half of the energy demand could be supplied by domestic energy resources in the second half of 1970s.

Although supplying energy from domestic resources and solving the energy bottleneck were the main objectives of energy policy of fourth plan period, electricity, coke gas, oil and coal were imported at that period. Importing primary and secondary energy sources in an economic way became a policy tool in the following plan periods due to inadequate domestic supply and energy investments. Although the priority was given to utilize the domestic resources, increasing manufacturing industry production needs and urbanization in Turkey accelerated the energy demand that could not be satisfied by domestic market supply because of low quality and inadequate reserves. We can observe that the share of imported resources is significant and this trend will continue for the medium and long run.

3.2.3. European Union Accession Process and International Agreements

As mentioned previously until the fourth development plan, Turkey prefers not to have any commitment about any sanctions or membership requirements related to environmental issues that may obstruct her economic growth (SPO, 1973). Although the relations between Turkey and European Union started in 1963 by the Ankara Agreement, the influence of European Union on Turkish energy policy could be observed by the year 1990 with the sixth plan stating that necessary adjustments should be made at sectorial level according to European Economic Community[10] (EEC) requirements. Considering the European Economic Community policies and targets, it was aimed to diversify energy sources and maintain a reliable energy supply for Turkish economy. There is an ongoing harmonization process of waste management, protection of nature, noise control and environmental impact assessment with EU. Nevertheless, there is still more to achieve about legislative frameworks and infrastructure for environmental concerns. The last development plan claims that there is still need for improving the infrastructure for environmental monitoring, auditing and reporting for increasing the efficiency and ensuring that the information flow and exchange among relevant institutions are carried out through an integrated system (SPO, 2007).

Turkey's participation in international and regional summits led to a change in environmental and energy policies adopted. As mentioned in the seventh development plan, participation of Turkey to United Nations Development Program (UNDP)

[10] EEC is the initial form of EU.

conference held in 1992 in Rio was marked as an important step towards the goal of sustainable development. Agenda 21 can be considered as an important development since it has binding regulations for all participating countries. Likewise, in 1995, The World Summit for Social Development held by United Nations Economic and Social Council pioneered a large participation among countries and envisaged to eradicate poverty, create full employment and encourage social integration. In relation to the concept of sustainable development, Turkey has become a party to UN Biological Diversity Convention in 1996 and also to UN Convention to Combat Desertification in Countries Experiencing Serious Drought and/or Desertification in 1998. In 2004, Turkey became a party to United Nations Framework Convention on Climate Change. This participation requires preparing a National Action Plan that sets policy and measures to reduce greenhouse gas emissions. Eventually, Turkey ratified the Kyoto Protocol in February 2009 and it went into effect in August 2009.

All these efforts that harmonize the energy and environmental policies of Turkey with EU norms and other international regulations result in changing priorities of Turkish policy. It is clearly stated in the seventh plan that any regulations or legislations that prevent the integration of environment and development shall be modified in favor of environmental concerns and sustainable development goals. Likewise in the last development plan it is stated that 'fulfillment of international obligations will be realized in the framework of the principle of sustainable development and the principle of common but differentiated responsibility' (SPO, 2007). Thus, Turkish energy policy has to find an optimal way to maintain its development goals and targets regarding the obligations of international institutions.

3.2.4. Sustainable Development and Sustainable Energy for Turkey

Until fourth plan period, there was no significant attempt to rationalize the use of natural resources and to care about environmental issues. The priority was totally given to economic growth. Although it was proposed to encourage environmental institutions, this was not realized until the fifth plan. Coordination between the related institutions and formulation of energy policies regarding environmental concerns were initiated by the fifth plan period. Moreover, there is an explicit acceptance of Brundtland Report approach in the fifth plan (SPO, 1985). It is observed that in the last four plans, environmental concerns became equally important as economic growth and cautions about possible environmental damages resulting from energy production were discussed. In the sixth plan, continuity of implementing environmental policies for the integration to European Community was declared. In addition, as energy production and consumption have negative impacts on the environment, necessary measures should be taken to protect the nature. To do so, National Environmental Action Plan (NEAP) was prepared to integrate environmental and development policies in the eight plan period. In the ninth plan, it is clearly stated that 'the environmental infrastructure will be completed in a well planned time horizon and cost effectiveness will be guaranteed as a requirement of the harmonization process with the international standards, including mainly those set by EU' (SPO, 2007). In other words, Turkish energy and environmental policies were aimed to be constructed parallel to sustainable development concept.

The term sustainable development was discussed for the first time in the sixth development plan but it was not until the seventh plan that real attempts and efforts were put into action. In the seventh development plan, realization of sustainable environment was discussed. For instance environmental impact assessment was introduced in that plan period. Nevertheless, it is hard to claim that these efforts are realized and put into action effectively. Although Ministry of Environment and related local administrations try to integrate economic and social policies with environmental policies through data and information access systems, environmental monitoring and measuring infrastructure, environmental inventories, statistics and standards, it has not been achieved yet (SPO, 2001).

There has been a considerable attitude change in Turkish energy policy about environmental issues and sustainability when we consider the recent development plans. Encouraging sustainable use of natural resources, protecting biodiversity, controlling and reducing the greenhouse gas emissions originating from energy and other sectors, protecting natural resources, cultural assets and environment for future generations, using energy in the most efficient and economical manner are some of the issues that have been discussed. As previously mentioned, although regulations have been introduced, some attempts have been realized or government publications declare optimistic results, there has still been a long way to reach sustainability goals. Another important issue is the lag factor in realization of policies. Although a structural change has taken part since 1980s, the impacts and results of relevant policies are observed after some time. For instance, we can see the implementations of neoliberal policy more concretely in the last three development plans.

In conclusion, considering dominant energy sources, privatization process, energy security and demand, European Union accession and sustainable development concept, priorities of Turkish energy policy can be summarized as having reliable, cost effective, secure and environmentally friendly energy sources. The development plans evolved through time in terms of objectives and policy implementations. Until 1990s, the main objectives were to achieve economic growth regardless of environmental concerns but after 1990s, environmental protection took its place besides economic growth and social welfare. As Turkey is growing, the fuel mix of energy is also changing. For instance, commercial energy sources such as coal, lignite, hard coal, petroleum products, natural gas and hydropower are preferred to non-commercial sources such as wood and dung. Turkey achieved to transform its fuel mix to a more commercial fuel based mix. Although development plans mentioned to add nuclear energy to the energy mix, it has not been realized until now. A special attention should be given to renewable energy, as Turkey has a great potential. Nevertheless, we can infer from development plans and indicators that Turkey has not achieved the required level of renewable energy share in total energy yet. While market structure and role of government are changing in today's world, the state-owned enterprises leave their place to private businesses. In Turkey, privatization process has taken part in all of the energy market such as privatization of electricity, distribution of natural gas, petroleum and coal mines. Rapid economic growth of Turkey brings about the increasing demand for energy. The discrepancy between energy consumption and production has continuously increased and energy import has always been inevitable especially after 1990s. Lastly, as our main concerns are sustainable development and sustainable energy issues, they become visible in the last four development plans. These plans pointed out that environmental concerns became equally important as economic growth. Required cautions should be taken about environmental damages that are resulting from energy production and consumption. Nevertheless, it is stated that economic growth and environmental concerns are equally important, in Turkey; but economic growth has always been in the first place without any doubt. Thus, there is still a long way to reach sustainability goals in Turkey.

3.3. Overview of European Union's Energy Policy

In this part, we discuss the European Union (EU) energy policy. We begin with why EU needs a common energy policy and how EU energy policy emerge and what are the main issues that should be discussed during this process. Similar to previous section about Turkish energy policy, we examine some dominant energy sources for European Union such as renewable and nuclear energy. After that, sustainable development and sustainable energy for EU are discussed. Section 3.5 is a brief summary of relationship between EU and Turkey.

There are three main reasons that brought the common energy policy for EU to the agenda. First, especially after 1970s oil shocks and security of energy supply became important concerns for EU. Second, there has been a rapid increase in energy prices due to economic growth and high energy demand; and insufficient supply levels by

European producers. Thirdly, global warming that threatens the whole world obliges the countries to take precautions about it. Environmental concerns became more and more important in terms of sustainable development. All of these factors have led EU to behave in accordance with the following objectives; to set up a single energy market through liberalization; to maintain security of energy supply and to reduce carbon emissions; and achieve sustainable development goals that were mentioned in '20 20 by 2020' plan (IEA, 2008a). EU's long term energy policy includes increasing energy efficiency, developing new sources for energy imports and new routes[11] for transportation of crude oil and natural gas, increasing stocks of crude oil and natural gas and developing climate-environment friendly energy sources for generating electricity and heat (IEA, 2008a).

Even though, there have been many attempts to construct a common energy market such as European coal and steel community (expired in 2002) and the Euratom Treaty (in 1957), it is hard to say that EU has a common energy policy yet. If a common energy policy is attained successfully, it may be beneficial for enabling an external energy policy, an internal energy market and common stance to environmental problems (Leonard, 2010).

The main reasons for an integrated energy policy are competitiveness that is to achieve a competitive energy market; security that is to ensure security of energy supply throughout Europe; and sustainability that consists of environmental concerns, and climate change. In other words the objectives of EU common energy policy are to set up a functioning market, to maintain secure energy supply and to encourage renewable energy sources (RES) regarding energy efficiency (Martinez et al., 2009). Although, there are ongoing attempts to achieve a common energy policy it is not an easy task. Pointvogl (2009) claimed that there are two main points that affect the evolution of EU common energy policy: perception of energy supply security of each country and

[11] Turkey is likely to be one of them.

strength of national energy business in relevant country. Therefore it is crucial to set up an optimal preferences mix and also consider the three challenges that EU faces, namely environmental sustainability, resource distribution and growing scarcity and maintaining competitiveness.

Before discussing the topics of a common energy policy, we should discuss the construction of EU bodies and their responsibility areas. EU has three main bodies: namely, European Commission, European Council and European Parliament. The European Commission (EC) has the right of starting legislation process, implementation, arbitration and monitoring functions about energy policy. Member states contribute to the decision making process through the Council of Ministers for Energy, the Council of Ministers for the Environment and the Council of Ministers for Finance. Apart from EC, European Parliament has its committees dealing with energy issues such as Committee on Industry, External Trade, Research and Energy, and Committee on Environment, Public Health and Consumer Policy. Although the regulations are binding for all member states, they have the opportunity to choose the form and methods according to their own country dynamics (Encyclopedia of Energy, n.d).

In the following part we are going to examine some of the important elements of EU's energy policy such as: constructing a single market, state aids, environmental concerns, maintaining the security of energy supply, nuclear energy and renewable energy.

3.4. Determinants of European Union's Energy Policy

3.4.1. Single Market

Liberalization of electricity and gas markets in 1997 required all member states to open their markets to full competition. Yet these markets remained national and liberalization efforts remained ineffective and therefore new revised directives were introduced in

2003. Countries were asked to modify their national legislation and open their markets to full competition in 2007 (Encyclopedia of Energy, n.d). European Commission wanted to construct a true single, fully competitive and transparent internal energy market through liberalization package (IEA, 2008).

3.4.2. State Aid

State aid is forbidden for all members to prevent market distortions and form a competitive market. It was observed that coal and steel sectors received the largest part of the state aids in Europe. It was expected that coal and steel become normal industrial products by 2002 due to abolishment of state aids. Only renewable energy production can get state aid with the regulation of Community guidelines and state aid can also be used for environmental protection. There is an ongoing process about state aid and it is still a non-clarified issue in EU.

3.4.3. Nuclear energy

Nuclear energy constitutes roughly 20% of total energy production among EU 15. Nevertheless, common regulations and arrangements for the improvement of nuclear energy have not been achieved yet. Especially regarding safety issues, there are lack of coordinated regulations and binding safety standards. Moreover, Western European Nuclear Regulators Association established in 1999 (WENRA) cannot achieve the objective of developing a common approach towards reactor safety and regulation procedures. Therefore, IEA report suggested EU to provide a 'Road Map' to member states (IEA, 2008b).

3.4.4. Renewable energy

There are three major reasons why renewable energy is so crucial for European Union (EU). The first reason is to reduce emissions as a local environmental effect and to reduce greenhouse gas emissions as a global environmental effect. The second reason is the security of energy supply. Increasing foreign resource dependency because of increasing energy demand of European countries motivated to foster the growth of domestic renewable energy sources (RESs). Replacing nuclear power plants with RESs is the third reason regarding the safety of nuclear power generation.

Moreover, there are other reasons, like creating new job opportunities, creation of a new sector and positive effects on regional economies that also contribute to RES's motivation (EC, 2001).

EU Parliament and EU Commission have long term energy scenarios that include RESs dominantly. For the mid and long term period, it is expected that EU will construct a uniform energy strategy in the near future because of the above mentioned reasons. The Johannesburg World Summit for Sustainable Development held in 2002 also contributed to the support of development of RESs technologies. Although a uniform strategy is on the agenda, differences among countries like country specific potentials, population densities, geographical advantages, per capita energy consumptions, different energy policies and incentives, economic conditions, existence of domestic energy resources etc. make it difficult to put all countries into the same pot. For instance, while Sweden, Finland and Austria supply more than 20% of their primary energy needs from RESs; in Germany, the Netherlands and the United Kingdom contribution of RESs is less than 10% (EC, 2009). Although disadvantages of country-specific conditions affect the development of RESs, there are exceptions that violate this assumption. For instance, low population density is an advantage to foster RESs, yet Denmark, which is a densely populated country, has achieved to supply 9% of its primary energy and 14% of its electricity generation from RESs. Like in Denmark, although country specific conditions may limit the utilization of RESs, it is the energy policy and determination of the country that matters. Thus, well defined political goals and measures mainly stimulate the motivation for renewable energy (IEA, 2009a).

European Parliament, Commission and Council have all supported the promotion of RESs in various ways. ‘Common rules for the internal market in electricity’ was issued in 1992 by European Union to create a fair market in which all players face with the same conditions. Moreover, to motivate the new established RES power plants, ‘The European Community Guidelines on State Aid for Environmental Protection’ was issued in 2008. EU commission issued a White Paper (1997) called ‘Energy for the future: renewable sources of energy’ to increase the share of RESs in total energy production. To reduce EU’s current implication failures about climate change was the main purpose of White Paper. It defined the adaptation measures about climate change. It is aimed to build a knowledge base about implication and consequences of climate change, to integrate actions into EU key policy areas, to ensure the delivery of adaptations effectively and to set up international cooperations. It was aimed to reach 12% which is the share of RES in EU’s gross domestic energy consumption by 2010, yet only 10% could be realized by 2010 (Martines et.al, 2009).

‘Campaign to Take-off’ (2006) is another attempts to increase the consumption of biofuels. Actually, all these attempts aimed to create a basis for a common European support instrument for electricity from RESs and to promote the electricity generation from RESs in internal markets. But these targets cannot be reached with the present policies, instruments or measures (Encyclopedia of Energy, n.d.). Without abolishing current energy market barriers and energy price distortions, it is hard to establish RES widely (Martines et.al, 2009). European Union has a long way to go to achieve a uniform renewable energy policy and spread the RESs widely.

3.4.5. Security of Energy Supply

Security of energy supply includes ‘the management of supplier relations and of energy systems, enabling the investment in critical infrastructure, achieving diversification of supply and preparing adequately for potential supply disruptions’ (IEA, 2008). Thus a common and consistent policy should be developed. Increasing energy imports and thus dependency on foreign energy resources, the need for a large scale reinvestment in energy industry and increased environmental and climate protection requirements resulted in the presentation of Green Paper, 'Towards a European Strategy for the Security of Energy Supply' by EU Commission in 2000 (Encyclopedia of Energy, n.d.). The study revealed the fact that external energy dependency will reach 70% by 2030. Since EU has a limited capacity of satisfying its energy demand and this energy demand continues to increase, the external dependency is inevitably increasing as well. Moreover, Green Paper stated that EU member states are interdependent about climate change issues and process of creating the internal energy market. Any policy of a member state will eventually have repercussions on other member states' policies and implementations. Green Paper is important because it brought about the debate, action plans and relevant measures for the objectives of EU energy policy to the agenda (Öner, 2005).

3.4.6. Environmental Concerns and Kyoto Protocol

EU, apart from its own regulations about environment, has also ratified the Kyoto Protocol and promised to reduce GHG emissions. European Climate Change Program (ECCP) was established in 2001. Directives include 'promotion of electricity produced from renewable sources (2001), promotion of cogeneration (2003), energy performance of buildings (2003) and energy services (2004)'. Moreover, European Emissions Trading Scheme (EU-ETS) was established to attain cost effective CO_2 emissions reductions in energy and industrial sectors. EU-ETS is important for being the first cross-border system of its kind. Carbon Capture and Storage (CCS) is another technology to fight with climate challenges and a good sign of EU's commitment to environmental concerns (IEA, 2008).

According to Kyoto agreement (2003/87/EC), EU committed to reduce its total greenhouse gas emissions by 8% between 2008-2012 and also every member country has its own targets accordingly. Kyoto enabled a surplus trade, countries who achieved to lower the emissions more than expected, can sell their surplus to other countries that exceed the quota. Nevertheless, there are problems with Kyoto. First, transportation and household sources that have huge energy saving potential are not included in the protocol.

Secondly, in Kyoto there was not a fixed quantity of total allowances allocated to member states, this was determined by National Allocation Plan (NAP) and this plan can be changed by EC at any time (Martines et.al, 2009). Although, there are some problems related to Kyoto, it is still a functional protocol to protect the environment. Kyoto enables countries to introduce national policies to reduce emissions and to cooperate with other countries in terms of exchanging experience and information and coordination of national policies about emission permits (Europa, 2010).

3.4.7. Sustainable Development and Sustainable Energy for European Union

'Winning the Battle Against Climate Change (COM 2005/0035)' in 2005 and 'Limiting Global Climate Change to 2°Celsius: The Way Ahead for 2020 and Beyond (COM 2007/0002)' in 2007 are the two major attempts held by EU to discuss the impacts of climate change. Both for developed and developing countries, a set of actions was discussed to keep climate change to manageable levels. The EU is committed to limit the average global temperature rise to a maximum of 2°Celsius and is committed to combat climate change (IEA, 2008). Another important measure for reduction of CO_2 emissions is the EU Emissions Trading Scheme (EU-ETS) launched in 2005. According to EU-ETS, each country is responsible to prepare a National Action Plan (NAP) for each trading period that will be approved by the Commission. The aim is to reduce CO_2 emissions in a cost effective manner. Each NAP determined the total allocation and specified how the allocation is to be distributed (IEA, 2008). Every member state has to prepare a report about final emissions and emissions allowances at the end of the year. The consistency of these reports with Kyoto target is crucial for the Commission.

EU-ETS is one of the most beneficial tools for EU in terms of EU energy policies that aim to mitigate the GHG emissions. EU adjusted its energy policy considering the seriousness of the climate change in 2007 and proposed to reduce GHG emissions by 20% by 2020. Moreover in case of a global co-operation, EU proposed to increase this ratio to 30%. All these attempts such as EU-ETS are obvious signals about how EU cares for energy and climate policies. Commission's sustainable energy policy is an integrated climate change policy that covers energy production, transport and use. As mentioned previously, reducing GHG emissions, increasing the total share of renewable energy supply and increasing the energy efficiency are major targets that EU declared in '20 20 by 2020' plan.

3.5. The Energy Relation between European Union and Turkey

There has not been a common policy about energy security or import of energy in the EU. Nevertheless, security of energy preserves its importance as EU's external dependence on energy has an increasing trend. Current data suggest that 50% of oil and natural gas are imported and this ratio is expected to increase to 70% by 2030 (European Commission, 2009). These figures point out that EU has limited internal sources and is dependent especially on oil and natural gas. The energy security policy of EU is not to maximize self-sufficiency or reduce dependence; rather it aims to minimize the risks that are related to import of energy (Tekin and Walterova, 2007). Considering EU's energy supply arteries, Middle East, Russia, Ukraine and Caspian regions are crucial. Having common borders with those regions make Turkey a perfect route.

EU energy policy pays attention mainly to three regions; Northern Region (Baltic states and Russia because of nuclear security and waste disposal), Caspian Basin (Turkey-Iran-Azerbaijan-Kazakhstan because of oil and gas reserves) and Ukraine (because of being a transit country for transporting Russian natural gas to Western Europe) (Çelebi, 2006; Taşan, 2008). As a part of Caspian Basin, Baku-Ceyhan project is also an important issue for Turkey. The Baku-Ceyhan Petroleum Pipeline Project and Trans-

Caspian Pipeline Project that aim to transfer Turkmen Gas to Europe have changed the role of Turkey. In the region her geographical advantage provides Turkey to be a transit country and to play an important role in terms of energy transmission between energy producing and consuming countries. According to Strategy of Turkey report (2009), Turkey inevitably became a transit country in the Eurasia energy axis and energy hub in the region especially for European Union. Thus, Turkey is likely to become Europe's fourth main artery of energy supply following Norway, Russia and Algeria through the realization of major pipelines projects (Republic of Turkey Foreign Ministry Affairs, 2009). Moreover, considering EU-Russian relations i.e. EU's dependence on imported energy sources and Russian attempts of building new pipelines and widen her downstream access, Russia has an advantage over EU. Thus, EU recognized Turkey as an alternative and secure energy route for importing non-Russian energy sources (Tekin and Williams, 2009).

By the enlargement process of EU, Turkey's importance has increased since she has been considered as an energy transport corridor for Europe. EU constructs networks enabling diversification of energy supplies and achieves its main priorities about energy policy. These networks are called Trans-European Energy Networks (TENs) established at Maastricht Treaty. Apart from that there are other programs and projects that all try to construct a regional energy trade between EU and her neighbors such as Interstate Oil and Gas Transport to Europe (INOGATE), Transport Corridor Europe-Caucasus-Asia (TRACECA) and Baku Initiative. As previously mentioned, Turkey is one of the most promising countries in terms of an energy corridor between mentioned regions and Europe (Taşan, 2008). We can easily realize how important Turkey is for EU from several publications. For instance both Green Papers issued in 2000 and 2006 stressed the strategic importance of Turkey. The geographical location of Turkey, which is at the heart of Middle East, Persian Gulf, Central Asia and Russia, confirms the EU's statement about the importance of Turkey.

These regions supply 40% of world's total oil production and 65% of total natural gas production. Therefore Turkey is one of the key countries for EU energy policy (Çelebi, 2006).

White Paper (1995), Green Paper (2006) and '20 20 by 2020' all explain EU energy policy and its priorities. White Paper, focused on overall competitiveness, security of energy supply and environmental protection. It aimed to encourage sustainable development and energy researches, integrate all markets and deal with external dependency. Another important publication is the Green Paper which is an environmentally friendly study that aimed sustainable energy, healthy competition and secure and continuous supply of energy. The last and the most current study is '20 20 targets'. It was released in 2008 with three objectives: 20% cut in GHG by 2020, 20% increase in renewable energy use by 2020 and 20% cut in energy consumption to attain energy efficient by 2020.

We can claim that after 1973 oil shocks, European Union took some measures such as setting up an internal market with common pricing, constructing a secure supply chain throughout the Europe, protecting the environment, encouraging regional development and technological innovations and developing external relations. All these attempts were to construct a common energy policy for EU but it is better to call the results as 'semi common policy, with agreement in principle on most objectives, but a patchwork division of responsibility between different sectors' (Leonard, 2010).

In conclusion, we can summarize energy priorities of European Union as energy efficiency, energy security and environmental concerns. Considering Turkey's energy policy and priorities, all these three titles are also valid for Turkey. We can discuss the sustainable energy concept under these three main titles.

With the help of this categorization, in Chapter Four, we discuss our methodology for sustainable development, introduce the tools to assess sustainable energy and construct our own framework regarding the results obtained from this chapter.

CHAPTER 4

DATA AND METHODOLOGY

Energy is one of the most important issues to relieve poverty, improve human welfare and raise the living conditions. Therefore, it is a crucial requirement for social and economic welfare. Unfortunately there is no energy production or conversion technology that does not involve any risk or waste. Most of the current patterns of energy supply are not sustainable (UN, 2001). For instance, use of fossil fuels leads to air pollution in urban areas; use of nuclear power has important problems such as storage and disposal of radioactive waste; or wide use of non-commercial fuels results in loss of biodiversity. As an integral part of sustainable development, socio-economic development can only be achieved by supply of secure and reliable energy. The contribution of sustainable energy concept would be that with the awareness of improved technology and impacts of energy, developing countries can now transform their economies from an agricultural economy to an industrial economy with lower costs and lower environmental damages than developed countries achieved during their transitions. Therefore, achieving sustainable energy goals not only benefits environmental protection but also economic growth that is more effective and less costly as well.

We try to analyze the past and current energy policies and their impacts on social, economic and environmental aspects regarding the sustainable development concept. Energy indicators are utilized in order to reach this target. They are useful to analyze progress of a specific country towards sustainable energy. Analysis of the results of energy indicators would be a guide to policy makers to modify and improve energy policies that have effects on human wealth, quality of air, water, soil and social and economic development.

Energy indicators cannot be simplified to a collection of data, they enable us to understand main issues and important relations regarding sustainable energy that data cannot reveal. Energy indicators play the role of a bridge between sustainable development and policy makers. Each energy indicator briefly gives relevant information about production or usage of energy. When we analyze all the relevant energy indicators, we can understand the general situation and changes of indicators in time give us the progress or lack of progress towards sustainable development. The main drive of using an energy indicator framework is to evaluate the progress towards sustainable development. Although we use the same indicator set that it is a defined/ standard set of energy indicators for all countries, the results vary according to a country's own dynamics like economic, social and geographical features. Therefore, as it is discussed in the Third Chapter, every country has a selected indicator set according to her energy policies and strategies. Our aim is to identify energy priorities, select appropriate indicators and analyze them in terms of sustainable development.

For this purpose, we use the EISD indicator set for our study. In the Second Chapter, the literature confirms that EISD is a worldwide accepted indicator set and case studies applications[12] depending on this framework are remarkable. The EISD indicator set is classified under three dimensions; social, economic and environmental. Social dimension includes two themes and 4 indicators, economic dimension has two themes and 16 indicators and environmental dimension has 3 themes with 10 indicators[13]. When we examine the country case studies that are discussed in detail in Chapter Two, we observe a common pattern that all countries followed during the implementation of EISD framework. This pattern can be summarized as analyzing the national energy plans and programs to identify energy priority goals, selecting relevant EISD indicators that are related with country specific conditions, determining the data required and finding the available data bases, compiling data in time series for each indicator,

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[12] Country case studies are discussed in section 2.8.

[13] Name and detailed definitions of indicators are available in Appendix 1.

analyzing the data and interpreting the implications, and monitoring the progress and effectiveness of past and present energy policies. A similar pattern is applied in our study.

Sustainable development aims to improve quality of life in a sustainable, economic and environmentally friendly manner. EISD is selected as a tool to analyze these aspects namely social, economic and environmental dimensions of sustainable energy.

Sustainable energy in terms of social dimension is related to poverty, employment opportunities, education, demographic transition, indoor pollution, health, gender and age (IAEA, 2005). For instance social dimension has sub-themes of accessibility, affordability, disparities and safety. While in developed countries energy is available by simply switching a button, in poor countries energy is only accessible by collecting wood and dung for cooking and heating. Limited income of households may also lead to extensive use of non-commercial/traditional fuels as energy source or the share of income spend on energy are higher in poor countries compared to developed ones because of the cost of energy. Level of income or accessibility of energy in rural and urban regions is also a major problem of disparity. The extraction, processing, transmission and distribution of energy are also prominent considering the safety issue (IAEA, n.d).

Sustainable energy in terms of economic dimension is related to communication, information technology, manufacturing and service sectors, employment, productivity and development (WEC, 2010b; IEA, 2008b). For instance economic dimension has sub-themes of overall use, productivity, supply efficiency, production, end use, fuel mix, prices, imports and security. For instance, countries have different energy intensities or different efficiencies of energy conversion according to their economic structures. Energy pricing is also an important determinant of efficient energy supply and use.

Security of energy, on the other hand, is crucial for all countries. It is vital for maintaining the economic activity and supplying reliable energy to the society.

Sustainable energy in terms of environmental dimension is related to air, water and land pollution. Energy production and use inevitably create pressures on the environment. For instance burning of fossil fuels results in GHG emissions, large hydropower dams cause siltings or nuclear energy generates waste and radiation (IAEA, 2005). The production, distribution and use of energy result in negative impacts on regional and global environment.

4.1. Definition of relevant energy indicators for Turkey

After Brundtland report, every country has begun to identify her own sustainable development objectives and priorities accordingly. Likewise, indicators are designed from a general point of view but the level of importance of an indicator varies according to country specific conditions. Therefore, selection of relevant and relatively important indicators depends on a country's energy policy, economic circumstances, sustainable development criteria, geography and range of energy resources. In this study, we select a set of indicators that are relevant to national policy goals and data availabilities. As previously mentioned in the First Chapter, Turkey is compared with selected European Union countries. Turkey, as a candidate country for European Union, has energy policies parallel to those of European Union's and she is currently modifying required titles according to European Directives.

In Chapter Three, we briefly discuss the energy policies of Turkey considering development plans and then we briefly discuss European Union's common energy policy[14]. We conclude that energy priorities of EU and Turkey can be grouped as

[14] Although it is hard to say that there exists a defined common energy policy for EU, there are certain titles that all EU countries comply with.

energy efficiency and energy intensity; energy security and fuel mix; and environmental concerns[15]. We select our indicators according to these three titles which form the framework of our study. As an elementary concern of sustainable development, increasing energy efficiency is a major energy priority both for Turkey and European Union countries. Increasing energy efficiency and decreasing energy intensity would enable a more cost effective economy, a less degraded environment and an opportunity for a slowdown in depletion of resources. As discussed in Chapter Three, energy security and fuel mix are also important concerns for both Turkey and EU. Turkey as a rapidly growing economy has increased her energy demand and import dependency due to inadequate domestic energy supply. EU has a similar situation that leads her to take precautions and develop strategies about energy dependency. Lastly, environmental concerns such as GHG emissions, water, air and soil pollutions gain more importance as the awareness about sustainability concept has increased among developed countries. Especially, European Union has paid special attention to environmental protection and care for sustainable development. Turkey, as a candidate for EU, also declared the importance of sustainability in the last three development plans (SPO, 1996; 2001;2007).

4.2. Time Period and Country Selection

We select the time period as 1980-2008. To begin with, 1980 is an important year for Turkey in terms of penetration of neoliberal policies and structural changes in Turkish economy. Integration to global economy, withdrawal of state from the market, privatizations all started to take place in 1980s and thus Turkey took the initial steps to become an open economy. Before 1980, we would not be able to compare Turkey with European Union as the structure of Turkish economy was having on import-substitution oriented economy and Turkey was self-sufficient in terms of energy use. Secondly, as

[15] It is a little bit ambiguous whether Turkey identified these mentioned titles especially environment title so as to become an European Union member and adapt to EU regulations or to really give importance to environment.

we compare Turkey and EU countries in this study, the relationship between Turkey and EU has been more intensive since 1980s. Lastly, we try to extend the time range as much as we can in order to observe the changes and trends explicitly. Thus, we compile our data set from 1980 to 2008 but due to data unavailability, some indicators are analyzed during the period 1990-2008.

We select European Union countries to compare with Turkey depending on three major reasons and one minor reason. As we discuss in Chapter One, there is an ongoing negotiation about Turkey's accession to European Union. During this accession process, there have been many titles opening for Turkey and EU expects Turkey to fulfill relevant regulations and legislations. Energy is one of the titles that Turkey should adapt herself to EU. Therefore, the comparison of Turkey with EU countries in terms of sustainable energy may give an idea about the progress. In addition, as discussed in detail in Chapter Three, Turkey is an essential energy corridor for EU. Energy security is an important concern, and so EU explicitly declared how much Turkey is important for them. Thus, comparing Turkey and European Union countries in terms of sustainable energy issue makes sense. Last reason for selecting European Union countries to compare with Turkey is the determination and willingness of EU about sustainable development and sustainable energy. EU has introduced many regulations and put targets ahead about both sustainable development and sustainable energy[16]. Moreover, the current implications and results show that EU is on her way and achieves her goals successfully. As a minor reason, we need to consider the data availability for the countries that we choose. Thus, we prefer the countries that are both members of European Union and International Energy Agency (IEA)[17]. These countries are: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece,

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[16] Some of them are as follows: 'European Climate Change Program, European Emissions Trading Scheme, Carbon Capture and Storage, Kyoto Protocol, Green Paper, National Allocation Plan, Campaign to Take-off, Winning the Battle Against Climate Change, 20 20 by 2020'.

[17] IEA is a major database that we use for this study.

Hungary, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Slovak Republic, Spain, Sweden, Turkey and the United Kingdom. We also compare the country groups as European Union 15 and European Union 27. We want to compare EU 15 countries with Turkey since EU 15 is like a core / initial form of European Union and also EU 27 as it is the final form of European Union. European Union 15 is composed of Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and United Kingdom while European Union 27 is composed of Austria, Belgium, Bulgaria, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Luxembourg, Malta, Netherlands, Poland, Portugal, Romania, Slovak Republic, Slovenia, Spain, Sweden and United Kingdom.

4.3. Selected Indicators

As previously mentioned, our study concentrates on three major titles related to sustainable energy: energy efficiency and energy intensity; energy security and fuel mix and environmental concerns. In section 4.1, we discuss how we define these major titles briefly. In the first title we analyze ECO 1: energy use per capita; ECO 2: energy use per unit of GDP; ECO 6: Industrial energy intensities; ECO 7 agricultural energy intensities and ECO 8: service/commercial energy intensities. In the second title we analyze ECO 12: non-carbon share in energy and electricity; ECO 13: renewable energy share in energy and electricity and ECO 15: net import dependency. Last title includes ENV 1: GHG emissions from energy production and use per capita and per unit of GDP; ENV 2: ambient concentrations of air pollutants in urban areas and ENV 6: rate of deforestation. The selected indicators considering energy policy priorities of both EU and Turkey are also summarized in Table 4.1.

As it can be seen from the Table 4.1., we mainly focus on economic and environmental dimension of sustainable development. Although, there is social dimension that includes indicators such as share of households without electricity or commercial energy, or heavily dependent on non commercial energy; share of household income spent on fuel and electricity; household energy use for each income group and corresponding fuel mix; and accident fatalities per energy produced by fuel chain, non-availability of data for these indicators prevents us from analyzing them.

Table 4. 1 Selected EISD for Turkey and European Union

Indicator Set for Turkey and European Union		
Energy Efficiency and Energy Intensity	**Energy Security and Fuel Mix**	**Environmental Concerns**
ECO 1: Energy use per capita	ECO 12: Non-carbon share in energy and electricity	ENV 1: GHG emissions from energy production and use per capita and per unit of GDP
ECO 2: Energy use per unit of GDP	ECO 13: Renewable energy share in energy and electricity	ENV 2: Ambient concentrations of air pollutants in urban areas
ECO 6: Industrial energy intensities	ECO 15: Net import dependency	ENV 6: Rate of deforestation attributed to energy use
ECO 7: Agricultural energy intensities		
ECO 8: Service/ commercial energy intensities		

Table 4.2. provides brief information about the indicators used in this study.

We especially try to collect all the available data from the same source in order to achieve consistency among data for calculations. Data are collected mainly from three major databases:

-International Energy Agency (www.iea.org),

-Eurostat

(http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database)

-World Development Indicators (http://data.worldbank.org/).

Before explaining the indicators one by one it is important to define some of the basic terms used in this study briefly.

Total Primary Energy Supply (TPES): It comprises production of primary energy, for example, coal, crude oil, natural gas, nuclear, hydro and other non-combustible and combustible renewables plus imports, less exports of all energy carriers, less international marine bunkers and finally corrected for net changes in energy stocks. We can formulate TPES as: production + imports – exports - international marine bunkers - international aviation bunkers + / - stock changes (IEA, 2010). It is expressed in toe or ktoe.

Total Final Consumption (TFC): TFC refers to the sum of consumption by different end-use sectors and thus excludes energy consumed, or losses incurred, in the conversion, transformation and distribution of the various energy carriers. TFC reflects for the most part deliveries to consumers (IEA, 2010). It is expressed in toe or kilo tons of oil equivalent (ktoe).

Electricity consumption is the gross production plus imports less exports less losses. If we formulate electricity consumption: Gross production + imports – exports – losses. It is expressed in terawatt hour (TWh) or gigawatt hour (GWh).

Gross Domestic Product (GDP) is expressed through purchasing power parities. In order to make a better comparison across the countries, we prefer to calculate the indicators with a constant GDP structure i.e. constant prices. For a better comparison, we use purchasing power parity at 2000 USD. It is useful to convert GDP at purchasing power parities to reflect differences in price levels. By this method the differences between countries in terms of economic development would be minimum (WEC, 2010).

Non-carbon energy sources: It is mainly composed of combustible renewables, non-combustible renewables and nuclear energy sources. Combustible renewable energy sources are biomass (fuel wood, vegetal waste and ethanol), animal products (animal materials/wastes and sulphite lyes), municipal waste (wastes produced by the residential, commercial and public service sectors that are collected by local authorities for disposal in a central location for the production of heat and/or power) and industrial waste. Non-combustible renewables are geothermal, solar, wind, hydro, tide and wave energy (IAEA, 2005).

Renewable Energy: ‘Energy sources that are naturally replenishing but flow limited are called renewable energy sources. They are inexhaustible in duration but limited in the amount of energy that is available per unit of time’ (Guey-Lee, 2007). Renewable energy is consisted of combustible and non-combustible renewables. According to EISD report, renewable energy resources are biomass, animal products, municipal and industrial waste, geothermal, wind, solar, hydro, tide and wave energy (IAEA, 2005). Actually, renewable energy is non-carbon energy sources excluding nuclear energy.

In the following part, each indicator that we select for our study is explained. Data required for calculations, the method of calculation and required definitions are explained in this part. The purpose of calculating the indicators, their relevance to sustainable development, any international convention or agreement relevant to the indicators, are all discussed in the following chapter.

4.3.1 Indicators for energy efficiency and intensity

ECO 1: Energy use per capita

Energy use per capita can be calculated in three different ways: TPES/population, TFC/population and electricity/population. We calculate TPES and TFC in order to analyze both supply and consumption patterns and electricity use per capita is an essential indicator in terms of secondary energy.

ECO 2: Energy use per unit of GDP

Energy use per unit of GDP can be calculated in three different ways: TPES/GDP, TFC/GDP and electricity/GDP.

ECO 6: Industrial energy intensities

Industrial energy intensity can be calculated in two different ways: TFC/value added in industrial sector and electricity consumption/value added in industrial sector.

ECO 7: Agricultural energy intensities

Similarly, agricultural intensity can be calculated in two different ways: TFC/value added in agricultural sector and electricity consumption/value added in agricultural sector.

ECO 8: Service sector/Commercial energy intensities

Energy intensity in service sector is calculated as: TFC/value added in service sector and electricity consumption/value added in service sector. The service sector data includes private households, small-scale industry, crafts, commerce, administrative bodies, services with the exception of transportation and fishing (Eurostat, metadata).

For the indicators ECO 6, 7 and 8, we use value added that is equal to the contribution to GDP arising from industrial, agriculture and service sectors. Using purchasing power parity (PPP), the value of output is converted to a common international currency in constant 2000 US dollars.

4.3.2 Indicators for energy security and fuel mix

ECO 12: Non-carbon share in energy and electricity

Non-carbon energy share in energy and electricity is calculated by dividing non-carbon primary energy sources by total primary energy supply and electricity generation from non-carbon sources by total electricity generation. We can show the non-carbon energy share in total energy as follows: (combustible renewables + non-combustible renewables + nuclear energy)/TPES. Similarly, non-carbon energy share in electricity can be written as follows: (combustible renewables + non-combustible renewables + nuclear energy)/TPES.

ECO 13: Renewable share in energy and electricity

Similar to ECO 12, we sum energy generated from renewable sources i.e. from biomass, municipal waste, geothermal, wind, solar, hydro and wave energy. Then we divide it to TPES. In other words, it can be formulated as energy generated from renewable energy sources/TPES. We also calculate share of renewables in electricity by compiling all renewable sources that generate electricity and then divide it to total electricity output.

ECO 15: Net energy import dependency

'Net energy import dependency is defined as the ratio of net imports to total primary energy supply (TPES) in a given year in terms of total amount according to fuel type (i.e. oil, petroleum products, gas, coal)' (IAEA, 2005). Imports and exports are the amounts that have crossed the national territorial boundaries of the country whether or not customs clearance has taken place (IEA, 2010).

We need to clarify what net energy import is. It can be calculated as imports minus exports measured in tons of oil equivalent. A negative value for this calculation indicates that the country is a net exporter. Depending on whether the country is a net importer or a net exporter of energy, calculations vary. If a country is a net importer, it will be calculated as the ratio of net imports to total primary energy consumption. If a country is a net exporter, the ratio would be exports to total primary energy supply. Net import dependency is calculated as (net imports of oil, natural gas and coal)/TPES.

4.3.3 Indicators for environmental concerns

ENV 1: GHG emissions from energy production and use, per capita and per unit of GDP

We gather data of emissions from energy production in terms of equivalent amounts of CO_2. Data are obtained from Eurostat between 1990 and 2008. Eurostat data show the trends in the emissions of the GHG gases (methane, carbon dioxide and nitrous oxide) regulated by Kyoto Protocol.

In order to calculate this indicator we need to define what GHGs are. Greenhouse gases like carbon dioxide (CO_2) or water vapor occur naturally in atmosphere and emitted to atmosphere through natural processes and human activities. Some GHGs, on the other hand, are created by human activities. Some of the human made GHGs are carbon dioxide (CO_2), methane (CH_4), Nitrous Oxide (N_2O) and fluorinated gases (EPA, 2011). Gases in the Earth's atmosphere allow sunlight to enter the atmosphere freely. When sunlight strikes the Earth's surface, some of it reflects back to space as heat. Yet GHGs absorb that heat (infrared radiation) and keep it in the atmosphere. The amount of energy sent from sun to earth and the amount of energy radiated back to space should be equal so that the temperature of Earth's surface be constant (EIA, 2010). The level of GHGs in the atmosphere is important since global warming is a result of intensification of greenhouse effect.

In calculating this indicator we are interested in the amount of GHG emission from energy production. Emissions of GHGs related to energy production will be divided by population and GDP. In order to obtain two different versions of our indicator ENV 1: GHG emissions from energy production/population and GHG emissions from energy production/GDP.

ENV 2: Ambient concentrations of air pollutants in urban areas

For the calculation of this indicator, we use Eurostat database. We use PM_{10} ambient concentrations of air pollutants in urban areas. PM_{10} particulate matter is described as fine particulates whose diameter is less than 10 micrometers, and can be carried deep into the lungs of human beings where they can cause inflammation and a worsening of the condition of people with heart and lung diseases.

ENV 6: Rate of deforestation attributed to energy use

UNDP (2004) describes, the rate of deforestation attributed to energy use as 'the annual change in the amount of natural and plantation forest area tracked over time that could be attributed to using wood as a fuel for energy purposes'. Forest area is the land with a tree crown cover equal to or more than 10% of the area. Plantation is the artificial establishment of forests by planting or seeding. Natural forests are the ones that were established naturally or semi naturally (FAOSTAT, 2011). We need to calculate forest area that is the sum of plantations and natural forests with tree crown cover of at least 10%.

In order to calculate this indicator, we need annual fuel wood, annual fellings, and forest area. The fuel wood production including charcoal between 1992 and 2009 is obtained from Eurostat in thousands of cubic meters. However, we have data for annual fellings for only three years: 1990, 2000 and 2005 in thousands of cubic meters. Therefore, the calculations will be done by taking into account the data for these years. Likewise, the data for the total area of forests and other wooded land is obtained from Eurostat in thousands of hectares. We calculated the total rate of deforestation from 1990 to 2000 and from 2000 to 2005, so we have two sets of different total rate of deforestation (TRD) values. We divide fuel wood production (FWP) to total forest fellings (TFF) for years 2000 and 2005 and multiply them by the corresponding TRD values.

Total rate of deforestation (TRD) is calculated by comparing the forest area over time using reference years. TRD is the annual rate in percent from year P to year N and the formula is:

$$TRD = 100 \left(1 - \left(\frac{Forest\ AreaN}{Forest\ AreaP}\right)^{\wedge}(1/\ (N-P)\right)$$

Then we multiply TRD with the ratio of average annual fuel wood production (FWP) to the annual total forest fellings (TFF). Fuel wood is comprised of firewood, charcoal, chips, sheets, pellets and sawdust. The formula for the rate of deforestation attributed to fuel wood is ($RDfw$):

$$RDfw = TRD\,(\frac{FWP}{TFF})$$

In our case we first calculate total rate of deforestation between 1990-2000 and 2000-2005. Positive values imply that forest area between these years has declined and negative values show that forest area has increased.

The second step is to calculate the rate of deforestation attributed to fuel wood ($RDfw$). We calculate the ratio of FWP to TFF in 2000 and 2005 since we have two intervals for TRD (1990-2000 and 2000-2005). The negative values for RD imply that TRD has negative values because the ratio of FWP to TFF is positive for all countries. Once again the negative TRD shows that deforestation did not occur.

Considering negative values of RD, the smaller the value with regard to its sign the lesser the deforestation. If the RD is a positive value, the bigger the value with regard to its sign, the bigger is the deforestation.

We exclude Ireland and Austria from calculations, as there are missing data for the total annual fellings of these countries.

In this chapter, we briefly describe our data and methodology. Country and time selection, sources of available data, definition of indicators and method of calculations are discussed: We construct our own framework for this study referencing to original EISD and explain how we set up our indicator set. The following chapter analyzes and discusses all of the indicators mentioned in this chapter by concentrating on Turkey and comparing her performance in terms of these indicators with the selected EU countries.

Table 4.2: Summary of selected indicators

		NAME OF INDICATOR	TIME	REQUIRED DATA	UNIT	SOURCE OF DATA
Energy efficiency and energy intensity	**Eco1**	Energy use per capita	1980-2008	TPES/Population, TFC/Population, Final electricity/Population	Toe per capita Toe per capita kWh per capita	www.iea.org
	Eco2	Energy use per unit of GDP	1980-2008	TPES/ GDP TFC/ GDP Final electricity consumption/ GDP	Toe per US dollars (in constant 2000 US dollars)(PPP) Toe per US dollars (in constant 2000 US dollars)(PPP) kWh per US dollars (in constant 2000 US dollars)	www.iea.org

Continued

		NAME OF INDICATOR	TIME	REQUIRED DATA	UNIT	SOURCE OF DATA
Energy efficiency and energy intensity	**Eco6**	Industrial energy intensities	1990-2008	Energy use in industrial sector/ Industrial value added Electricity consumption by industrial sector/ Industrial value added	Toe for final energy in constant 2000 US dollars(PPP) kWh for electricity per US dollar, in constant 2000 US dollars(PPP)	http://appsso.eurostat.ec.europa.eu/nui/show.do http://databank.worldbank.org

Continued

		NAME OF INDICATOR	TIME	REQUIRED DATA	UNIT	SOURCE OF DATA
Energy efficiency and energy intensity	**Eco7**	Agricultural energy intensities	1990-2008	Energy use in agricultural sector/ Agricultural value added Electricity consumption by agricultural sector/ Agricultural value added	Toe for final energy kWh for electricity per US dollar, in constant 2000 US dollars(PPP)	http://appsso.eurostat.ec.europa.eu/nui/show.do http://databank.worldbank.org/ddp/home.do?Step=3&id=4

Continued

		NAME OF INDICATOR	TIME	REQUIRED DATA	UNIT	SOURCE OF DATA
Energy efficiency and energy intensity	**Eco8**	Service sector energy intensities	1990-2008	Energy use in service sector/ Service sector value added Electricity consumption by service sector/ Service sector value added	Toe for final energy kWh for electricity per US dollar, in constant 2000 US dollars(PPP)	http://appsso.eurostat.ec.europa.eu/nui/show.do http://appsso.eurostat.ec.europa.eu/nui/show.do http://databank.worldbank.org/ddp/home.do
Energy security and fuel mix	**Eco12**	Non-carbon energy share in energy and electricity	1980-2008	TPES obtained from non-carbon energy sources/ Total TPES Electricity obtained from non-carbon energy sources/ Total Electricity production	ktoe GWh	www.iea.org

Continued

		NAME OF INDICATOR	TIME	REQUIRED DATA	UNIT	SOURCE OF DATA
Energy security and fuel mix	**Eco13**	Renewable energy share in energy and electricity	1980-2008	TPES obtained from renewable energy sources/ Total TPES Electricity obtained from renewable energy sources/ Total electricity production	ktoe Gwh	www.iea.org
	Eco15	Net energy import dependency	1980-2008	Energy imports/Total primary energy supply	Energy in ktoe and ratios are in percentage	www.iea.org
Environmental Concerns	**Env1**	Greenhouse gas emissions from energy production and use, per capita and per unit of GDP	1990-2008	GHG emissions from energy and transport/ GDP GHG emissions from energy and transport/ Population	GHG emissions in thousands of tons as CO_2 equivalents GDP in billion 2000 USD using PPPs Population in billions	EEA: http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do IEA: www.iea.org

Continued

		NAME OF INDICATOR	TIME	REQUIRED DATA	UNIT	SOURCE OF DATA
Environmental Concerns	**Env2**	Ambient concentrations of air pollutants in urban areas	1996-2007	Urban population exposure to air pollution by particulate matters	µg	http://epp.eurostat.ec.europa.eu/tgm/table.do?tab=table&init=1&plugin=1&language=en&pcode=tsien110

Continued

		NAME OF INDICATOR	TIME	REQUIRED DATA	UNIT	SOURCE OF DATA
Environmental Concerns	**Env6**	Rate of deforestation attributed to energy use	1990-2000 and 2000-2005	Annual fellings	1000m^3	http://epp.eurostat.ec.europa.eu/tgm/refreshTableAction.do?tab=table&plugin=1&pcode=tsdnr520&language=en
				Annual fuel wood production	1000m^3	http://appsso.eurostat.ec.europa.eu/nui/setupModifyTableLayout.do
				Forest area	thousands of hectares	http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

CHAPTER 5

RESULTS

As mentioned in Chapter Four, we mainly focus on three major energy policies: energy efficiency and energy intensity; energy security and fuel mix; and environmental concerns. For each of these major priorities of energy we use several indicators as explained in detail in previous chapter. Therefore, in this chapter we analyze the behavior of Turkey and selected EU countries in terms of these indicators of sustainable energy.

5.1. Energy efficiency and energy intensity

As discussed in Chapter Two, sustainable energy perspective aims to increase energy efficiency and decrease energy intensity. Before analyzing the indicators, we should briefly explain what energy efficiency and energy intensity are.

Energy efficiency can be defined as all changes that decrease the amount of energy to produce one unit of economic activity. Energy efficiency can be attained by either technological improvement or better management and organization or behavioral changes. Energy efficiency is prominent for sustainable energy policy. The increasing energy efficiency implies less energy demand and less carbon dioxide emission. Energy intensity on the other hand can be defined as a measure of the energy efficiency of a nation's economy. It is calculated as energy use per GDP. In other words, energy intensity measures how much energy is required to generate one unit of GDP. As understood from the definitions, there is an inverse correlation between energy intensity and efficiency as decreasing energy intensities result in more effective use of energy resources and also result in less negative environmental impacts. From the perspective of sustainable development, the decrease in energy intensities or increase in energy efficiency in all sectors is desirable. Nevertheless, there is an important point about the relation between energy efficiency and energy intensity. Energy intensities are related, but not equivalent, to the inverse of energy efficiency. Increases in energy efficiency help to reduce energy intensities, but changes in other factors (e.g. usage patterns) can either augment or counter-balance the impact of improved efficiencies on energy intensity (Unander et al, 2004). Decreases in energy intensity may increase energy efficiency or does not have an effect on energy efficiency. For example, when people get older, they use heating equipments more and as a result the energy intensity increases. But as they use the same equipment, energy efficiency does not change. In addition, a shift from energy intensive industries to a less energy intensive industries decreases energy intensity but does not imply to an improvement in energy efficiency (US Department of Energy, 2008).

5.1.1. ECO 1: Energy use per capita

Energy use per capita is calculated by dividing total primary energy supply (TPES) by population or total final consumption (TFC) by population or electricity generation by population. Energy use per capita is a useful tool to determine the energy use patterns and energy efficiency. Low final energy and electricity use per capita may imply low living standards or high-energy efficiency or a dominant service based economy. Nevertheless, by only looking at energy use per capita we cannot reach any concrete conclusion. For instance, countries whose informal economic activity is dense and use of traditional fuels is wide should be interpreted carefully.

Although from the perspective of sustainable development, increase in energy consumption per capita is not desirable, it might be a good indicator of development for transition and developing economies. There is a positive relationship between GDP and TPES growth where low level of per capita energy consumption might be an indication of low income and low living standards (IAEA, 2005; UN, 2001). In order to see the relation between a country's level of development and energy use per capita, Human Development Index (HDI) may be used.

HDI is an indicator to monitor sustainable development. United Nations Development Program (UNDP) first launched HDI in 1990. The purpose was to construct a more comprehensive measure of human development apart from only focusing on income. HDI has three components: educational component, income component and health/longevity component (Neumayer, 2001). The country rankings constructed according to HDI calculations give us a clue about progress of sustainable development.

Therefore, in the following, we also compare countries in both HDI and TPES per capita in order to monitor the sustainable development goals.

In Turkey, both energy and electricity consumption per capita has increased since 1980. Total final consumption per capita has growth rate of 76.70 % and total primary energy supply per capita grew by 95.84% during 1980-2008. Electricity use per capita has the highest growth by 389% for the same period. The growth rates are calculated as follows:

$$\left(\frac{x_{t+1}}{x_t} - \frac{x_t}{x_t}\right) * 100$$

The steep increase in electricity demand, as observed in Figure 5.1 is because of intense use of heating and cooling systems. Apart from economic growth we can explain the increase in TPES in terms of increased levels of natural gas and coal consumption in Turkey (IEA, 2009).

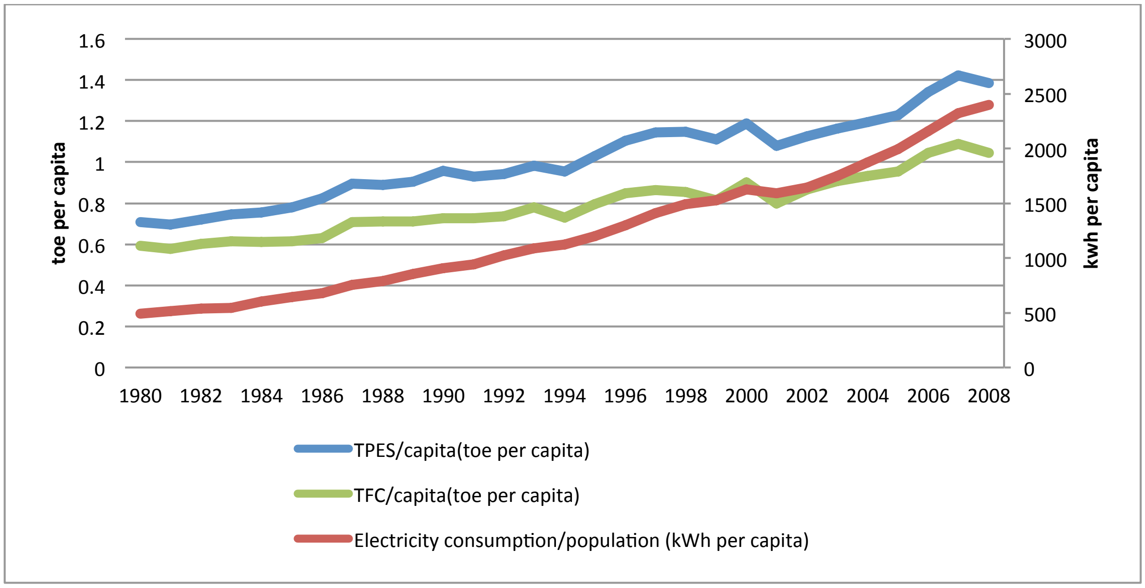

Figure 5- 1 Energy use per capita in Turkey

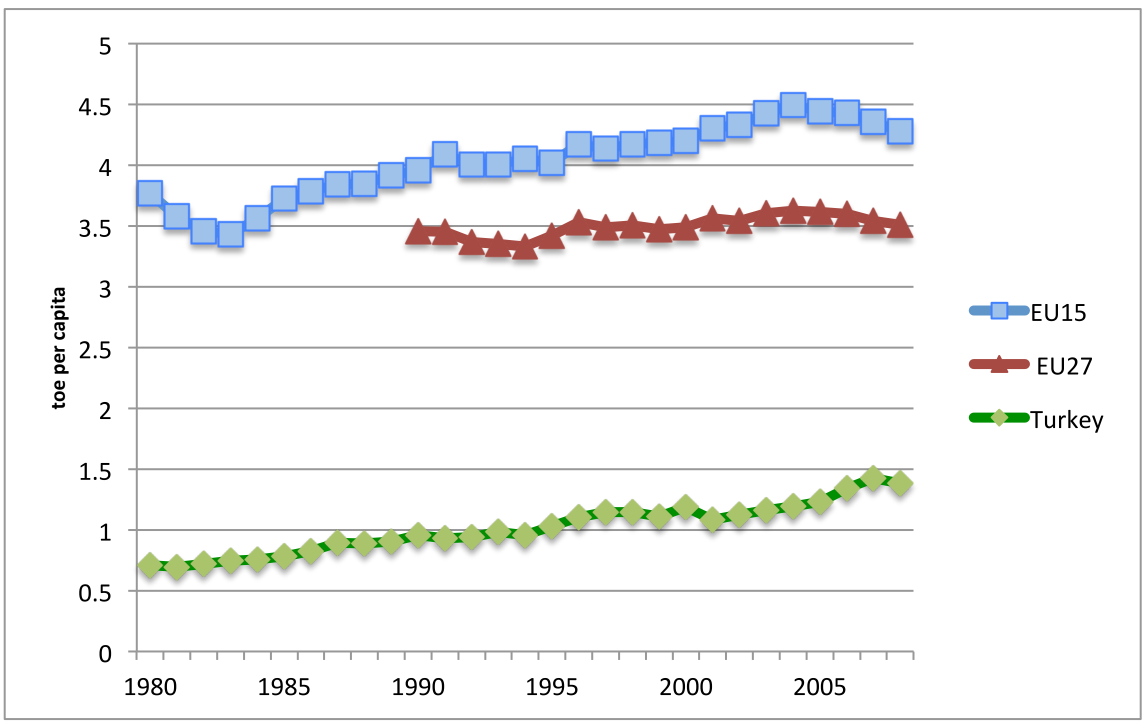

Figure 5- 2 TPES per capita for EU 15, EU 27 and Turkey

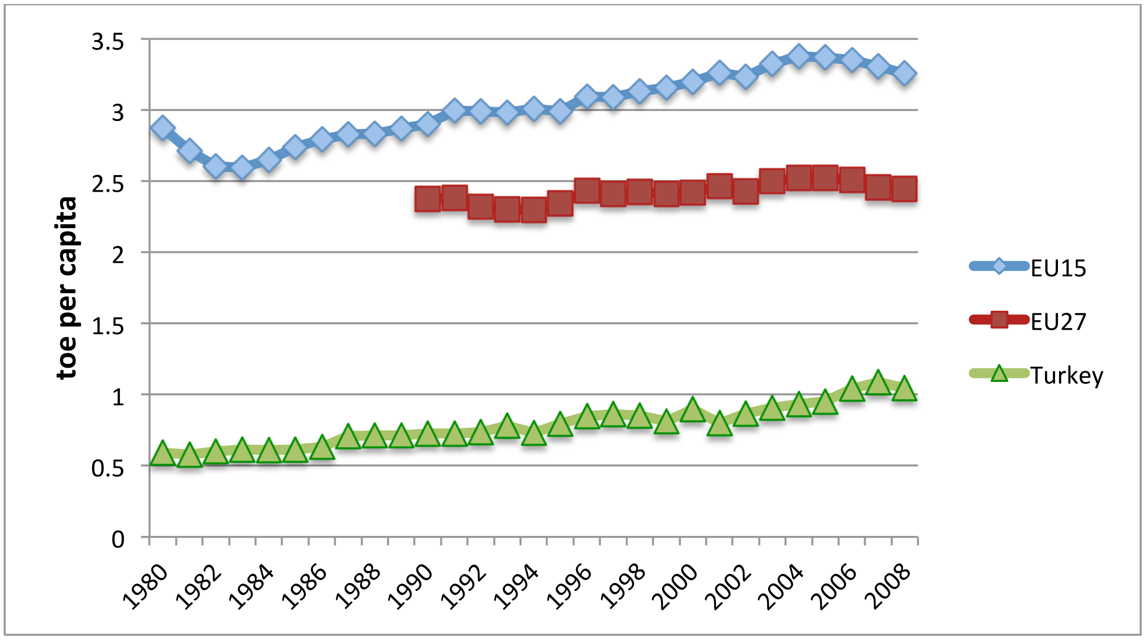

Figure 5- 3 TFC per capita for EU 15, EU 27 and Turkey

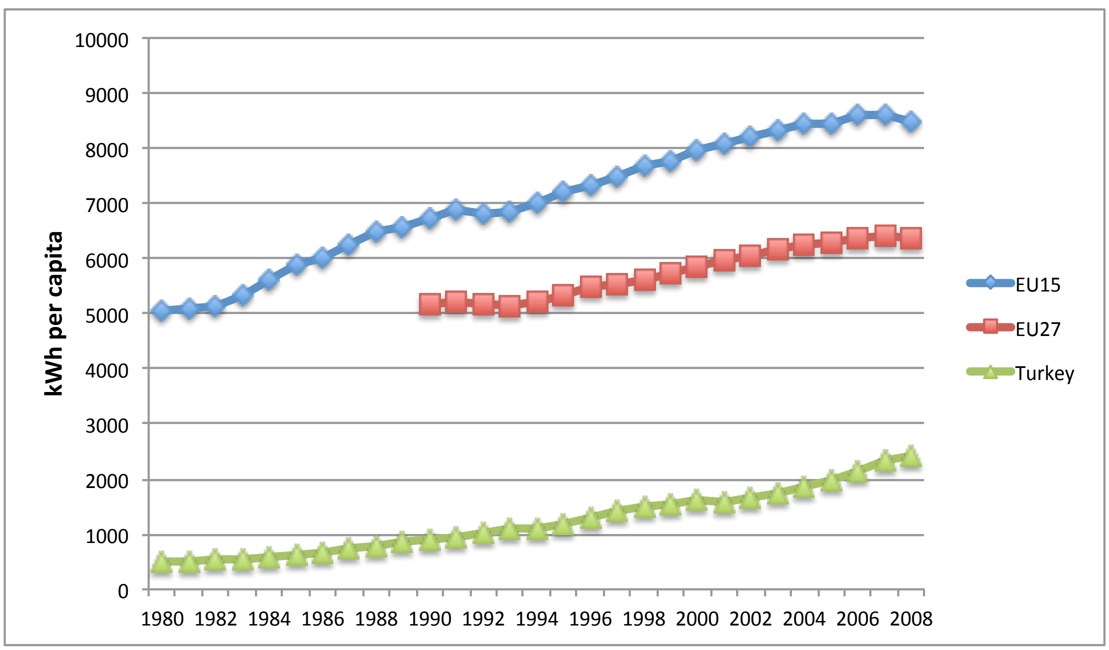

Figure 5- 4 Electricity use per capita for EU 15, EU 27 and Turkey

As observed from Figure 5.2, growth rates of TPES per capita for EU 15 and EU 27 are 13.48% and 1.52% respectively while Turkey's ratio is 95.84% between 1980-2008. If we compare TFC per capita of Turkey with EU 15 and EU 27 in Figure 5.3, growth rates are 76.70%, 13.24%, and 2.87%, respectively. Turkey's TFC per capita has increased significantly more than both EU 15 and EU 27.

In Figure 5.4 per capita growth rate of electricity consumption is 68.22% and 23.15% for EU 15 and EU 27, respectively while this ratio is 389% for Turkey. Although, energy use per capita for Turkey has increased more than EU 15 and EU 27, the level of energy use per capita is very low in Turkey compared to EU 15 and EU 27. We can claim that in EU 15 and EU 27, energy efficiency is attained more successfully than Turkey. The improvements in technology, better management of energy sources may be the reasons of this success (European Commission, 2008). Moreover, these ratios point out to two significant issues. First in terms of sustainability, increase in energy use per capita is not desirable and in Turkey this ratio has increased. Second, in developing and transitional countries, increase in energy use per capita is essential to achieve a considerable level of economic growth and social welfare. Turkey, as a country with growing economy and increasing population, increased its energy use per capita. In other words, increase in energy use per capita may imply positive economic growth and signal that Turkey has increased its well being to a higher level during this period (IAEA ; UNDESA, 2005).

HDI versus TPES per capita for 1980 and 2008 are compared in Figures 5-5 and 5-6, respectively to evaluate the progress of countries. Higher TPES per capita figures imply that energy accessibility and commercial use of energy are higher. In those countries health, knowledge and standard of living that are the components of HDI, are expected to be higher. Thus, countries that have higher HDI values also have higher TPES per capita values. The aim is to detect whether any country has changed its position in the scatter plot, between 1980 and 2008 in a positive or negative way.

There is no HDI data available for Poland, Czech Republic, Slovakia and Germany in 1980. Therefore, in Figure 5-5, we cannot analyze these countries. The average value for TPES per capita is 3.45 and HDI is 0.705 for 1980. If we divide the graph into four quadrants considering the average values, third region is the one with highest HDI and TPES per capita values. The countries that fall into this region are Luxembourg, Finland, Sweden, Belgium Netherlands, Denmark, United Kingdom and France. On the other hand, countries that have lower HDI and TPES per capita values are taking place in quadrant two: Hungary, Spain, Portugal and Turkey.

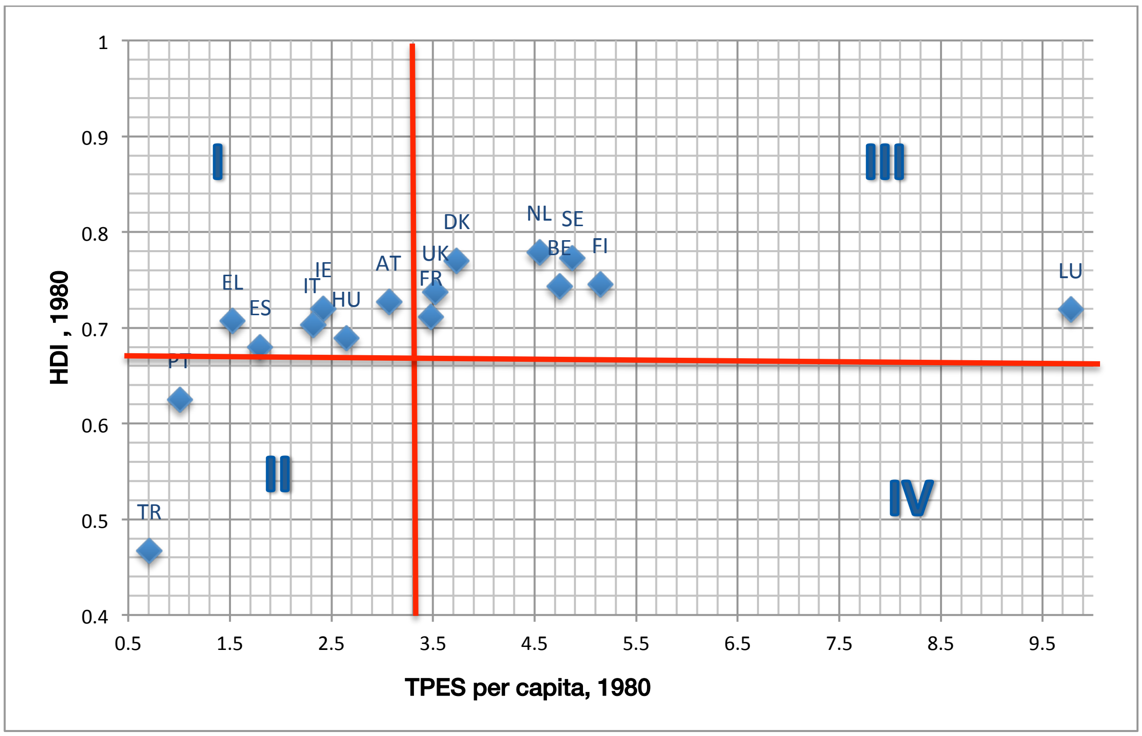

Figure 5- 5 HDI versus TPES per capita, 1980

Figure 5- 6 shows the relation between HDI and TPES per capita in 2008. The average values for TPES per capita and HDI are 3.92 and 0.842, respectively. If we divide the graph into four quadrants considering the average values, third region is the one with highest HDI and TPES per capita values. The countries that fall into this region are Luxembourg, Finland, Belgium, Sweden, Netherlands, Germany, France, Austria and Czech Republic. On the other hand, countries that have the lowest HDI and TPES per

capita values are located in quadrant two: Slovakia, Hungary, Portugal, Poland and Turkey.

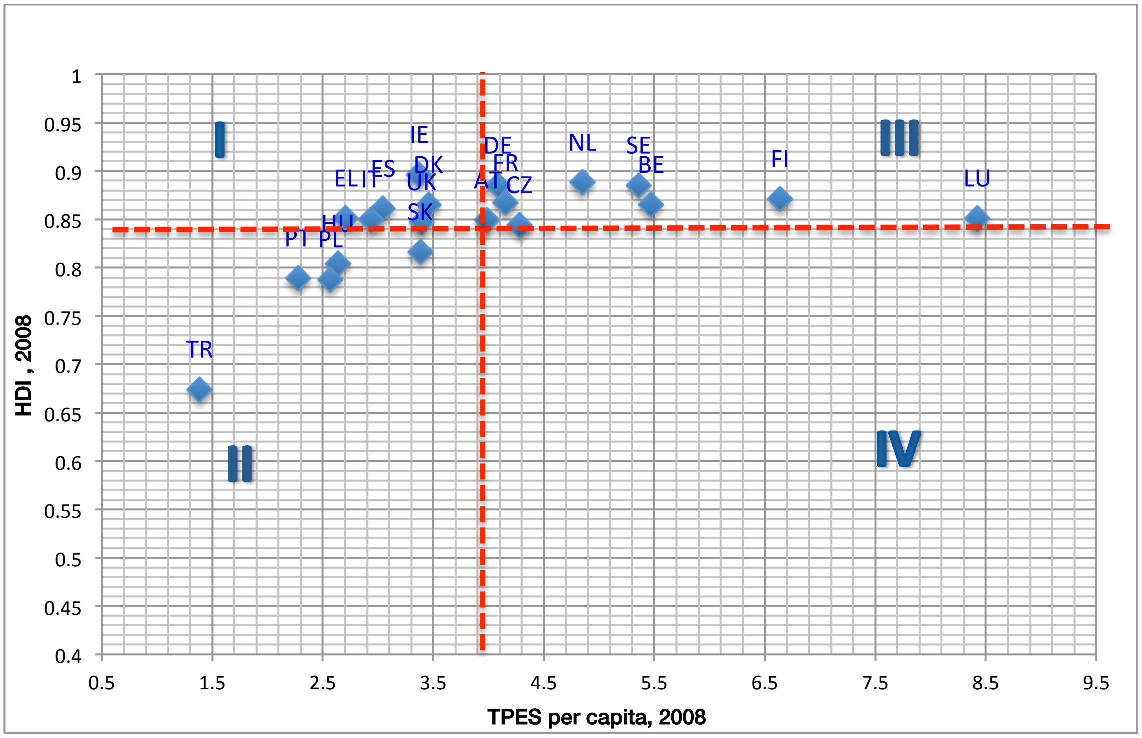

Figure 5- 6 HDI versus TPES per capita, 2008

Between 1980 and 2008, Austria and Czech Republic managed to increase their HDI and TPES per capita values and are placed in the third quadrant while Denmark and United Kingdom decreased their TPES per capita and are placed in the first quadrant. To decrease TPES per capita is a positive result for sustainable development goals. Turkey, Hungary and Portugal stayed in the second quadrant by having the lowest ratios for both indicators between 1980-2008. Neither HDI nor TPES per capita increased enough through the years and compared to other countries Turkey, Hungary and Portugal could not increase their HDI and TPES per capita. Spain, on the other hand, managed to increase HDI and TPES per capita and is placed in the first quadrant. Turkey and Luxembourg are outliers as can be seen from Figure 5- 6. Although Luxembourg has the highest TPES per capita for both years 1980-2008, she managed to decrease TPES per capita during this period and achieve to increase HDI. Turkey, on the other hand, managed to increase HDI slightly but also increased TPES per capita during 1980-2008.

Although, there is a slight progress, we can claim that the pattern during these years has not been changed in Turkey and no convergence is observed in terms of HDI or TPES per capita values.

Lastly, we can make a general comment for all countries. Comparing Figures 5-5 and 5-6 points out that there is a shift towards northeast direction meaning that both TPES per capita and HDI has positively evolved during 1980-2008. We can claim that HDI increase signals us a higher level of human welfare and higher TPES per capita can be a sign of economic growth and development. As mentioned previously, low level of energy use per capita may either imply low level of living standards or high energy efficiency or service sector dominant economy. The scatter graphs help us to understand the increase or decrease in energy use per capita resulting from efficiency or lower living standards. The movement towards northwest direction is a sign of improved energy efficiency because as HDI increases (higher living standards), the energy use per capita is decreasing. If we look at Turkey, during the period, the increase of TPES per capita is more than the increase in HDI. They do not increase in a similar way. Thus, it is hard to say Turkey achieved energy efficiency compared to other countries like Denmark or United Kingdom. These countries both decreased TPES/population and increased HDI values.

5.1.2. ECO 2: Energy use per unit of GDP

This indicator will identify the relationship between energy use and economic development. To decrease energy intensity and to achieve economic development with less energy use are main objectives of sustainable development. At the same time, improvements in energy productivity decrease the carbon dioxide emissions. Kyoto Protocol objectives and constraints about energy security have brought the energy intensity and energy efficiency issue on the agenda. For instance, energy efficiency in electricity sector will enable more consumers to have access to the electricity network by using the same production capacity and also it will slow down the energy demand growth. Moreover, decreasing energy intensity is one of the major energy policy priorities for countries and may be more important for those that are highly depending on energy imports and having economic problems (WEC, 2010a).

We use TPES/GDP and electricity/GDP to measure energy intensity and compare the findings for the given set of countries. Nevertheless, the results should be interpreted carefully. Structure of economy is important to interpret the results. For instance, if a country has a sector that mainly deals with primary extraction and processing of mines, the energy intensity will be higher. Energy use per GDP is affected by many factors such as climate, geography, travel distance, home size and manufacturing structure. Disregarding these factors would lead to a poor conclusion. Therefore, for a good understanding of energy intensity levels, countries with similar climate, size, income and economic structure should be compared (Streimikiene et.al, 2007). To sum up, energy intensity of a country should be monitored by considering that country's energy mix, transport infrastructure, end use efficiency of equipment and buildings and country specific economic and industrial structure.

There is not any convention, regulation or agreement that proposes a certain level of energy intensity. Nevertheless, Agenda 21, The Johannesburg Plan of Implementation which was agreed at 2002 World Summit on Sustainable Development, the Sixth Environmental Action Plan, Energy Efficiency in the European Community: Towards a Strategy for the Rational Use of Energy, all emphasize the need for a more efficient use of energy. All EU Directives, action plans and community strategies emphasize the importance of decreasing energy intensity with economic growth.

In Turkey, there has been a positive relation between GDP and TPES since 1980s. Decreasing energy intensity results in less additional energy consumption for economic growth. Structural changes such as privatization and the increase in energy efficiency may cause energy intensity to fall. In order to see the relationship between energy intensity, GDP and TPES for Turkey, EU 15 and EU 27, we indexed these 3 variables by taking 1980 as the base year (index 1980 = 100) for Turkey and EU 15 and 1990 as the base year (index 1990 = 100) for EU 27. From Figures 5-7, 5-8, 5-9 it is possible to see that TPES increased for Turkey, EU 15 and EU 27 from 100 to 313, 122 and 107, respectively. GDP on the other hand increased for Turkey, EU 15 and EU 27 from 100 to 335, 184 and 146, respectively. As a sustainable energy goal, decrease in energy intensity is desirable. Turkey, EU 15 and EU 27 all managed to decrease TPES per GDP from 100 to 93, 64 and 73, respectively during the period of analysis[18]. As the Figures 5-8 and 5-9 demonstrate there are significant divergences in EU 15 and EU 27 but the trend in Turkey is almost flat and the decrease is not satisfactory enough as observed in Figure 5-7. The decreased intensity may result from the shift from industry towards service sector whose energy intensity is less than industry. Moreover, improvements in the efficiency of power generation as well as in intensity in some end-use sectors may contribute to the reduced overall energy intensity in Europe (EEA, 2006). Therefore, compared to EU 15 and EU 27 country groups, it is hard to say that Turkey achieved to decrease its energy intensity.

[18] The periods are 1980-2008 for EU 15 and Turkey and 1990-2008 for EU 27

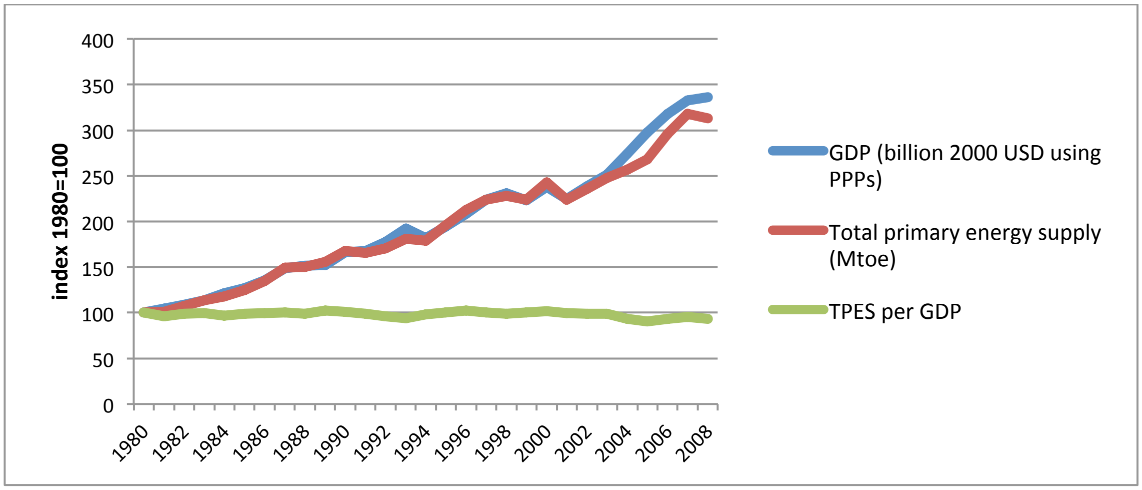

Figure 5- 7 Trends in energy intensity, GDP and TPES for Turkey

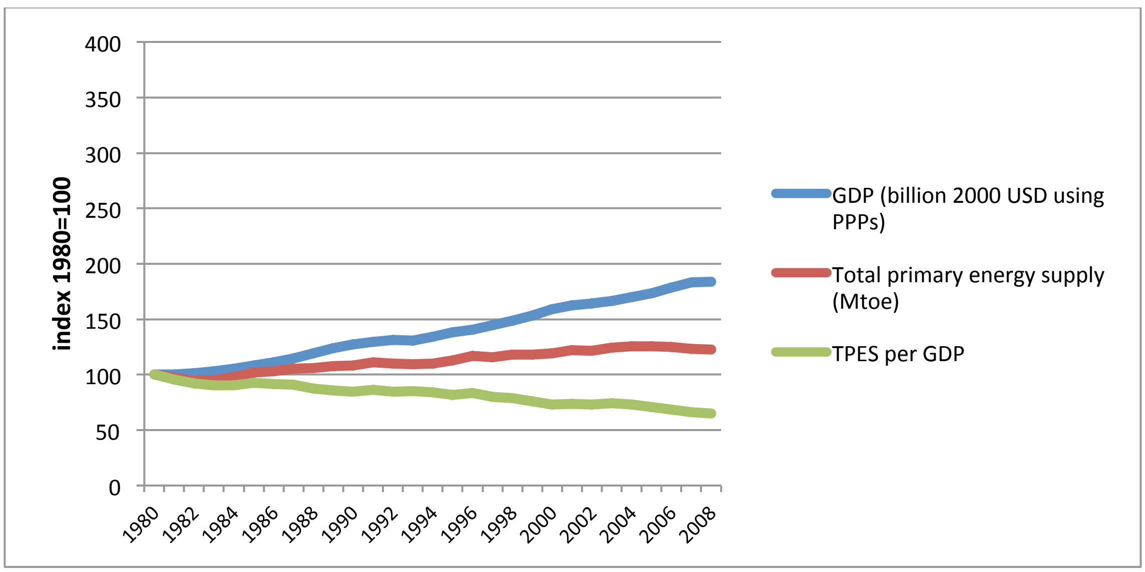

Figure 5- 8 Trends in energy intensity, GDP and TPES for EU 15

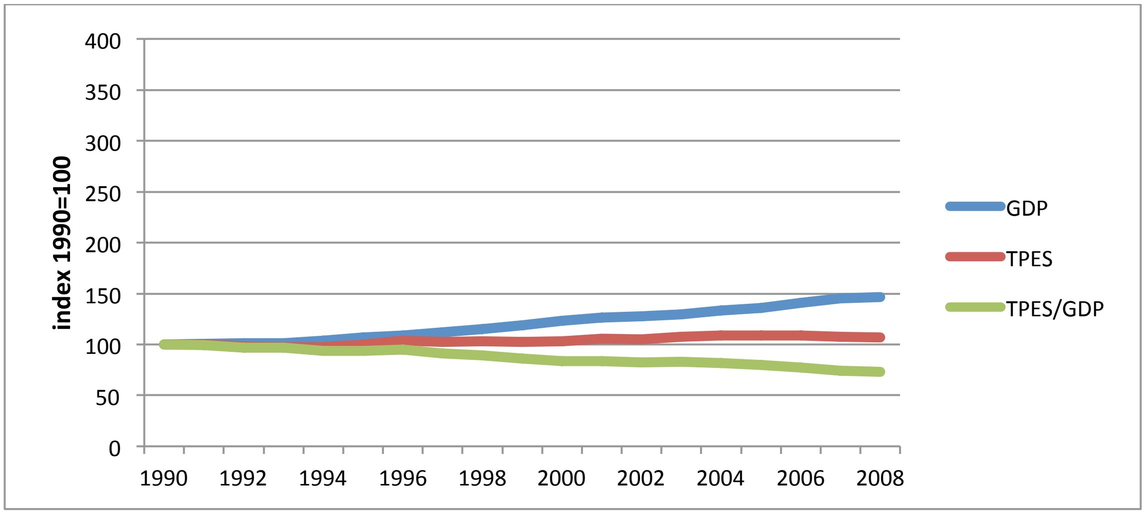

Figure 5- 9 Trends in energy intensity, GDP and TPES for EU 27

Energy and electricity demand of Turkey have been increasing with an average growth by 5% and 8%, respectively. The losses during transmission of energy, inefficient distribution of energy, environmental concerns in terms of CO_2 emissions and increasing energy import dependency all bring about energy efficiency issue on the agenda (TMMOB, 2008). Turkey's energy efficiency policy is guided by the 2007 Energy Efficiency Law and the subsequent by-laws. These, in turn, meet the 2004 Energy Efficiency Strategy's goal of harmonizing Turkey's energy efficiency legislation with that of the European Union. The 2004 strategy includes the general principles and tools for developing a national energy efficiency policy. The 2007 Energy Efficiency Law aims to reduce energy intensity by 15% below the reference scenario projections by 2020 and targets the largest energy-using sectors: manufacturing industry, transport, services and buildings, as well as the power sector (generation, transmission and distribution) (IEA, 2009).

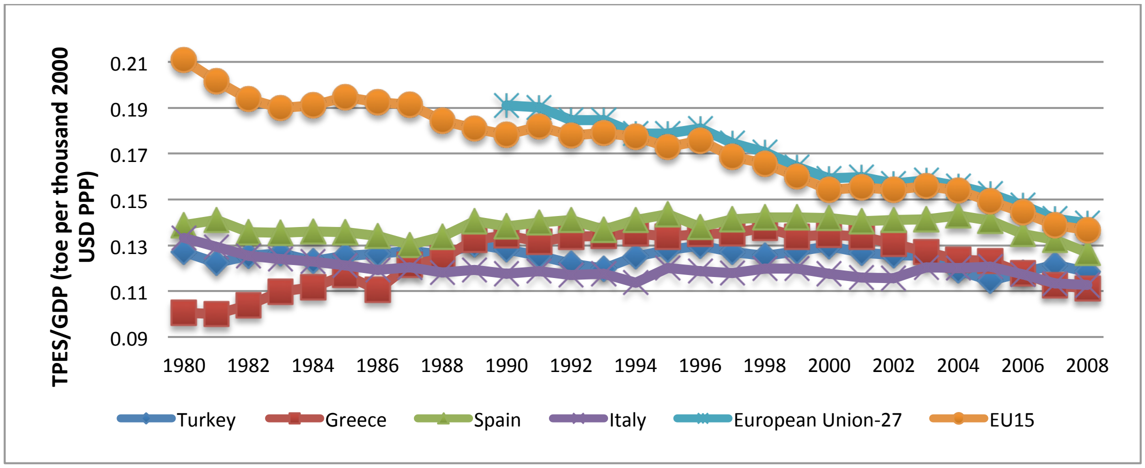

Figure 5- 10 Energy intensities for Turkey and selected countries between 1980-2008

From Figure 5-10, we observe a convergence that all countries have achieved to decrease their TPES/GDP ratios throughout the years. While energy intensity has significantly decreased in EU 27 and EU 15, Turkey's energy intensity has remained relatively stable. The negative growth of energy intensity between 1980-2008 is 6.76% for Turkey, while these ratios are 23.32% for EU 27 and 26.87% for EU 15. EU 15 and EU 27 have managed to decrease the energy intensity almost 4 times more than Turkey. In Turkey, service sector has grown faster than industry and given that industry sector is more energy intensive, we expect energy intensities to decrease. Nevertheless, there has not been a significant reduction in intensities because there has been increased energy use linked to the increasing wealth of the Turkey's growing population (IEA, 2009). As mentioned previously, this indicator should be analyzed for similar countries in terms of geographical position and economic structure. Italy, Greece and Spain are compared to Turkey because they have similar geographical features, they are located close to each other and their economic structures are alike. As it can be seen from Figure 5-10, apart from Greece, all countries decreased their energy intensities but Turkey stayed relatively stable compared to Spain, Italy, EU 15 and EU 27.

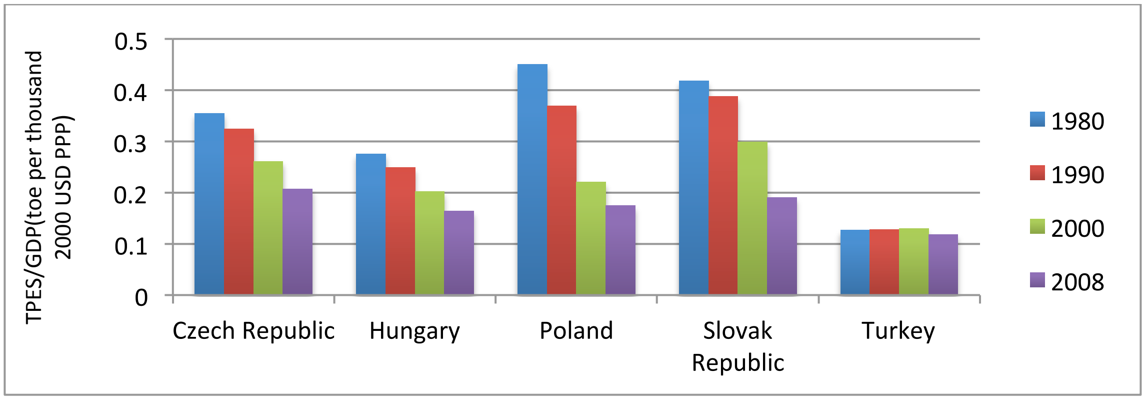

Figure 5- 11 Energy intensities of transition countries and Turkey

Compared to other countries, Poland, Slovakia, Czech Republic and Hungary have higher energy intensities and at the same time, these countries have the highest negative growth rates for energy intensity. Compared to EU 15 and EU 27, level of TPES/GDP ratios of these four countries, are higher during 1980-2008 yet the disparity between these countries and EU 15 and EU 27 have decreased significantly since 1990s. Structural changes like increasing privatization, rising prices of raw materials and therefore increasing importance of energy efficiency, removal of subsidies about energy investments are all possible reasons for this decrease (EEA, 2006). As it can be seen from Figure 5-11, Turkey compared to transition countries relatively stayed stable and decreased her energy intensity less than transition countries.

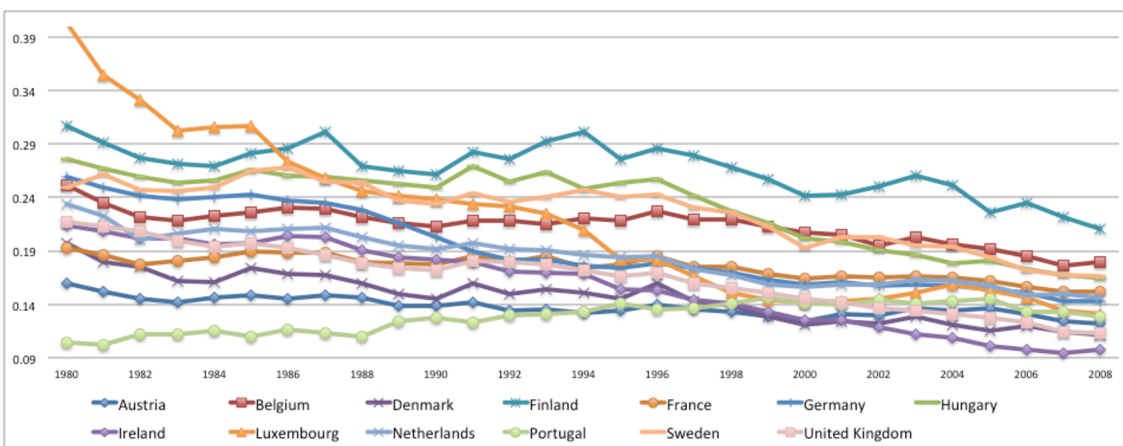

Figure 5- 12 Energy intensities of selected countries

Apart from Turkey, Spain, Greece, Italy and the transition countries the rest of the countries are graphed in Figure 5.12. Except Portugal, all countries managed to decrease their energy intensities and convergence towards lower levels of energy intensity is observed. Considerable intensity decreases occurred in Luxembourg, Ireland, United Kingdom, Denmark and Sweden while in Ireland, booming economic growth and service sector are the main reasons for the decrease; in the United Kingdom this decrease is due to reduction in the share of manufacturing sectors and increasing share of service sector (EEA, 2006).

From the figures it is observed that total primary energy supply intensities have been declining in Europe since 1980. Europe managed to decrease energy intensities by reducing the losses in energy transformation and the development of wind power (WEC, 2010a). Moreover, improvements in energy efficiency in the end use devices, structural changes in the economy, changes in levels of energy needed by different sectors and declines in sub-sectorial energy intensities such as in manufacturing, household, transportation and services are some of the other reasons of the intensity fall (Goldemberg, J., Sicker Prado, L.T., 2011).

We draw Figures 5-13, 5-14 to compare GDP per capita and energy intensity of the countries in 1980 and 2008, respectively. GDP per capita is a rough measure of productivity and standard of living. Higher levels of GDP per capita imply higher economic growth and higher social welfare. The graphs may give an idea about energy efficiency. Higher energy intensity, on the other hand, implies lower efficiency. Increasing energy efficiency and decreasing energy intensity are taking place among the major sustainable energy goals.

We categorize countries in Figure 5-14 accordingly[19]: Luxembourg, Ireland, Austria, Netherlands, Denmark, United Kingdom, Germany and Italy are countries that are both energy efficient and have high GDP per capita. The transition economies; Czech Republic, Slovakia, Hungary and Poland have both lower productivity and inefficient energy use. Sweden, Finland, Belgium and France managed to attain high productivity but with the cost of inefficient energy use. The last group includes countries which are energy efficient but having lower productivity such as Greece, Spain, Portugal and Turkey. Between 1980-2008, Austria, Italy, Denmark and the United Kingdom maintained their location while Ireland increased her GDP per capita and Netherlands and Germany decreased their TPES/GDP ratios. Transition countries improved their situation by increasing GDP per capita and decreasing their TPES/GDP ratios but stayed in the same quadrant between 1980-2008.

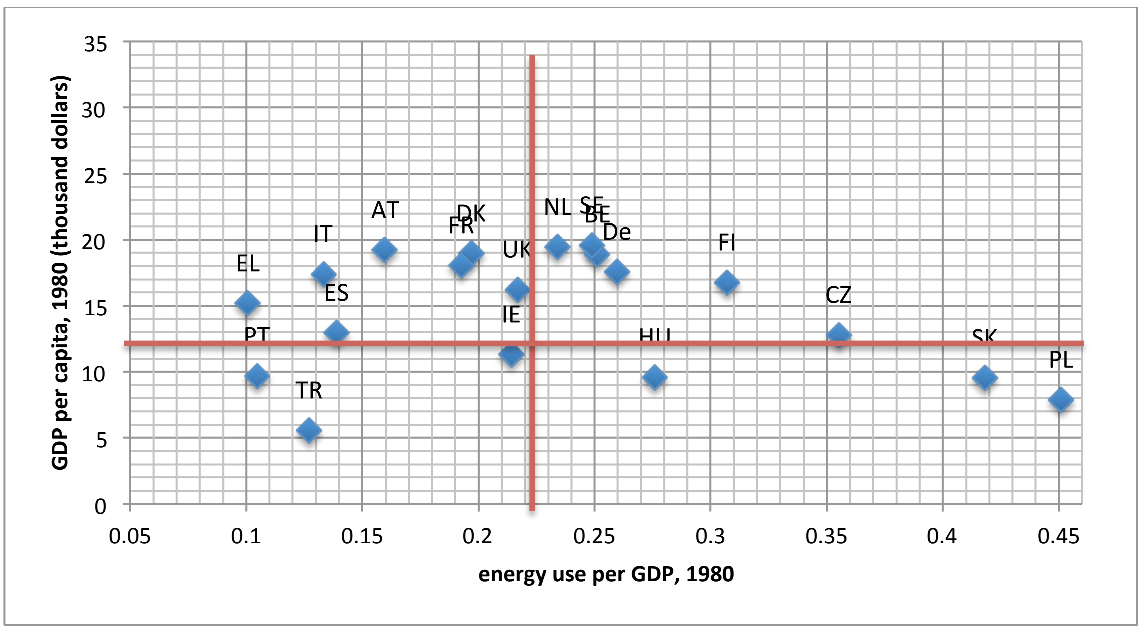

Figure 5- 13 GDP per capita and energy use per GDP, 1980

[19] In order to attain a decent graphical demonstration, Luxembourg is not shown on the graphs since its GDP per capita is extremely high compared to other countries.

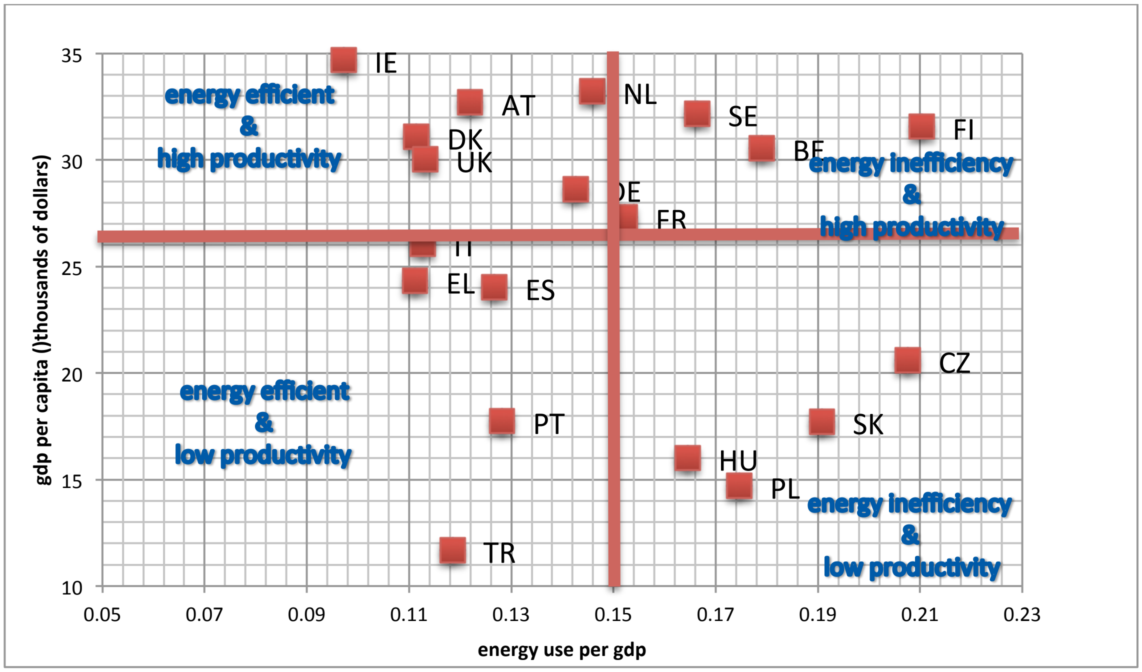

Figure 5- 14 GDP per capita and energy use per GDP, 2008

In Turkey, GDP per capita has doubled but TPES/GDP almost stayed same during this period. Here we again confirm that although GDP per capita increased, energy intensity does not show any desirable progress in Turkey. Increased economic activity and improved living conditions explain the increase in GDP per capita. But we cannot claim Turkey improved her energy efficiency during 1980-2008.

Figures 5-15 and 5-16 show TPES/GDP and net import dependency in 1980 and 2008, respectively. The aim of this demonstration is to find out whether there is a negative relation between energy intensity and net import dependency. As expected, when the net import dependency increases for a country, the energy intensity, in other words, the TPES per GDP should decrease. Increasing energy import would be a burden on the economy and countries seek to find ways to produce one unit of output with less energy input. We examine if such a trend exists from Figures 5.15, 5.16.

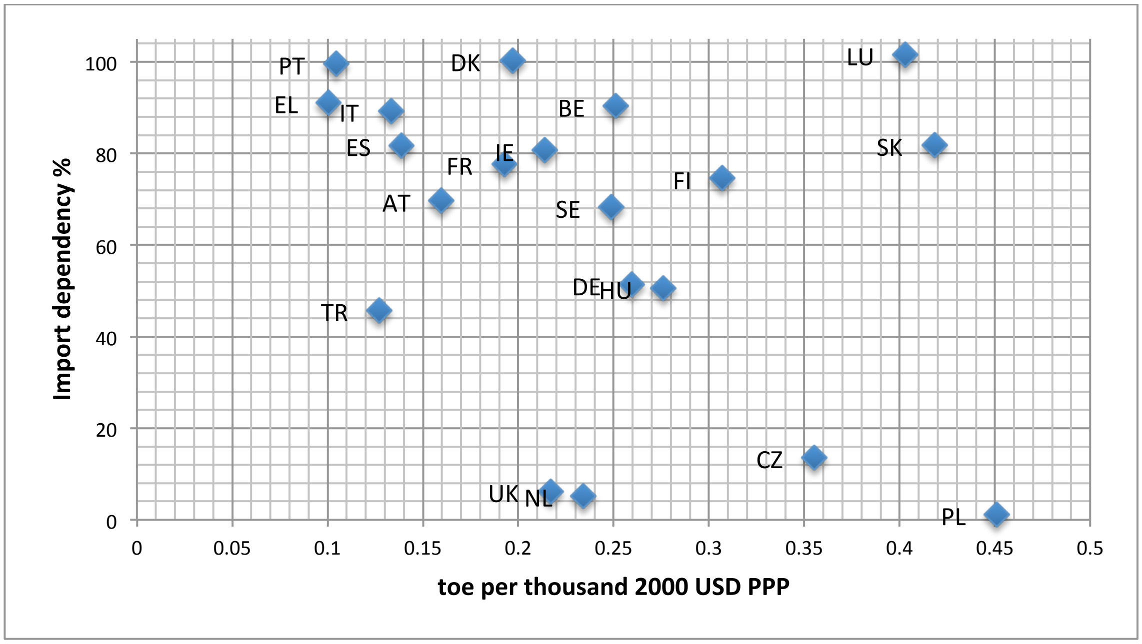

Figure 5- 15 Net import dependency and TPES/GDP, 1980

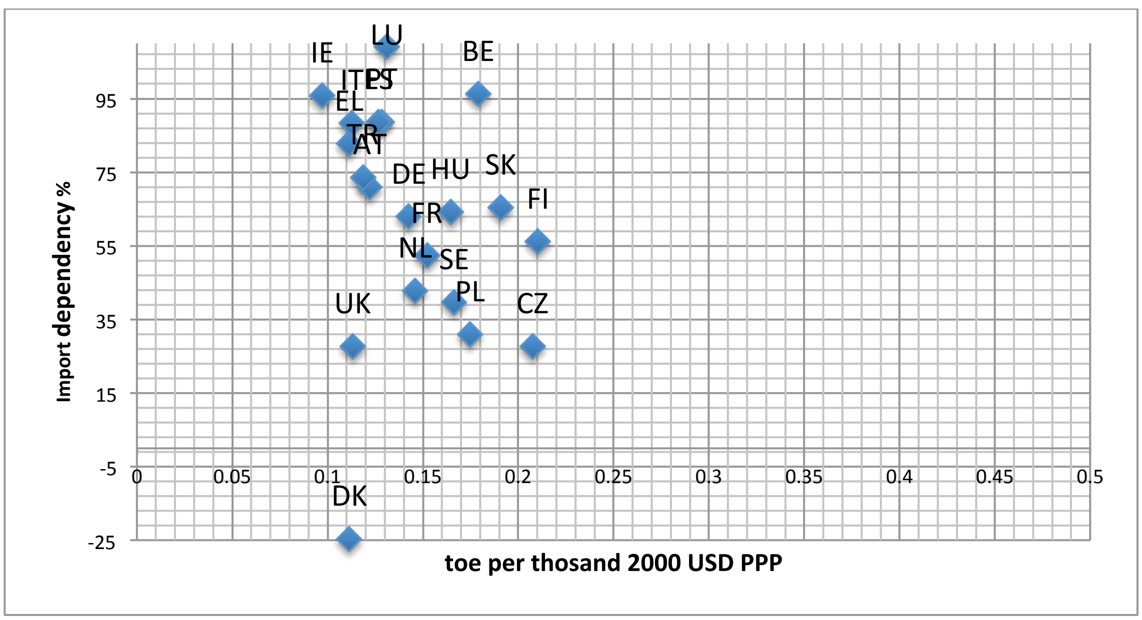

Figure 5- 16 Net import dependency and TPES/GDP, 2008

According to Figures 5-15 and 5-16, Belgium, Czech Republic, Germany, Hungary, Ireland, Luxembourg, Netherlands, Poland, Spain, Turkey and the United Kingdom all increased their import dependency between 1980-2008. We also expect these countries to decrease their TPES/GDP ratios but especially, Turkey and Spain did not show such a pattern. The energy intensities did not decrease as much as the increase occurred in import dependency ratios. Denmark, on the other hand, demonstrates a different pattern compared to other countries between 1980-2008. Contrary to many countries, Denmark managed to decrease her import dependency significantly and became an energy exporter country. It has been self sufficient in energy use since 1999 due to gas and oil production in North Sea. Oil and gas cover the two thirds of primary energy supply in Denmark. Moreover, the production of oil has been significantly increasing since 2000s and Denmark is the second largest oil producer in EU (EC, 2007).

5.1.3. ECO 6: Industrial energy intensities

Energy use per unit of value added in the industry gives information about industrial energy intensity. In general, intensity indicators provide information about energy use per unit of output. These indicators are helpful to monitor the trends in energy intensity. Moreover, we can evaluate the technological improvements and changes in the structure of the relevant sector by analyzing these indicators. We use final energy consumption/industrial value added and electricity consumption/ industrial value added in order to calculate this indicator[20]. This indicator is useful to determine the structural changes and to evaluate the trends about technological improvements in this sector. We compare countries according to their energy intensities and then conclude whether a decline in energy intensity is attained or not.

[20] In industrial energy intensity analyses, we compare Turkey and EU 27 since value added data for EU 15 countries are not available.

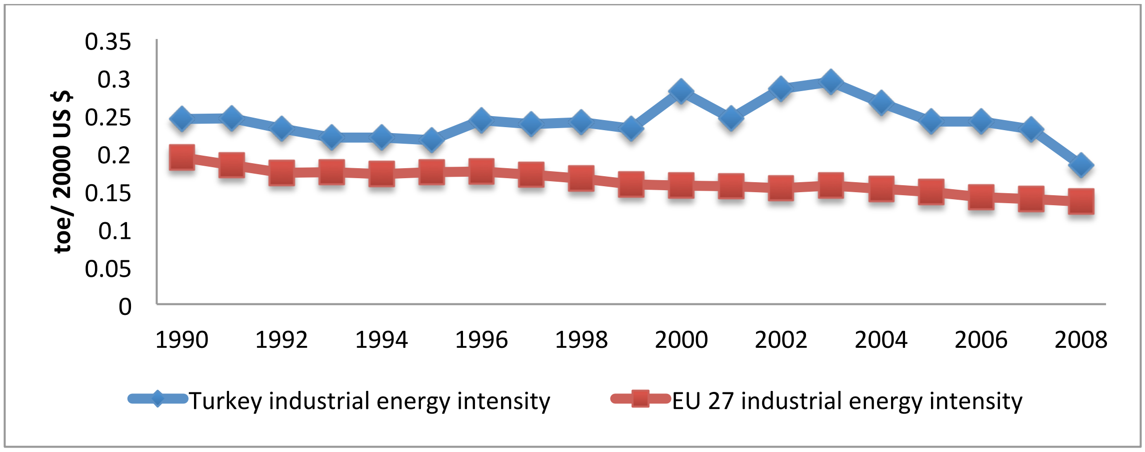

Figure 5- 17 Industrial energy intensities of Turkey and EU 27

Figure 5.17 points out that both Turkey and EU 27 have decreased their industrial energy intensities between 1990 and 2008 by 25% and 31%, respectively. Turkish industrial energy intensity stayed more or less stable until 1999 and after that period, there have been many fluctuations. The final energy use increased by 63%, value added increased by 117% and energy intensity decreased by 25 in Turkey between 1980-2008. Nevertheless, Turkey catches up EU 27 in 2008.

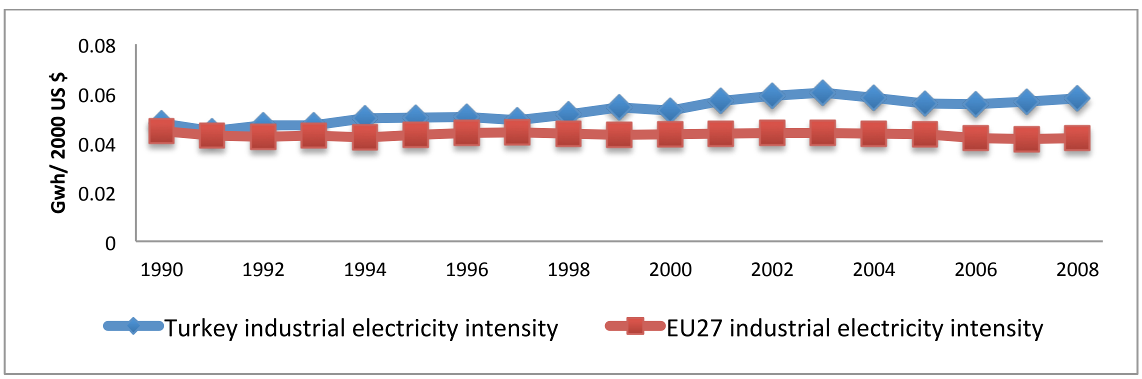

Figure 5- 18 Industrial electricity intensities of Turkey and EU 27

As it is seen from Figure 5-18, similar pattern is observed in electricity intensities of Turkey and EU 27 yet the electricity intensity trend is more stable than energy intensity in Turkey. EU 27 managed to decrease industrial electricity intensity by 7% between 1990-2008 whereas in Turkey industrial electricity intensity increased by 21% during the same period. Increasing electricity use in industry may imply growing electricity intensive sectors in Turkey. If we look at the changes in value added and final electricity use in Turkey between 1990-2008 we can confirm increasing electricity use in industry. While value added of industrial sector increased by 117%, total electricity use increased by 164% and electricity intensity increased by 21% in Turkey.

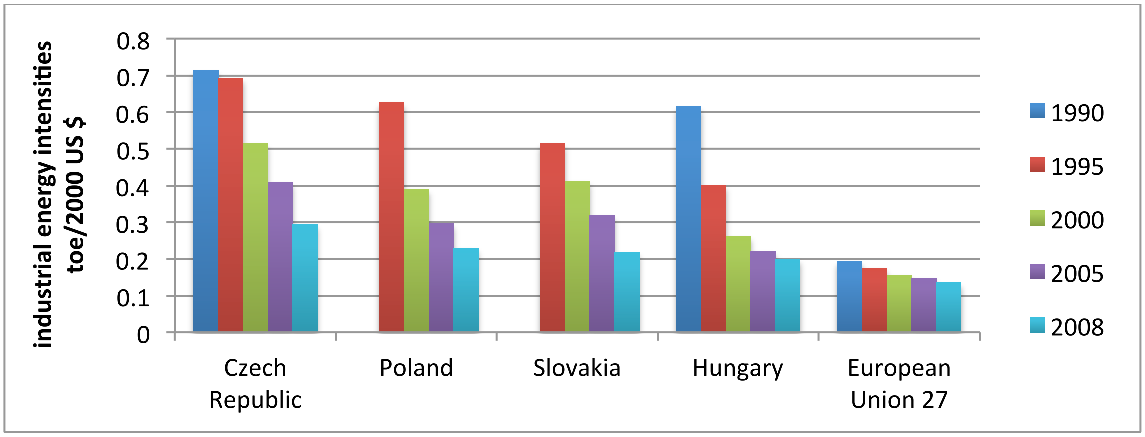

Figure 5- 19 The highest industrial energy intensities

In Figure 5.19, the highest industrial energy intensities are observed in Poland, Czech Republic, Hungary and Slovakia. These countries have significantly higher industrial energy intensities compared to EU 27. For the case of these countries, high energy intensities may imply higher costs or price of converting energy into GDP. Opening up the economies, changes in ownership structures, rising prices of raw materials and removal of energy subsidies are common characteristics for these countries. Although, they have higher energy intensities, their speed of decreasing energy intensities are also very high in these countries throughout the years. We can claim that they are more successful in decreasing industrial energy intensities during this period.

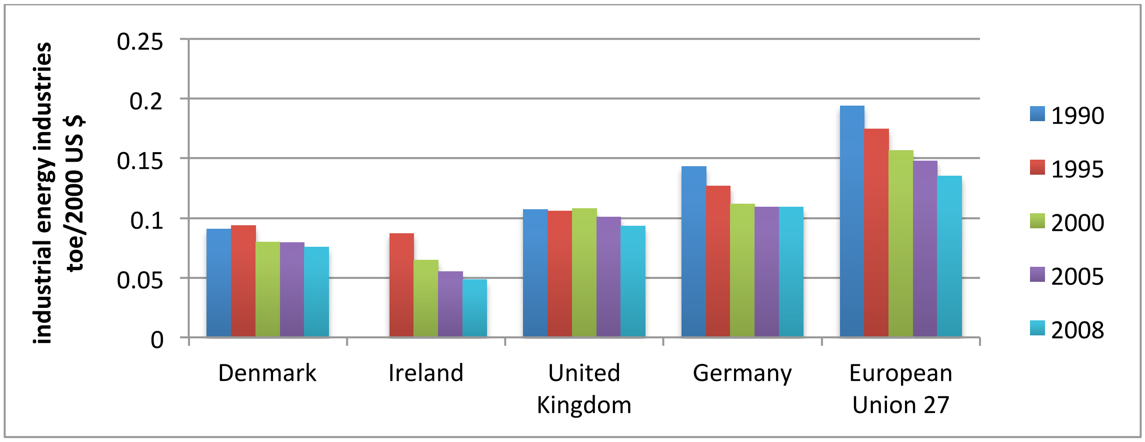

Figure 5- 20 The lowest industrial energy intensities

Contrary to transition countries, Ireland, Denmark, United Kingdom and Germany have managed to achieve the lowest industrial energy intensities during 1990-2008 as shown in Figure 5-20. The possible reasons why these countries have lower industrial energy intensities might be: increased service sector as in Ireland, decreased manufacturing sector as in United Kingdom, structural shift from energy intensive sectors to less energy intensive sectors as in Germany (WCE, 2010a). Decreased industrial energy intensities are mainly influenced by two factors: improvements in energy efficiency and structural changes in the economy. There has been a shift from industry to service sector and a shift towards less energy intensive but higher value added sectors. Nevertheless, it would be better to keep in mind that as service sector activities are increasing, the demand for heating, cooling and transportation for households are increasing as well. Thus the energy demand will inevitably be increasing. Whether this demand would offset the decrease in energy intensities or not is unclear.

When we analyze industrial energy intensities of countries, we observe the following: transition countries such as Poland, Czech Republic, Slovakia and Hungary have the highest industrial energy intensities and also the highest rates of declines observed during the period 1990-2008. United Kingdom, Denmark, France, Greece, Spain, Germany, Italy and Austria followed a relatively stable trend that is decreasing between

1990-2008. Considerable decreases were achieved by Turkey, Ireland, Belgium and Netherlands. Except for Poland, Czech Republic, Slovakia and Hungary, the most significant decreases were achieved by Luxembourg, Finland and Sweden whose energy intensities were higher.

On the other hand, when we analyze industrial electricity intensities of countries, results are similar to energy intensities: transition countries (Poland, Czech Republic, Slovakia and Hungary) have the highest intensities and they have the highest speed of decline. United Kingdom, Denmark, Netherlands, France, Belgium, Greece and Austria followed a relatively stable trend that did not change much between 1990-2008. Turkey and Portugal increased their electricity intensities significantly and intensities of Germany, Spain and Italy have increased slightly. The countries whose electricity intensities were significantly high but were decreased throughout the period are Luxembourg, Sweden, Finland and Ireland.

According to IEA (2008) report, since 1990 energy efficiency improvements in Europe have been significant. Sectoral analysis in IEA report reveals the fact that industry has the largest part in that success as the efficiency improved by 20% since 1990. Especially the EU-ETS promotes the energy efficiency in industry by reducing the carbon dioxide emissions. Apart from ETS scheme, there are some other programs such as Best Available Techniques Reference Document (BREF) and The Motor Challenge Program to increase efficiency (IEA, 2008a).

As mentioned above, the trend in Europe is towards a decrease in the amount of energy required per unit of value added. Moreover, industrial intensities are converging to lower rates through time. The possible reasons for this convergence are as follows: globalization of industrial activities, energy productivity improvements in some branches (e.g. steel, chemicals, non-metallic minerals) and changes in the structure of the industrial value added. Moreover, specialization in less energy intensive branches contributes to the decrease in intensities. On the contrary, increasing intensities is influenced by the growing importance of energy intensive industries that take place in the Middle East region (WCE, 2010). By contrast, European economy shifts to a more service oriented economic structure and therefore, this decreases the industrial energy intensities.

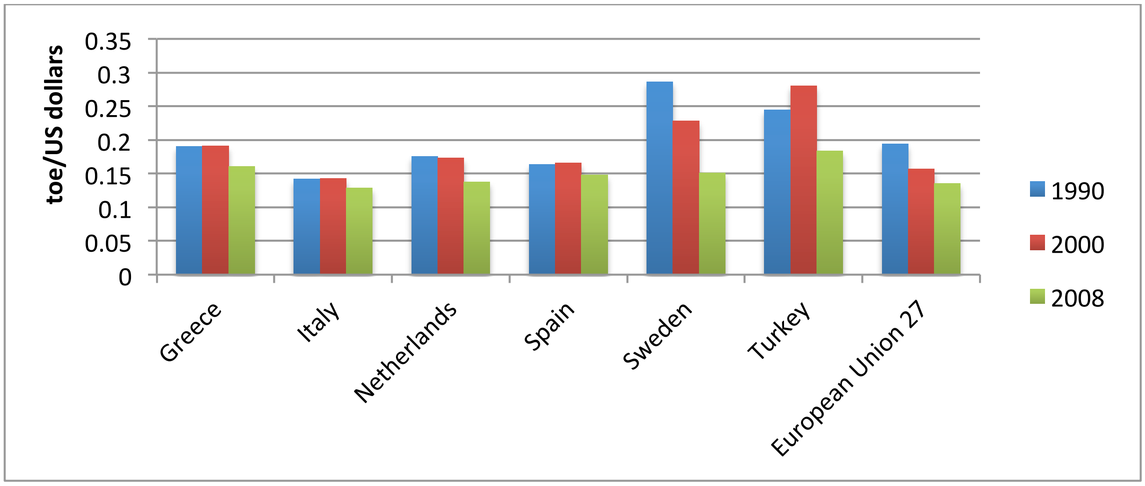

Figure 5- 21 Industrial energy intensities of selected countries

Figure 5.21 shows industrial energy intensities for selected countries in 1990, 2000 and 2008. Greece, Italy, Netherlands, Spain and Sweden are compared to Turkey as all countries have similar value added figures. Also geographically, Turkey and Greece, Italy and Spain locate in the same region. As can be seen from Figure 5.21, EU 27 has achieved a significant decrease: its industrial energy intensity decreased by 30.31% between 1990-2008. Italy, Netherlands, and Sweden decreased their industrial energy intensity by 9%, 21%, and 47%, respectively. Although, there are slight increases from 1990 to 2000 in Turkey, Greece and Spain, they also managed to decrease industrial energy intensity by 25%, 15% and 9% respectively. Turkey increased her industrial intensity by 14.7% in 2000 compared to 1990 level. In Turkey, the share of energy-intensive sectors in industry may have increased during this period. Strong economic growth may have led to an increase in the demand for energy and this might have increased the use of energy that resulted in an increase in industrial intensities.

In Turkey, the need to take precautions and develop energy policies by taking into account energy efficiency resulted by the introduction of the Energy Efficiency Law in 2007. Priority policies and programs are prepared for increasing energy efficiencies and decreasing energy intensities not only for industrial sector but also for all sectors. Raising public awareness, monitoring sector specific energy consumption and supporting energy efficiency projects are some of them (IEA, 2009).

5.1.4. ECO7: Agricultural energy intensities

This indicator is a tool to analyze energy intensity in agricultural sector. Agricultural activities include land preparation, mechanization, fertilization, irrigation, harvesting, transport, processing and storage. All these activities require different forms of energy (IAEA, 2005). Monitoring the changes in agricultural energy intensity will help us to guide policy and investment decisions regarding energy issue in agriculture.

Higher energy intensity implies either high level of energy consumption or low level of value added in agriculture. Low intensity and large share of agriculture in the economy imply efficient energy use in the related sector. For instance, Turkey has the largest share and lower intensity compared to other countries. As, share of agriculture is very small in Belgium and Denmark and the energy intensities are higher, we can claim that both countries are not energy efficient. A similar pattern is observed for the transition countries. Poland, Hungary and Czech Republic do not have an intense agricultural sector and their energy use is very high. Countries such as Luxembourg, Sweden, Germany, Italy, France, Ireland and Austria have also smaller shares compared to other sectors and their energy intensities are also lower; therefore, those countries are efficient in energy use. Compared to other countries' share of agriculture and energy intensities, Turkey, Greece, Spain, Finland, Portugal and Slovakia successfully achieved energy efficiency in agricultural sector because they have relatively larger share of agriculture with relatively lower energy intensities.

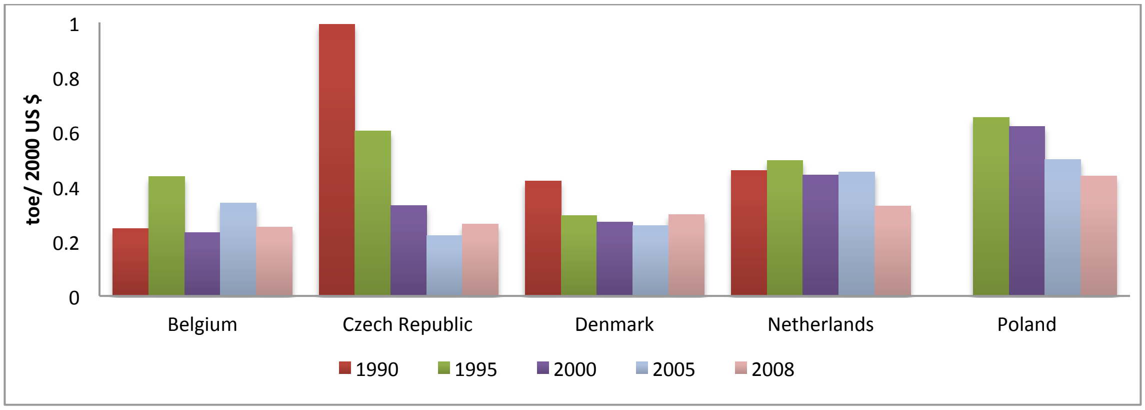

Figure 5- 22 Highest agricultural energy intensities

Figures 5-22 and 5-23 show countries with the highest and lowest agricultural energy intensities, respectively. Belgium, Czech Republic, Denmark, Netherlands and Poland have higher agricultural energy intensities with lower shares in agriculture as seen in Figure 5.22. There is not a common pattern for these countries. Except Belgium all countries managed to decrease their agricultural energy intensities: Belgium (2.38%), Czech Republic (-73%), Denmark (-29%), Netherlands (-28%) and Poland (-16%) between 1990-2008.

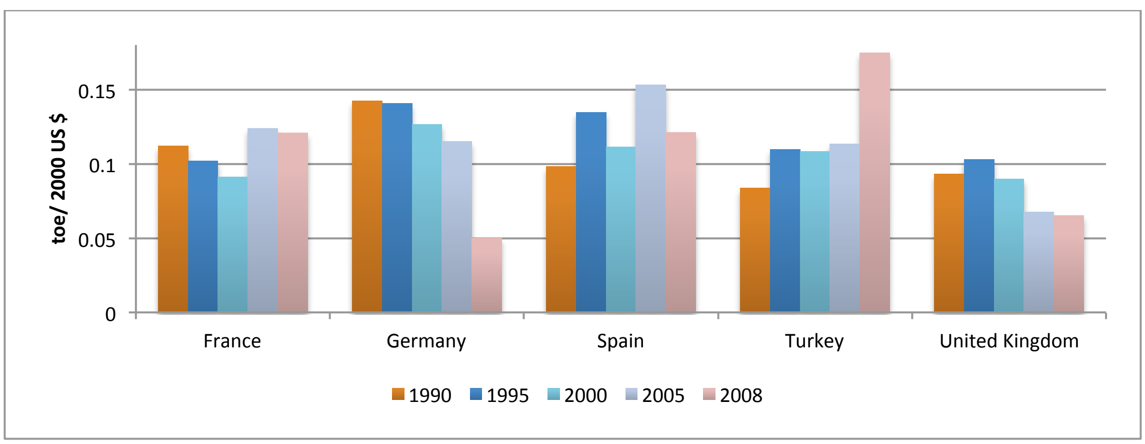

Figure 5- 23 Lowest agricultural energy intensities

France, Germany, Spain, Turkey and United Kingdom have the lowest agricultural energy intensities as can be seen in Figure 5-23. Spain and Turkey increased their energy intensities by 23% and 109%, respectively. Other countries decreased their energy intensities: France (-7%), Germany (-64%) and United Kingdom (-30%).

If we consider other countries, we see that Luxembourg is keeping the agricultural share constant, while her agricultural energy intensity is increasing. Also, Hungary and Finland achieved to decrease their intensities. Spain increased the share of agriculture in GDP whereas Portugal decreased it while both countries managed to keep intensities constant during 1990-2008. Turkey increased her agricultural energy intensity considerably, which violates the sustainability goals about energy intensities. The agricultural energy intensity increased from 0.08 to 0.17 and share of agriculture in the economy decreased from 13.42 to 8.46 between 1990 and 2008 in Turkey. Nevertheless, compared to other European countries, Turkey still has lower energy intensity and higher share of agriculture.

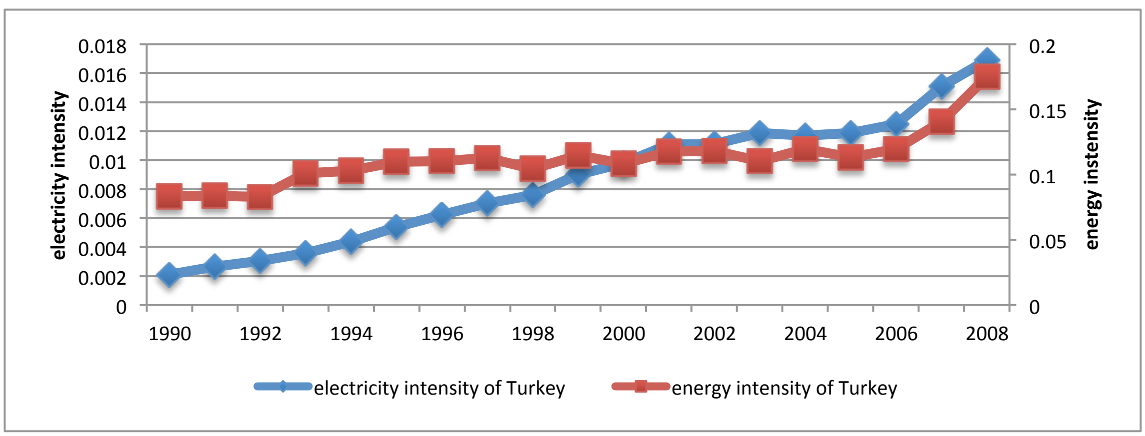

Figure 5- 24 Agricultural energy and electricity intensities of Turkey

Figure 5.24 shows electricity and energy intensities in agriculture. There is a steep increase in electricity intensity while energy intensity shows a relatively stable change. In Turkey, agricultural value added increased by 22%, final energy use in agriculture increased by 157% and final electricity use in agriculture increased by 898 %. The increase in electricity use is quite significant. Electricity use has increased during the period 1990-2008 and thus electricity intensity increased by more than ten times. The technological improvement of equipments used in agriculture might be the reason for this intensity rise due to increased need for electricity.

5.1.5. ECO 8: Service sector energy intensities

Service sector is one of the major components of GDP. Considering the increasing share of service sector in the whole economy, this indicator is useful to monitor the trends in energy and electricity use. Like any other sector, sustainable development targets to increase energy efficiency, reduce overall energy use and minimize negative environmental impacts of the service sector. Countries take actions about lighting or heating to reduce energy intensity of the service sector. Although service sector is less energy intensive compared to industry, the use of electricity might be more because of lighting, heating, ventilation, computing and lifting.

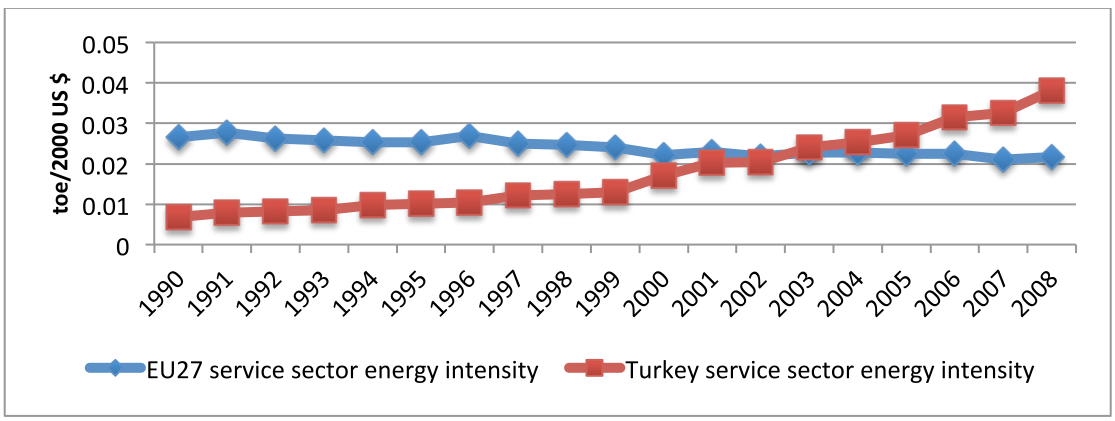

Figure 5- 25 Energy intensity in service sector for Turkey and EU 27

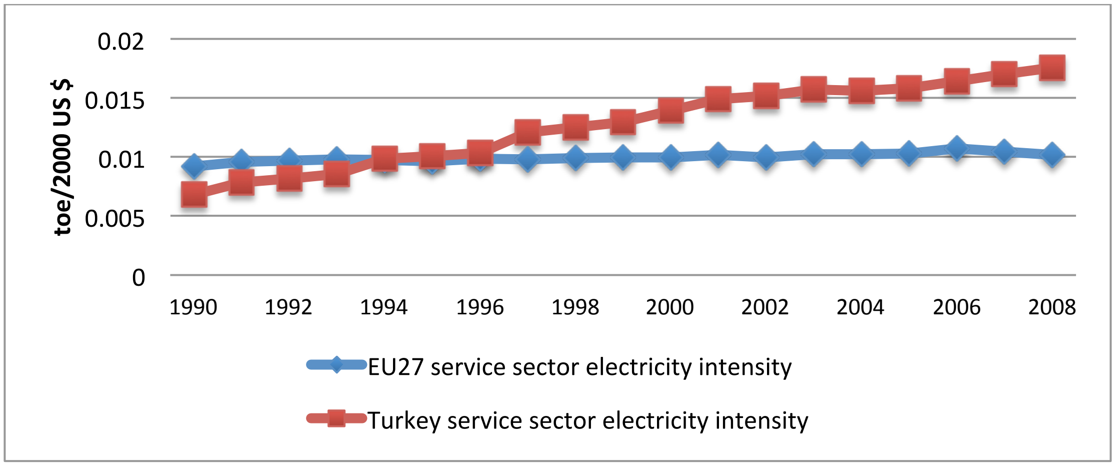

Figure 5- 26 Electricity intensitiy in service sector for Turkey and EU 27

As observed from Figure 5-25, service sector energy intensity in Turkey shows a steep increase especially after 2000s and it almost quintupled compared to 1990 values. Value added of this sector increased by 113% and final energy use increased enormously during 1990-2008. Similarly, electricity intensity increased by 157% during 1990-2008 as denoted in Figure 5-26. Both service energy and electricity intensities increased enormously in Turkey while in EU 27 these values relatively stayed unchanged. The electricity and energy consumption increased more than value added. Service sector energy and electricity intensities are growing faster than the value added for Turkey. Especially, increased use of air conditioning and office appliances may be the reason of this increase, but such a trend in industrialized countries like EU 27 is not observed (WCE, 2010b).

5.1.6. Total sectors

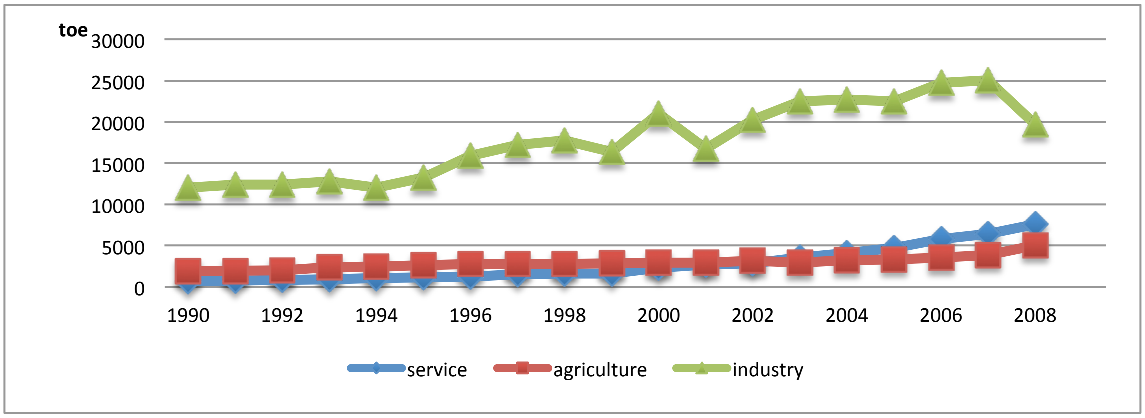

Figure 5- 27 Final energy consumption in Turkey by sectors

Figure 5-27 denotes that in Turkey, final energy consumption in the service sector has a growth rate of 1094% between 1990 and 2008 whereas; it is 157% and 63% for agriculture and industry, respectively. Although the level of consumption of energy in the industrial sector is the highest, the maximum change in energy use is observed in service sector. Figure 5.28 shows the percentage share of final energy use in each sector. Industry share in final energy use has decreased by 26% whereas share of agriculture in final energy use and share of service sector in final energy use have increased by 16% and 441%, respectively. The modernization of equipments used in service sector and the construction of new buildings in Turkey might have increased the demand for energy.

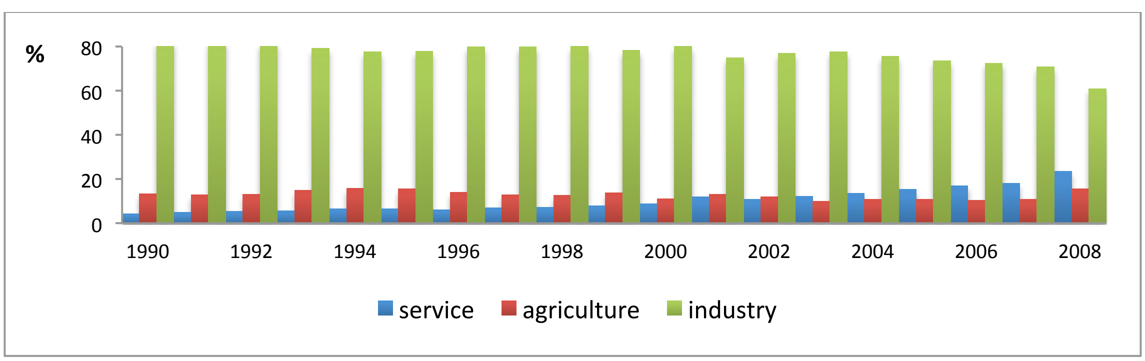

Figure 5- 28 Share of energy use in Turkey by sectors

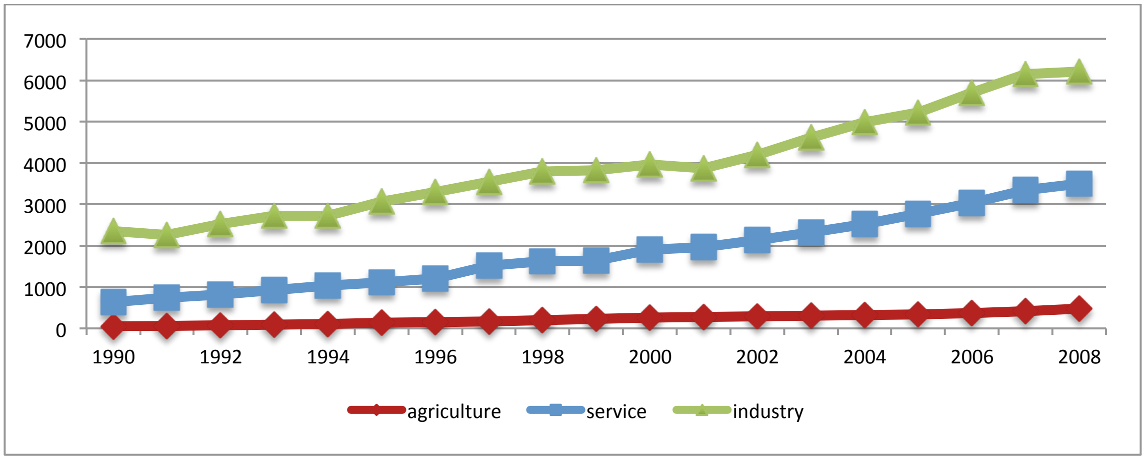

Figure 5- 29 Final electricity consumption of Turkey by sectors

In Figure 5.29, final electricity use has increased by 164% in industry during the period 1990-2008 while it has also increased by 889% and 450% in agriculture and service sectors, respectively. The electricity use has increased significantly in agricultural sector.

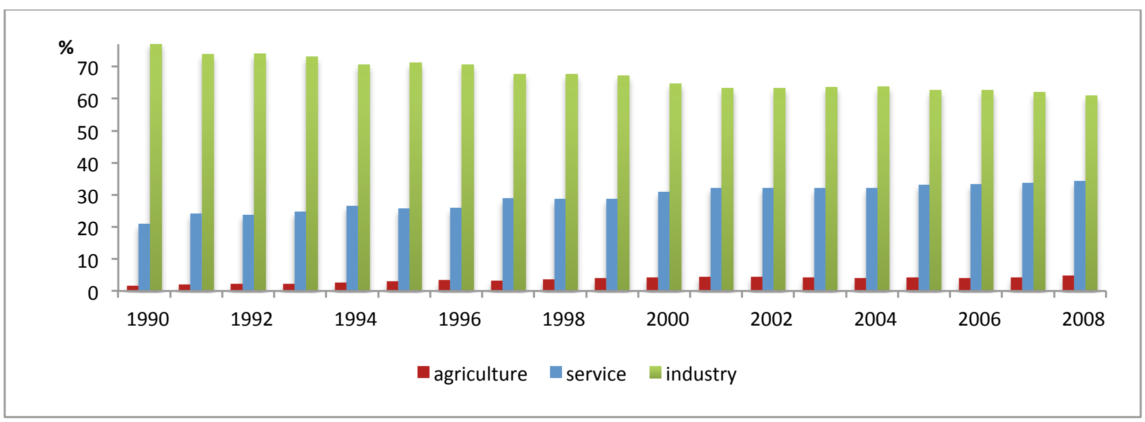

Figure 5- 30 Share of electricity use in Turkey by sectors

Figure 5.30 shows the percentage share of final electricity use in each sector. Industry share in final energy use has decreased by 21% whereas share of agriculture in final energy use and share of service sector in final energy use have increased by 195% and 64%, respectively.

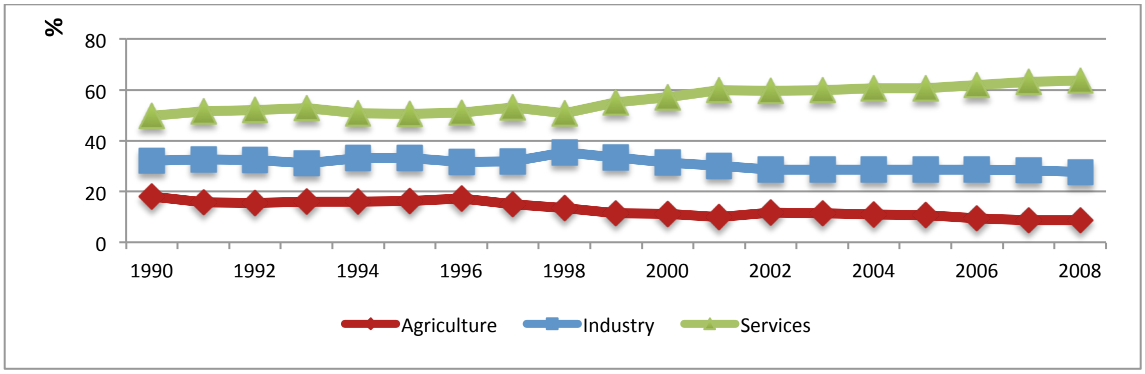

Figure 5- 31 Share of value added by sectors in Turkey

In Figure 5-31 we observe the share of value added by sectors. Share of value added of agriculture and industry decreased by 52% and 13%, respectively during 1990-2008. Share of value added of service sector increased by 28% during 1990-2008. In agriculture, value added decreased by 52%, energy intensity increased by 109% and electricity intensity increased by 705% due to increased final energy and electricity use. In industry, value added decreased by 13%, energy intensity decreased by 25% and electricity intensity increased by 21%. In service sector, value added increased by 28%, energy intensity increased by 460% and electricity intensity increased by 157% due to increased final energy and electricity use.

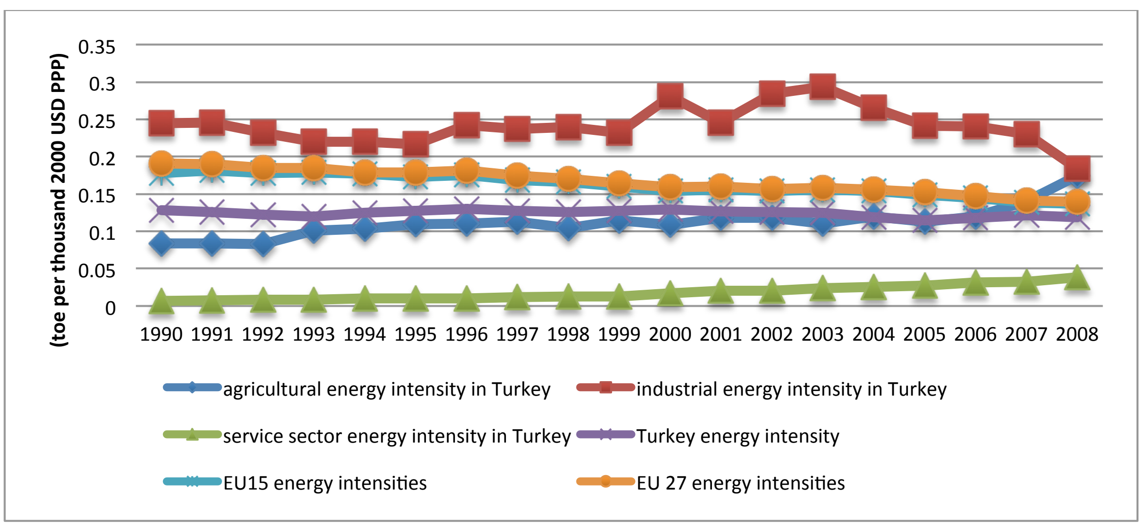

Figure 5- 32 Overall and sectoral energy intensities for Turkey, EU 15 and EU 27

Energy intensity in agriculture and service sectors has increased considerably while it decreased in industry. Overall energy intensity of Turkey did not change significantly, which is not a desirable outcome for sustainability goals. We observe a convergence of energy intensities of Turkey, EU 15 and EU 27 during 1990-2008 as can be seen from Figure 5-32. Considering Turkey's adaptation to EU regulations and legislation on her way to EU membership, convergence of Turkey with EU 15 and EU 27 can be regarded as a desirable progress but this trend cannot be assigned to the success of Turkey at decreasing her energy intensities; the reason behind this trend is the success of EU 15 and EU 27 at decreasing their intensities during this period.

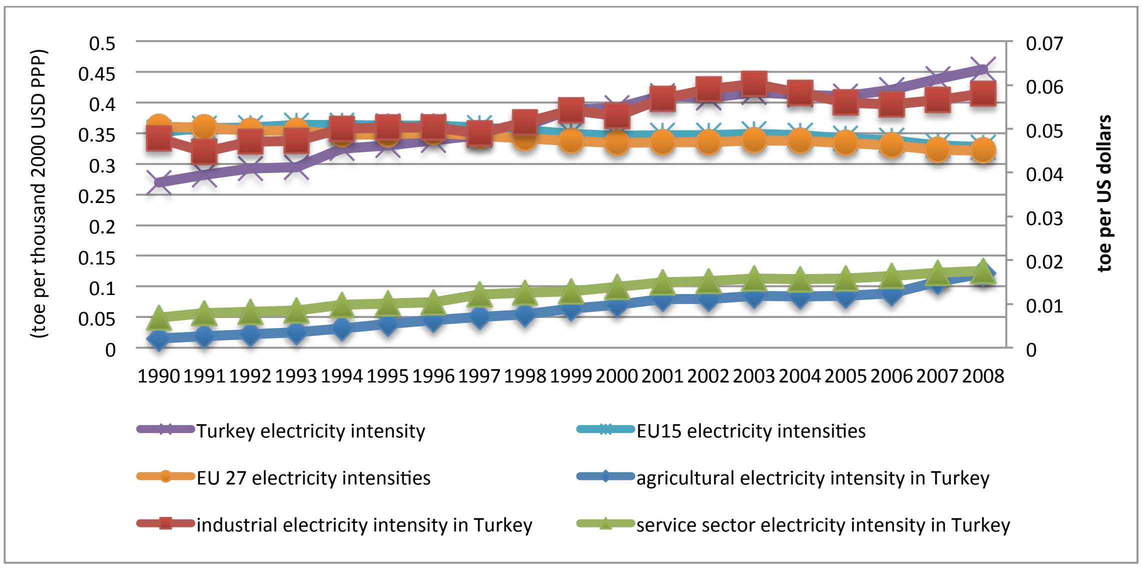

Figure 5- 33 Overall and sectoral electricity intensity for Turkey, EU 15 and EU 27

As it can be observed from Figure 5-33 in Turkey, electricity intensities are increased in agriculture and service sector and compared to them, in industrial sector it stayed stable. EU 15 and EU 27 have decreased their electricity intensities slightly during 1990-2008 whereas electricity intensity of Turkey has increased significantly by 73% during the same period. This might be due to increases in electricity demand because of increasing use in heating and cooling systems and rapidly growing population that also increases the demand for electricity in Turkey.

Turkey is converging to European Union countries in terms of her increasing energy use and production because of increasing population and increasing demand for energy.

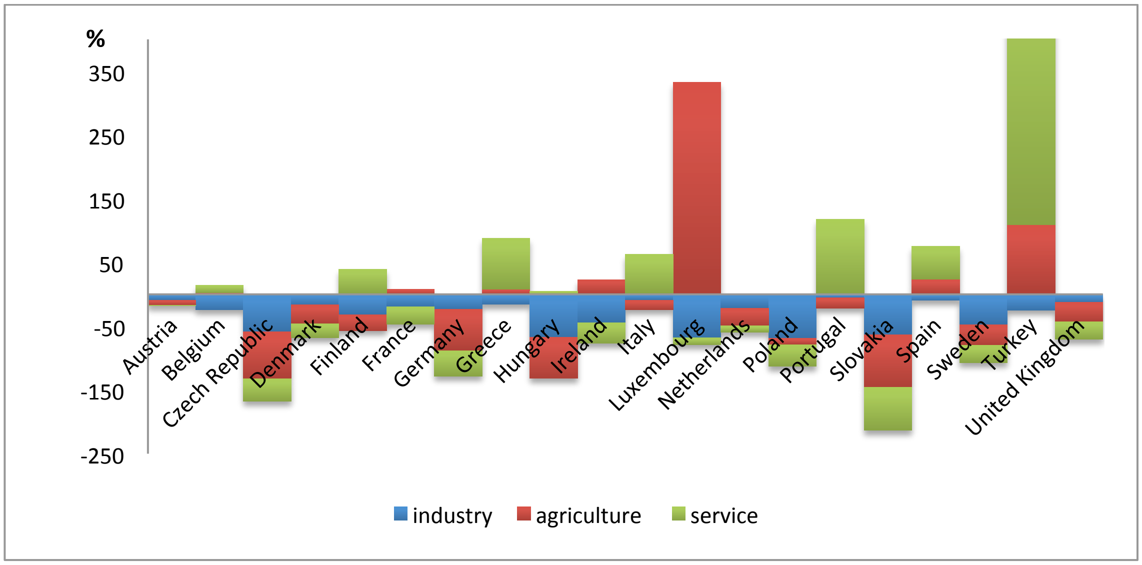

Figure 5- 34 Growth of sectoral energy intensities between 1990-2008

As can be seen from Figure 5-34, Poland, Czech Republic, Slovakia, Hungary and Luxembourg managed to reduce their industrial energy intensities the most. In agricultural sector the intensities decreased most in Germany, Czech Republic, Slovakia and Hungary whereas the intensities of agricultural sector increased significantly in Ireland, Turkey, Spain and Luxembourg. Lastly, in the service sector, energy intensities of Turkey, Greece, Portugal, Finland, Italy and Spain increased whereas it decreased the most in Poland, Czech Republic, Slovakia, Germany and Ireland. Austria, Czech Republic, Denmark, Germany, Netherlands, Poland, Slovakia, Sweden and United Kingdom managed to decrease energy intensities for all sectors. Industrial energy intensities are reduced in all countries but agricultural and service energy intensities are increased in some countries such as Belgium, Greece, Spain and Turkey.

5.2. Energy Security and Fuel Mix

The second energy policy priority is energy security and fuel mix. As discussed in Chapter Three, increasing demand for energy and limited domestic energy sources have led the countries to increase their energy import rates. This is valid both for European Union and Turkey. Fuel mix, on the other hand, is a crucial subject implying that sustainable development encourages using less carbon energy sources and increasing the use of renewable energy sources. Energy security and fuel mix title mainly targets to ensure sufficient energy supply, promote renewable energy and reduce import dependency. In this part of the study, we analyze the indicators which are relevant to the energy security and fuel mix issue. These indicators are non-carbon energy share in total primary energy and electricity, renewable energy shares in total primary energy and electricity and net import dependency.

5.2.1. ECO 12: Non-Carbon share in energy and electricity

This indicator determines the share of non-carbon energy sources in primary energy supply and in electricity generation. Non-carbon energy sources include combustible and non-combustible renewables[21] and nuclear energy. The higher share of non-carbon sources in the primary energy mix is crucial in terms of energy security, diversification of energy supply and environmental protection.

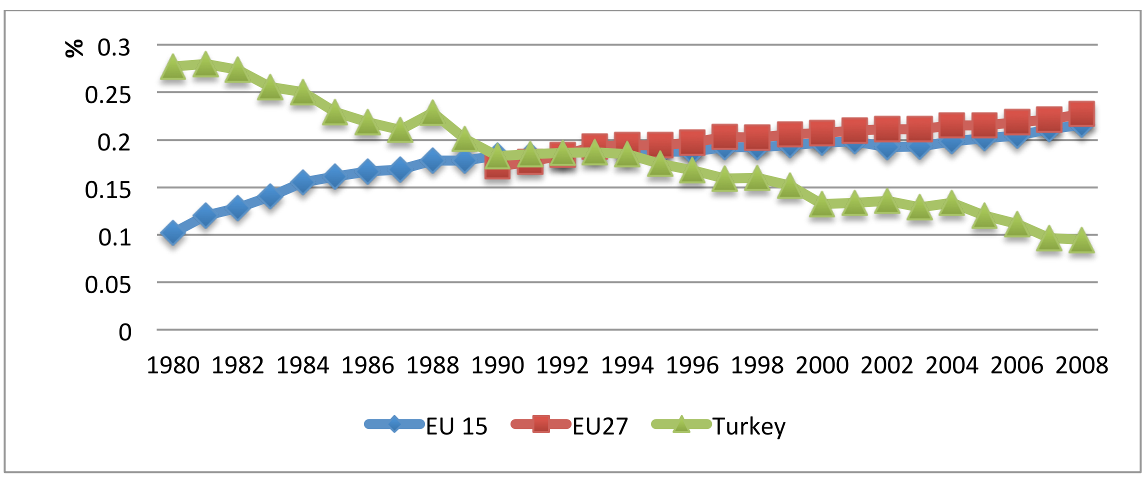

Figure 5- 35 Share of non-carbon energy sources in TPES

From Figure 5-35, contrary to EU 15 and EU 27, Turkey decreased the non-carbon share in energy by 65% during 1980-2008 whereas EU 15 and EU 27 increased their

[21] The definitions are given in Chapter Four.

shares by 112% and 32%, respectively. Similar trend is also valid for electricity generation from non-carbon energy sources as Turkey decreased the share by 64% and EU 15 and EU 27 increased their shares by 29% and 4.64%, respectively as observed in Figure 5-36. The pattern in 1988 is quite different than other years. The share of non-carbon energy sources in TPES and the share of non-carbon share energy in electricity generation increased significantly in 1988. The reason behind this trend is due to increase in hydropower energy. According to data obtained from Ministry of Energy and Natural Resources, hydropower increased by 54.3% between 1987-1988.

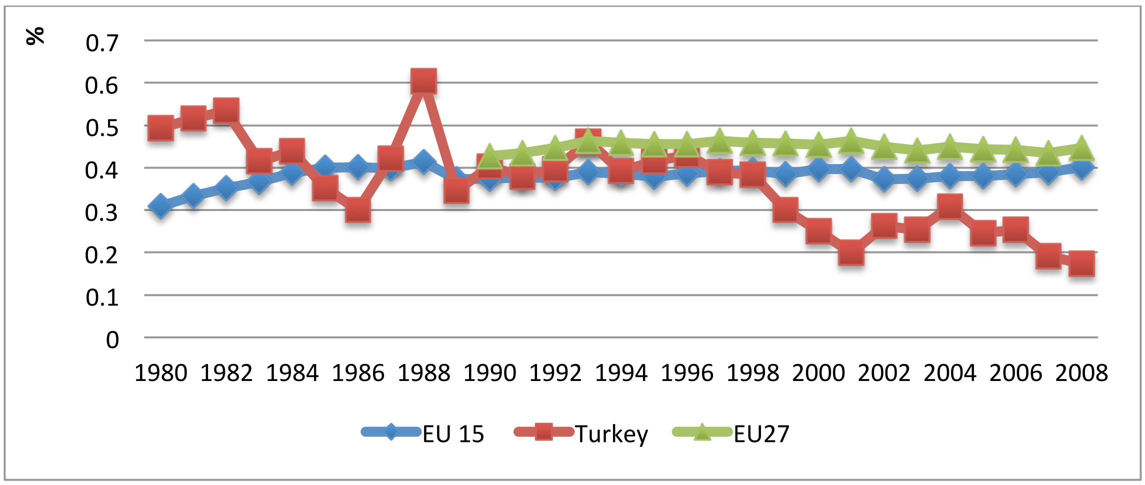

Figure 5- 36 Share of non-carbon energy sources in electricity generation

To sum up, the share of non-carbon energy and electricity in Turkey has decreased during 1980-2008 by 65% and 64%, respectively. Because the fuel mix of Turkey is dominantly composed of carbon based energy sources as can be seen from Figure 5.37[22] and Figure 5-38 share of non-carbon energy sources does not increase. Figure 5-38 exhibits the share of non-carbon energy sources as 24% of total primary energy supply in 2008 and the dominant energy source is coal which is a carbon-based energy source and its share in TPES is 44%. Electricity generation from non-carbon energy sources has declined between 1980-2008 as it can be seen from Figure 5-39 and 5.40.

[22] Crw: combustible renewable energy. Non-crw: non-combustible renewable energy.

Electricity is generated mainly from natural gas (50%) and coal (29%) in 2008 rather than non-carbon sources as we can see from Figure 5-40.

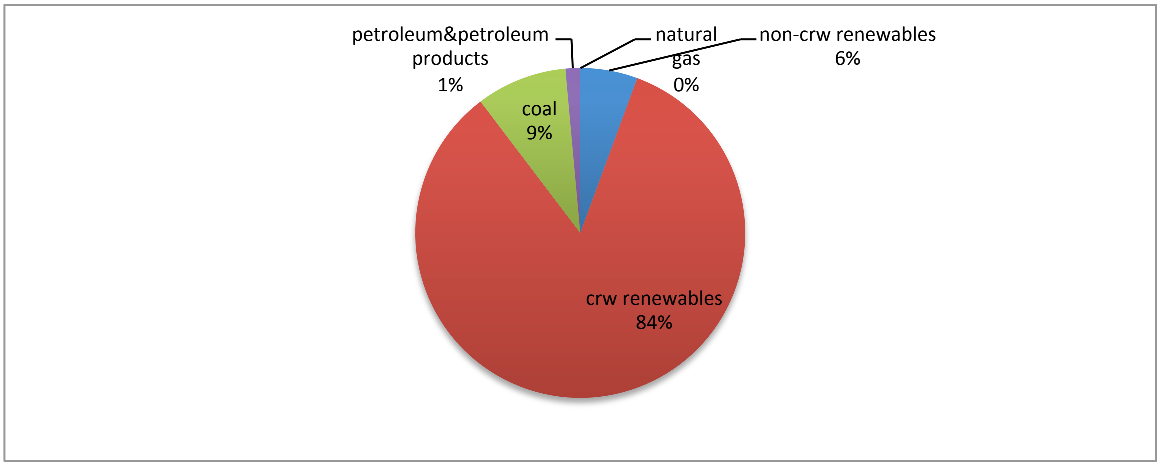

Figure 5- 37 Share of total primary energy sources in Turkey in 1980

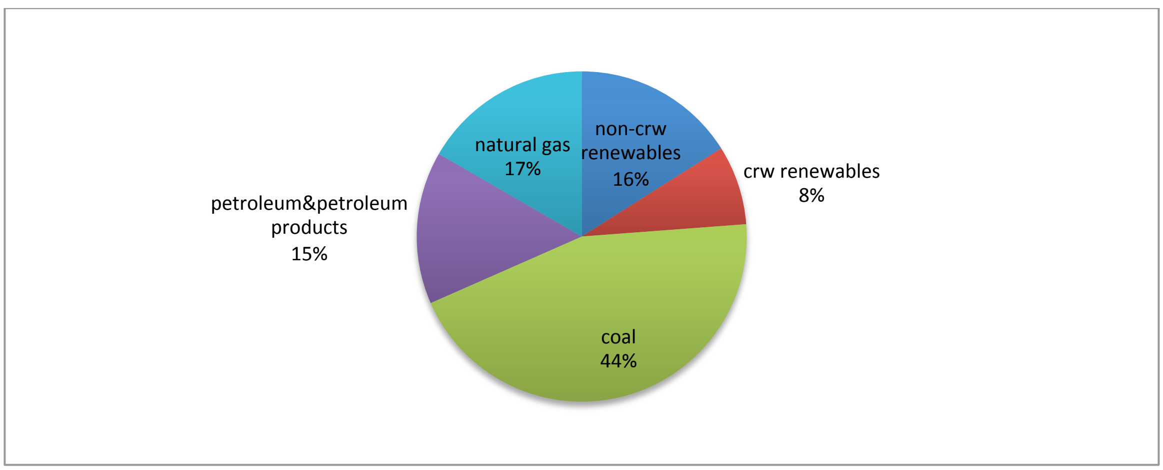

Figure 5- 38 Share of total primary energy sources in Turkey in 2008

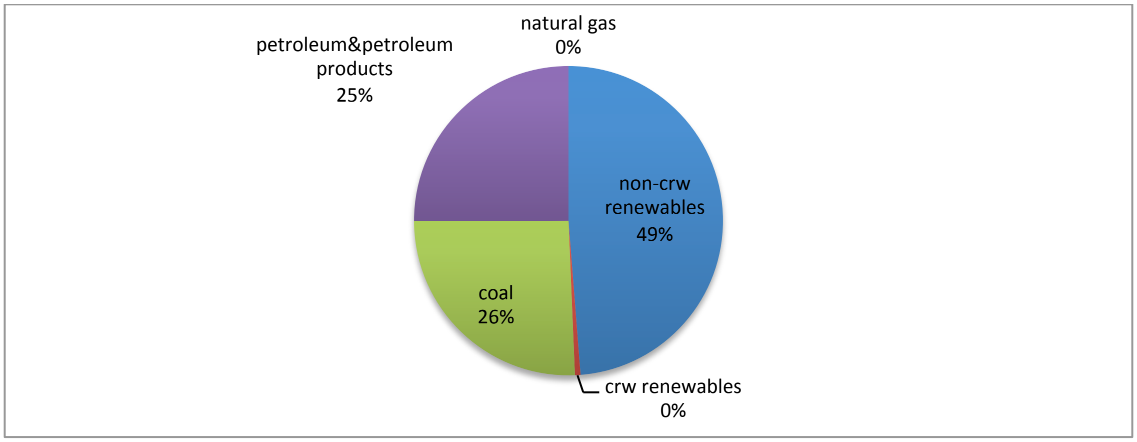

Figure 5- 39 Share of electricity sources in Turkey in 1980

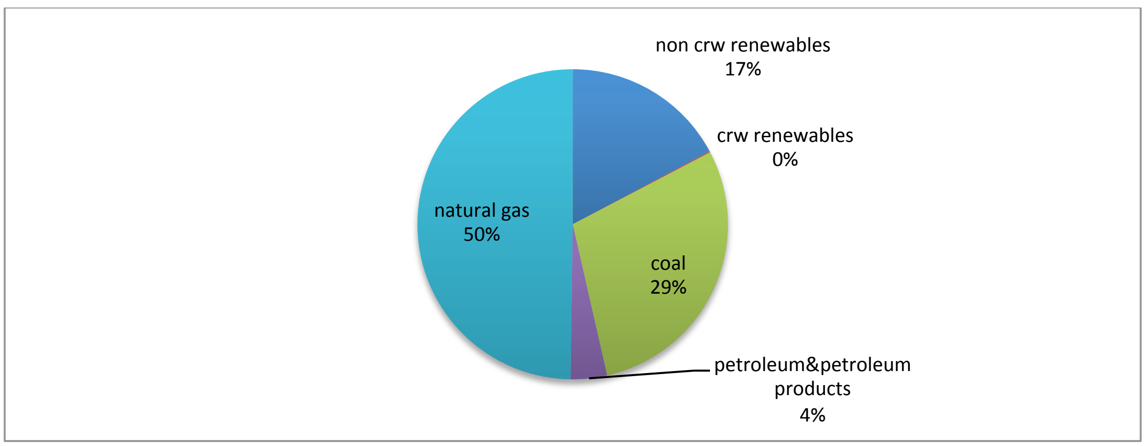

Figure 5- 40 Share of electricity sources in Turkey in 2008

Sweden, France, Finland, Austria, Belgium and Slovakia have the highest percentages of non-carbon energy share in TPES throughout the period. The same situation is valid for electricity data. Sweden, France, Austria, Finland, Slovakia and Belgium have the highest percentages of non-carbon electricity generation share throughout the period. The lowest ratios for energy and electricity shares between 1980-2008 belong to Luxembourg, Ireland, Netherlands, Poland, Greece and Italy.

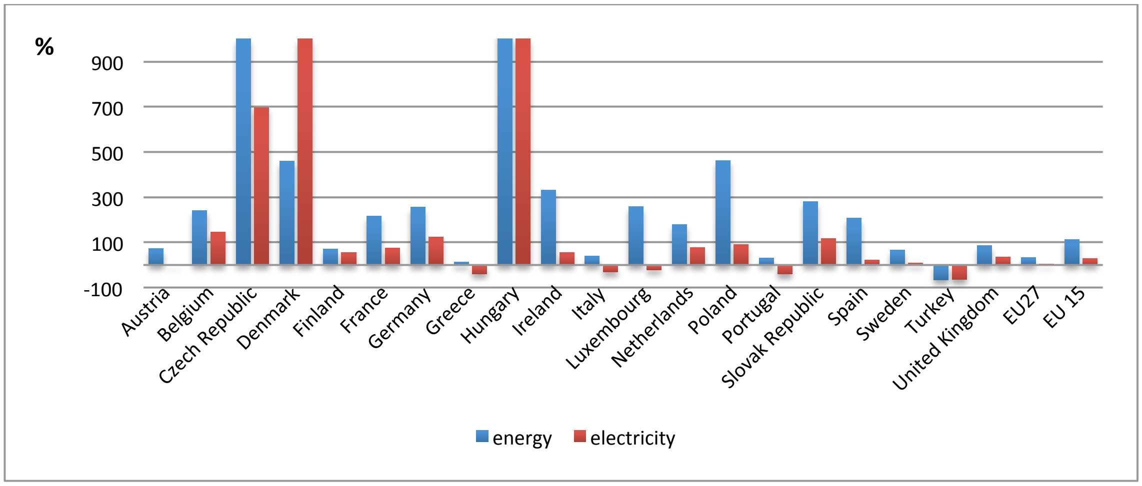

Figure 5- 41 Growth rate of non-carbon energy shares between 1980-2008

Figure 5-41 shows the progress of countries between 1980-2008. All countries have increased their non-carbon energy share in total primary energy except Turkey (-65%). In terms of non-carbon electricity generation share, the same trend is valid except for Turkey (-64%), Portugal (-40%), Greece (-39%), Italy (-31), Luxembourg (-21%) and Austria (-3%). Among these figures, the maximum decrease is observed in Turkey. Again the only country, which has negative growth rates for both total primary energy supply and electricity generation, is Turkey.

The increasing share of renewable energy sources has affected the increase of non-carbon energy share in TPES. Higher fossil fuel prices, promotion of hydro and wind power based electricity generation, the increasing share of biomass in transportation have affected the total share of non-carbon sources to increase. It should be kept in mind that ECO 12 and ECO 13 are not different for Turkey. The difference between the two is the inclusion of nuclear energy in ECO 12. As nuclear energy does not exist in Turkey, ECO 12 and ECO 13 give same results for Turkey. EU 15 and EU 27 countries exhibit an increasing trend in terms of the share of non-carbon primary energy and electricity in total energy supply and electricity generation, respectively, for the period 1980-2008.

Sustainable energy requires the reduction of carbon emissions and the increase of low carbon energy usage. This leads us to accept the fact that non-carbon energy utilization is an important concern. As reported in Green Paper (2001), renewable energy does not reach the intended levels, energy import dependency and the utilization of coal and oil have an increasing trend and concerns about nuclear energy is still on the agenda. All these factors lead countries to take precautions and to develop low carbon energy policies. One can count low carbon energy use in transportation and production of less carbon intensive energy products among the low carbon energy policies (Green Paper, 2001). Similarly, in order to reduce GHG emissions in EU 27, there has been a switch from coal-fired power stations to less carbon intensive natural gas fired plants. We also observed the replacement of carbon-based fuels by non-carbon energy sources.

Table 5.1 Share of primary energy production and change between 1996-2006

EU 27 Primary energy production	1996 (mtoe)	2006 (mtoe)	Change 1996-2006 %
Total	971	871	-10.30
Oil	170	119	-30.00
Gas	210	179	-14.76
Nuclear	233	255	9.44
Hard Coal	166	94	-43.37
RES	88	127	44.32
Lignite	105	97	-8.24
Turkey Primary energy production	**1996 (mtoe)**	**2006 (mtoe)**	**Change 1996-2006 %**
Total	94	109	15.95
Oil	27	30	11.11
Gas	7	26	271.43
Nuclear	0	0	0
Hard Coal	4	5	17.93
RES	4	5	25.00
Lignite	52	43	-17.31

Source: Formed by using Eurostat Pocketbooks (EC, 2008)

Table 5.1, formed by using Eurostat Pocketbooks (2008), exhibits the share of primary energy production and its change during 1996-2006. These ratios might be helpful to understand how non-carbon energy share in primary energy supply has increased in

Europe. In EU 27, nuclear and RES have increased while hard coal, oil, natural gas and lignite exhibited an inverse trend. According to Eurostat Pocketbooks (2008), the total amount of municipal waste generated, which is a combustible renewable has been increasing and it will remain high. Germany alone generated 18% of the total amount of waste in EU 27, followed by United Kingdom (14%) and France (13%) (Eurostat, 2008). In Turkey municipal waste has decreased (-3.82%) slightly. To sum up, in Europe both combustible and non-combustible renewables and nuclear energy shares increased while in Turkey, combustible and non-combustible renewables is not increased. We should understand why non-carbon energy share is decreasing in Turkey. Coal is a carbon based energy source and constitutes 24% of total primary energy sources and 29% of electricity generation in Turkey. Turkey is one of the important lignite producers in the world and Turkish governments plan to triple the lignite production by 2020 (Soyhan, 2009). Also the use of natural gas has increased extensively. Therefore, the decreasing trend in non-carbon share is not surprising.

5.2.2. ECO 13: Renewable energy share in energy and electricity

The definition of this indicator is explained in UN report as the share of renewable energy in total primary energy supply (TPES) and the share of renewable energy in electricity generation and generating capacity (IAEA, 2005).

This indicator is used to monitor the use and production pattern in terms of end use of energy. It gives the opportunity to compare countries regarding their renewable energy use. Renewable energy is an important issue for sustainable energy and a priority for sustainable development goals. The production of energy from renewable sources is one of the major concerns of sustainable development. Increasing share of renewables in a country not only helps to diversify energy sources and maintain energy security but also helps environmental protection. In addition, renewable energy sources produce very small amounts of GHG emissions. For instance, geothermal power plant, which is a renewable energy type, produces electricity by only emitting one-sixth of carbon dioxide emitted from natural gas fueled power plant (Soyhan, 2009). Once again, renewable energy is crucial because of environmental degradation, climate change and energy security (WEC, 2010). There are ongoing attempts in Europe to increase and promote renewable energy. For instance, EU energy policies targeted to increase the share of renewables to 22% for EU 15 by 2010 and to 21% for EU 27 by 2010 (Eurostat, 2009).

It was aimed to increase the global share of renewable energy sources at the World Summit on Sustainable Development in Johannesburg in 2002. For this purpose a coalition was formed proposing that every member country would set its own targets and time frames in order to increase the share of renewable energy sources (IAEA, 2005). Apart from this, EU itself set targets and time frames for this purpose. White Paper for a Community Strategy and Action Plan - Energy for the Future (1997) proposed that 12% of gross domestic energy consumption should be from renewable sources by 2010. In EU 27, the ratio of TPES from renewables to TPES is 5.69% in 1997 and 8.75% in 2008. The growth rate of TPES from renewables to TPES is 4.06% between 1997-2008 and these values are not sufficient to satisfy the targets. Although there is a progress in terms of increasing the share of renewable energy, European Commission could not achieve these targeted values in 2010 (Europa, 2010).

The same situation is also valid for electricity generation. The share of electricity consumption from renewable energy sources in total energy sources being 21% is the target for EU. The national targets differed from country to country because of different historical backgrounds and developments. Although some countries are on the track to meet their targets, most of them are lagging behind the proposed rates. The ratio of renewables to total electricity sources in EU 27 is 17.09% in 2008, which shows again that targets could not be met and additional efforts are needed to achieve the targets.

Table 5.2 briefly indicates country specific ratios, i.e. renewable energy shares in total energy supply, that should be attained by 2020 and the current share of countries in 2008.

Table 5.2 Renewable energy shares in total energy supply in 2008 and targets for 2020

	RES share 2008	Target for RES share in 2020		RES share 2008	Target for RES share in 2020
Austria	27%	34%	Italy	8%	17%
Belgium	4%	13%	Luxembourg	3%	11%
Czech Republic	5%	13%	Netherlands	4%	14%
Denmark	19%	30%	Poland	6%	15%
Finland	26%	38%	Portugal	18%	31%
France	8%	23%	Slovakia	6%	14%
Germany	9%	18%	Spain	8%	20%
Greece	5%	18%	Sweden	32%	49%
Hungary	6%	13%	Turkey	9%	N/A
Ireland	4%	16%	United Kingdom	3%	15%

Source: Derived from Eurostat (EC, 2009)

Before analyzing the data once again it is important to consider the EU targets about renewable energy. First attempt was observed in 1997 in relation to White Paper that set a goal of doubling the renewables' share from 6% to 12% between 1996 and 2010. The share of renewables in TPES for EU 27 was 5.41% in 1996 while it reached to 8.75% in 2008. There has been a 60% growth in the ratio yet the target could not be reached. As it is understood that the proposed targets could not be attained, the Commission adapted a long term Renewable Energy Roadmap in 2007. It aimed to increase the share of renewables to 20% by 2020, and the share of electricity generated from renewable sources to 21% by 2020. As previously mentioned, due to different historical backgrounds and developments, the targets differed from country to country. For instance, Germany aimed at generating of 35% electricity from renewables by 2020 and it aimed to increase renewable energy share to 18% by 2020. Spain targeted renewable energy share to be 20% by 2020. The effort sharing agreement regulates how much each country needs to contribute according to that country's current share of renewables, its resource base and wealth (Eurostat, 2009).

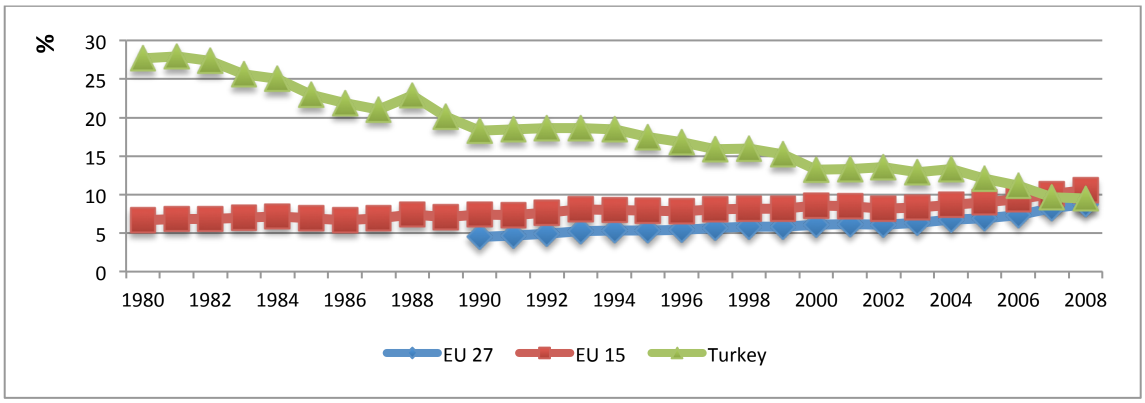

Figure 5- 42 Share of renewable energy in TPES

As can be seen from Figure 5-42, renewable energy share of Turkey has decreased continuously by 66% while both in EU 15 and EU 27 the share of renewable energy sources in TPES has increased by 59% and 94%, respectively during 1980-2008. There is an increasing trend in the share of RES in TPES in EU 27 and EU 15. They have a continuous positive growth during the period. The reasons behind that increase might be the increase in fossil fuel prices, energy security concerns, strong policy supports about promotion of renewables, subsidies and lower costs of renewable energy as renewable energy R&D and technologies mature by the time. The difference between the growth rates of share of renewable energy sources in TPES of EU 15 (59%) and EU 27 (94%) is because of the accession of new member states whose share of renewables are high relative to EU.

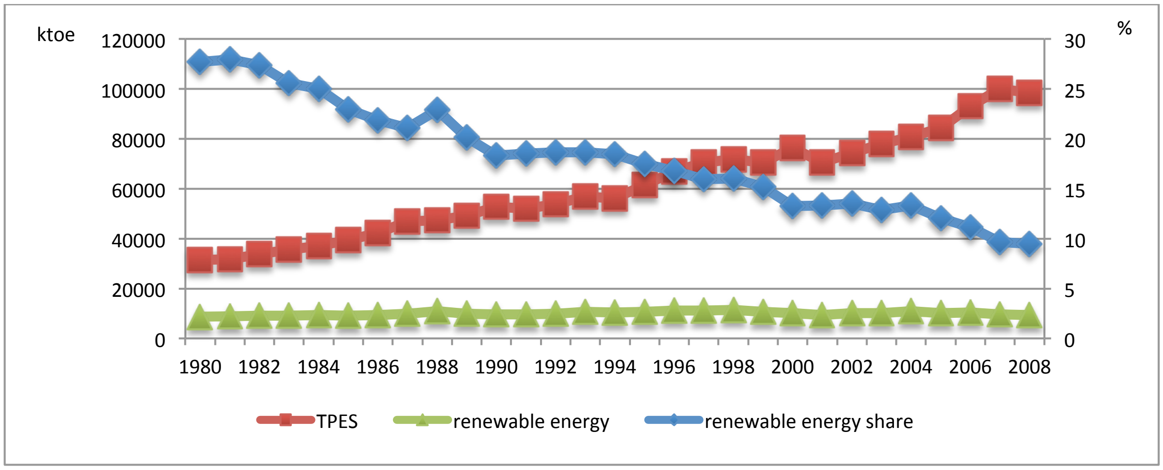

Figure 5- 43 TPES, Renewable energy and its share of renewable energy for Turkey

The decreasing trend in the share of renewable energy in Turkey might be attributed to increase in TPES and decrease in renewable energy. In Figure 5-43, TPES has tripled whereas renewable energy almost stayed stable during the period 1980-2008. Although there has been an increasing trend after 1990 and 2001, renewable energy level is still not high enough. As a result of these developments, the share of renewable energy in TPES is decreasing continuously in Turkey.

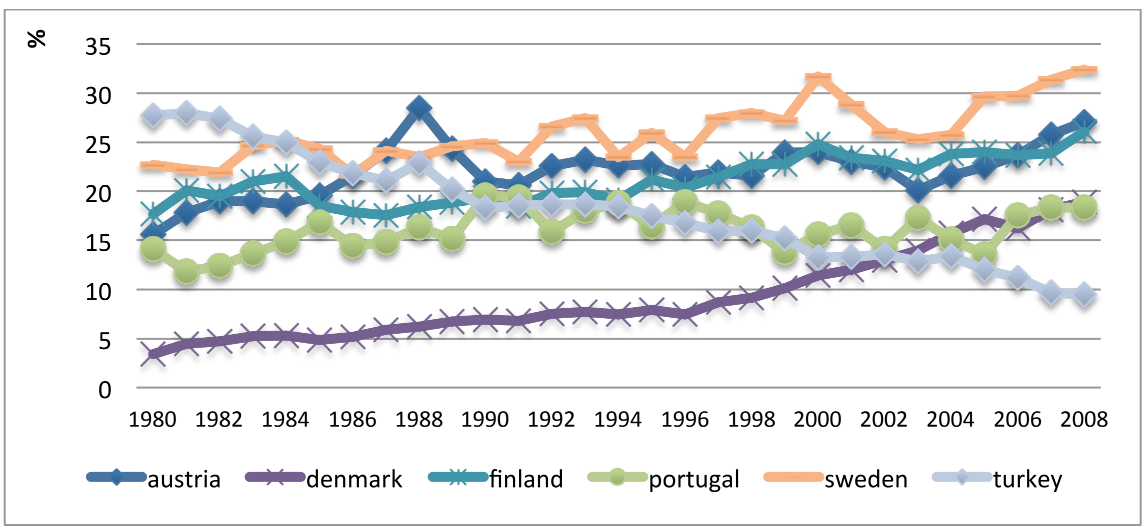

Figure 5- 44 Share of RES in TPES for selected EU countries and Turkey

As we can see from Figure 5-44, Sweden, Denmark, Austria, Finland and Portugal are the countries, which use renewable energy sources intensively. What all these countries have in common is that the amounts of forest and water sources are high. Compared to Turkey, all of them managed to increase their RES share during the period 1980-2008. On the other hand, as can be seen from Table 5.2, Luxembourg, Ireland, Belgium, Netherlands, United Kingdom and Czech Republic have the lowest levels of RES share in TPES.

Sustainable development targets to increase the share of electricity produced from renewable sources. Renewable Energy Roadmap (2007) aims an average share of 21% in terms of electricity generated from renewable sources by 2020 for EU 27 countries. If we look at the Figure 5-45, the trend between 1980 and 2008 suggests that EU 27 is on her way to achieve 21% target. EU 27 has an average of 17.09% of renewable energy share in 2008 which is currently below the target rate whereas EU 15 has 23.18% share in 2008. Nevertheless, increasing share of renewable energy in electricity generation is not less and we can infer that support policies for promoting renewable energy have been successful. For EU 27, share of renewables in electricity generation grows by 42% between 1990-2008. This significant growth is due to support policies and technological development. For instance onshore wind energy now competes with fossil energy sources without any support and it is an alternative energy source for European Union countries (IEA, 2008a). The Figures 5-46 and 5-47 indicate that the growth rates of renewable electricity production accelerated between 1990 and 2000 and continue to increase afterwards.

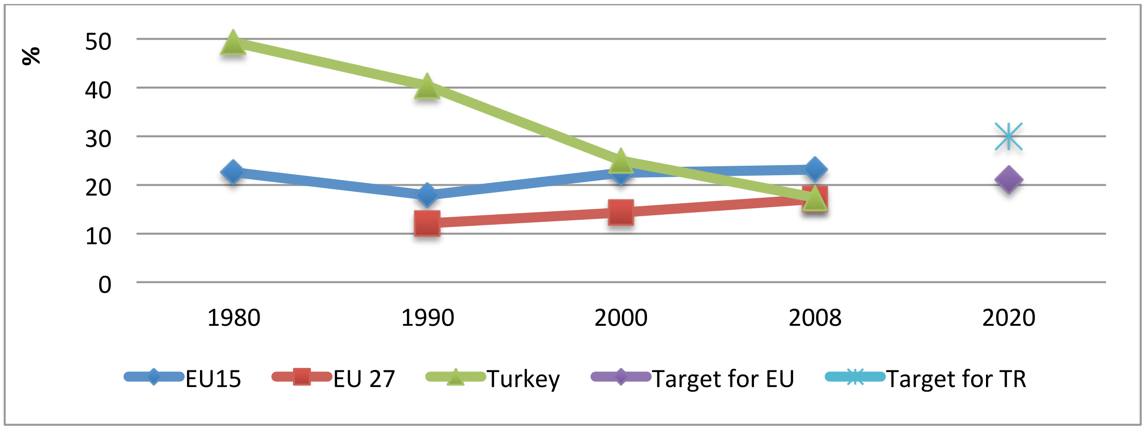

Figure 5- 45 Renewable share in electricity and electricity generation targets for EU 15, EU 27 and Turkey

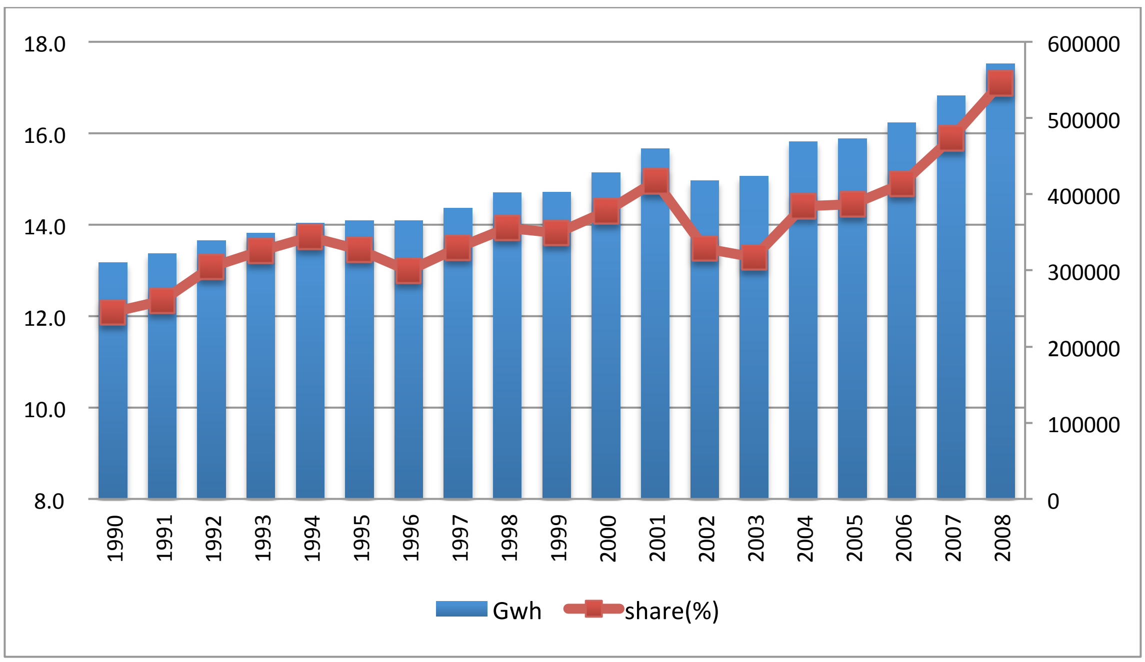

Figure 5- 46 Total electricity production from renewables and RES share in EU 27

In Figure 5-46, total electricity produced from renewables in EU 27 and their corresponding shares between 1990 and 2008 are presented. The contribution of RES has increased from 310Twh in 1990 with a 12.1% share to 571Twh in 2008 with a share of 17.1%. High fossil fuel prices, government support and declining investment costs in RES constructions have led renewable energy based electricity generation to increase substantially.

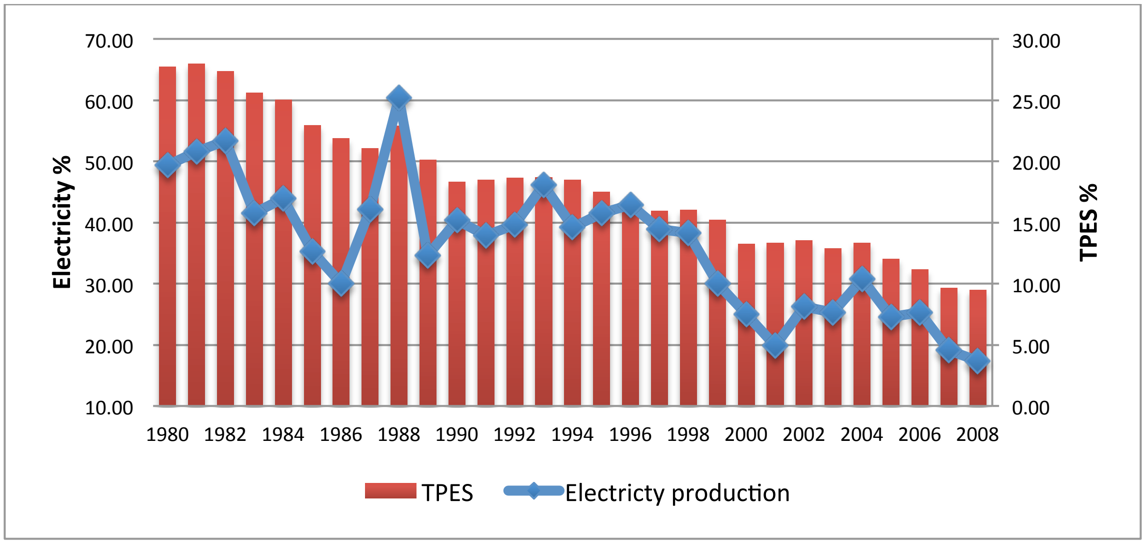

Figure 5- 47 Share of renewable energy sources in electricity generation and TPES share in Turkey

Figure 5.47 shows the share of renewable resources in electricity generation and TPES in Turkey. Similar to RES share in total primary energy, RES share in electricity also has a declining trend. According to the strategic plan of the Republic of Turkey Ministry of Energy and Natural Resources, it is aimed to increase the share of electricity generation from renewable energy sources to 30% by 2023. Renewable energy is mainly composed of hydropower (50%) and biomass (50%); and other sources such as geothermal, solar and wind energies are negligible in Turkey (IEA, 2009). As it is observed in ECO 12, there is a contrary trend in 1988 in terms of share of renewable energy in TPES and share of energy in electricity generation. The reason of increasing share of renewable energy in 1988 is because of 54% increase in hydropower energy.

Turkish energy policy aims to enhance the share of all kinds of renewable energy sources. There is a regulation regarding this target and claims that, "by the law of Utilization of the Renewable Energy Resources for the Electricity Energy Production that was enforced in 2005, the opportunity for the production of electricity energy from the renewable energy sources by the private sector has been provided" (MENR, 2010). Our data suggests that the impact of this policy has not been effective yet. The share of electricity from renewable sources between 2005 and 2008 has not demonstrated an increasing trend yet. The possible reasons of this trend might be due to extensive use of natural gas and fossil-fueled based energy; high capital requirements, high cost of technology and high production costs during the construction of renewable energy plants (Toklu 2010).

The average share of RES in TPES between 1980-1990, 1990-2000, 2000-2008 are 23.71%, 17.02% and 12.07%, respectively. Since 2005, the contribution of renewable energy to TPES has almost remained unchanged. However, the government has introduced targets and policies to reverse this trend (IEA, 2009). As previously mentioned, the government introduced several laws and amendments such as 'The 2005 Law on the Utilization of Renewable Energy Resources in Electricity Generation', 'Energy Efficiency Law- No 5627 in 2007', 'Law on geothermal resources and natural mineral waters – Law No 5686 in 2007' and Renewable Energy Law 2010. They all aimed to promote renewable energy share in Turkey, but the implication/effectiveness of these attempts should be considered carefully.

5.2.3. ECO 15: Net energy import dependency

This indicator identifies to what extent a country relies on imports to meet its energy requirements (IAEA, 2005). It gives an idea whether a country has an import based energy supply or not. It is crucial to discuss this indicator in order to identify country specific energy policies and strategies.

The aim of calculating this indicator is to develop energy policies and strategies according to level of imports and evaluate energy dependency for the future. Import dependency itself is not the main concern for a modern industrialized economy, it is also not realistic for a country to achieve self-sufficiency in energy supply by its own. What is important here is to manage supplier relations and implement related strategies to secure energy supply (IEA, 2008b). Net energy import dependency and energy security are interrelated. Energy security is one of the most important energy priorities for both Turkey and the European Union countries. As previously mentioned, there are three main primary policy targets, energy security, energy efficiency and environmental protection (IEA, 2009). Among them energy security has a higher priority resulting from the increasing economic growth and energy demand.

Turkey is a net importer of natural gas and oil. It imports almost all of the oil and gas consumed and it is expected that imports are going to double for the next decade. In 2008, Turkey imported 68% of oil that was mainly diesel and 98% of natural gas demand (IEA, 2009). Therefore, it is crucial for Turkey to develop long-term relationships in the region and cooperate with other countries to diversify her import sources and routes. In summary, to ensure energy security, Turkey aims to diversify energy resources by focusing on domestic resources and pay specific attention to diversify foreign sources of oil and natural gas (MENR, 2010).

European Union is a continuously growing economy and thus energy demand has an increasing trend. There is a significant gap between production and consumption of energy that entails energy importing. According to Green Paper (2000), overall energy dependency of EU will reach to 70% in the next decade. While for oil this rate will converge to 90%; for natural gas and coal it will be 70% and 100%, respectively (Green Paper, 2000). Currently, EU 27 has imported 84% of its natural gas from three countries: Russia, Norway and Algeria. Oil is also imported since EU only produces 14% of its demand. Import of coal, on the other hand, has increased since 2005 due to competition with countries that have lower production costs; reduction of state subsidies; exhaustion of the best reserves and shifting to higher value added activities. To sum up, European Union is dependent on imports of oil, gas, coal and electricity and it is expected to continue being a net importer for the future.

Green Paper (2000), described the EU’s long term strategy such as describing energy supply security to ensure the well being of its citizens and proper functioning of the economy, the uninterrupted physical availability of energy products on the market, at a price which is affordable for all consumers while at the same time respecting environmental concerns (Green Paper, 2000). Compared to Turkey, EU has similar policies to reduce its energy dependence. Demand management, development of national resources and diversification and research in renewable energies are some of them (Green paper, 2000). Energy security has become a major issue since 2005 due to import dependency problems in Europe. For instance, interruptions of gas supply from Russia and therefore gas shortages in EU member countries or threats that are the disputes between neighboring suppliers and transit countries are some of the reasons for existing energy security problems (IEA, 2008). ‘Diversification of energy imports by fuel, by source and by transportation route, promote the development of production and export capacities in producer countries in a safe and secure environment are some of the cautions taken by EU in the Action Plan on the energy policy for Europe 2007-2009’ (IEA, 2008a).

As previously mentioned, sustainable development and energy are interrelated. Sustainable development without considering sustainable energy is not feasible since any country aiming sustainable development needs to have a stable supply of energy. Therefore, to pursuit sustainable development, every country cares for security of energy supply. It is crucial to maintain availability of physical energy supplies to satisfy demand at a given price for economic and social sustainability (IAEA, 2005). Interruptions about energy supply would constitute a type of systematic risk for sustainable development. According to IAEA (2005) report, there are two types of systematic risks: quantity and price. Both of them are linked to the level of country’s energy import rates. Any changes in energy imports would result in changes in energy supply and affect economic and social conditions. Therefore, if a country achieves to decrease its import dependency, the risks that it might encounter will be minimum.

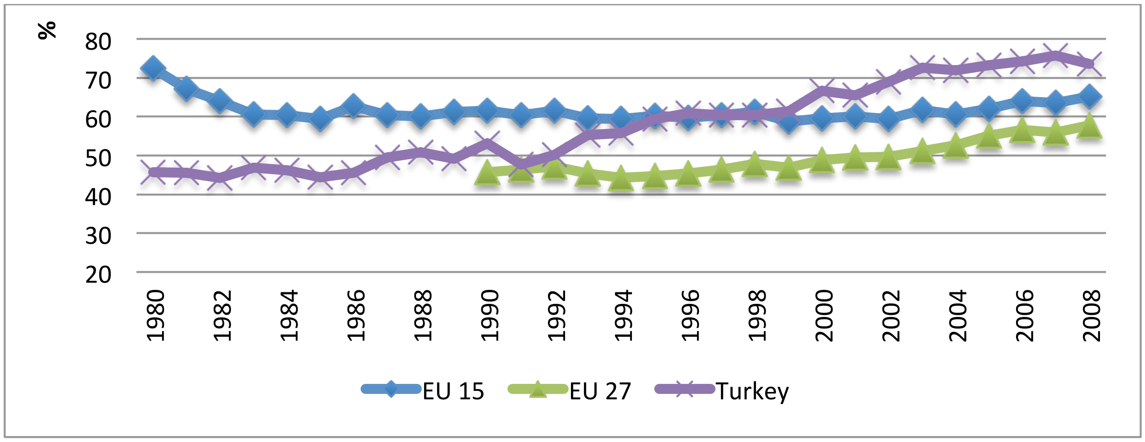

Figure 5- 48 Net Energy Import Dependency

Over the years 1998-2008, the import dependency of EU 27 has increased by 21%. Green Paper (2000) report also emphasizes the increasing dependency of EU and claims that 'security of supply in the energy field must be geared to ensuring, for the good of the general public and the smooth functioning of the economy, the uninterrupted physical availability on the market of energy products at prices for all consumers (both private and industrial), in the framework of the objective of sustainable development enshrined in the Amsterdam Treaty' (Green Paper, 2000; 10).

Import dependency of EU 27 has increased from 46% in 1990 to 58% in 2008. This 27% growth in this indicator may result from the growing energy consumption of European Union countries. The decline in North Sea oil and gas production may be another factor of increasing import dependency. Moreover, EU 27 has low solid fuel production and nuclear energy. There is a continuous increasing rate of import dependency for EU 27 that justifies concerns of EU about energy supply security. Currently EU 27 supplies 58% of its energy from foreign sources whereas it is 63% for EU 15 and 74% for Turkey as it can be seen from Figure 5-48. EU 27 increased its import dependency by 27% between 1990-2008. Thus, we cannot tell whether enlargement process of EU helped to reduce her foreign supply dependency or not. EU 15 managed to decrease its import dependency by 10% but in EU 27 the import dependency has increased. Import dependency of Turkey, on the other hand, has increased by 61% during the period 1980-2008.

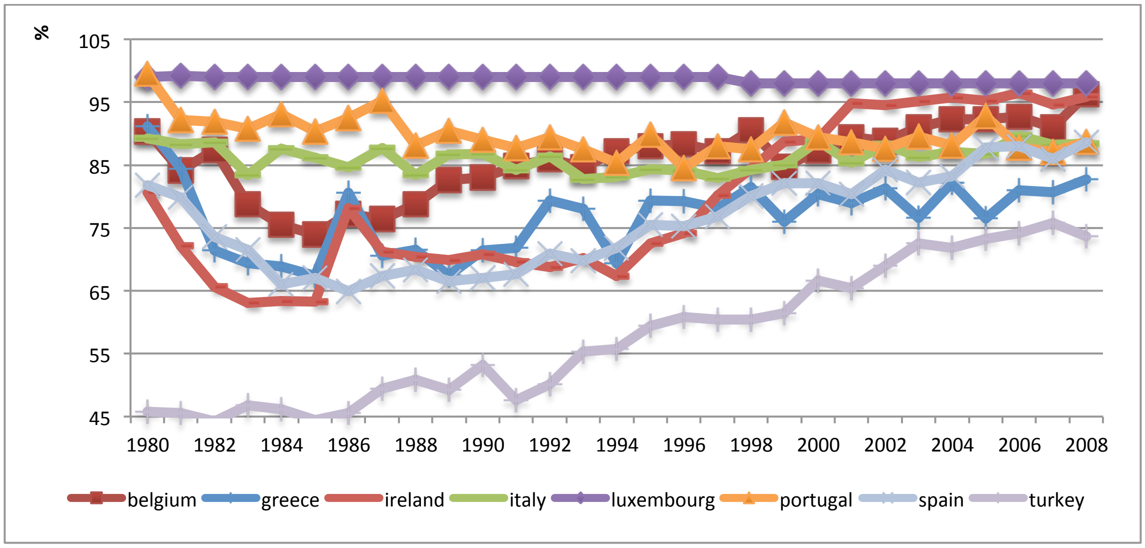

Figure 5- 49 Countries with the highest net energy import dependency

We can claim that Luxembourg[23] (99%), Portugal (90%), Belgium (86%), Italy (86%), Ireland (80%), Greece (77%) and Spain (76%) are the main energy importers. In Figure 5-49, we can observe that these countries have the highest rates during the whole period.

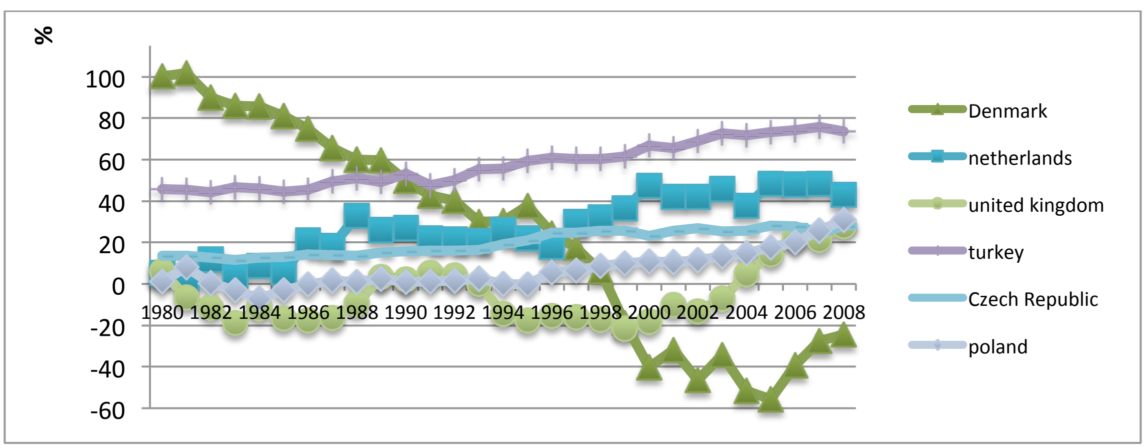

Figure 5- 50 Countries with the lowest energy import dependency

[23] Unlike other countries, import dependency data of Luxembourg is taken from www.wdi.org due to data problem and not from www.iea.org database.

From Figure 5-50, we can observe that United Kingdom (28%), Poland (31%), Czech Republic (28%), Denmark (-25%) and Netherlands (43%) have the lowest average rates of import dependency.

The net import dependency of total energy has increased between 1980 and 2008 for Turkey. A net increasing trend is observed from 45.74% in 1980 to 73.62% in 2008 with an average of 61% increase. Therefore, as mentioned previously, security of energy supply is a major issue for Turkish energy policy.

Luxembourg imports almost all of its energy needs so the rate of net import dependency is the highest. Denmark on the other hand achieved to change its status from being an importer country in 1980s to an exporter country (-23% in 2009). Until 1998 it was one of the importers, which has high rates of import dependency (100% in 1980, 81% in 1985, 50% in 1990 and 38% in 1995). There are three main reasons behind this trend. First one is the proactive energy policies about energy efficiency and as a result of adopting these policies, Denmark achieved to increase its energy efficiency. By the help of government's effort to improve efficiency, Denmark's energy intensity is now below IEA average. Second one is the increasing share of renewable energy. The share of renewable energy increased by 40% between 1990-2007. Renewable energy is a domestic resource that helps to diversify energy supply and reduce import dependency (IEA, 2004). Lastly, the oil in North Sea enables Denmark to decrease her import dependency. Sustainable development emphasizes the importance of energy security and renewable energy share. To obtain energy in a secure and continuous manner with a cost effective way is prominent for all countries. In addition, increasing share of renewable energy is always a desirable issue for sustainability. Figures 5-51 and Figure 5-52 demonstrate the relation between net import dependency and renewable energy share in total energy supply in 1980 and 2008, respectively.

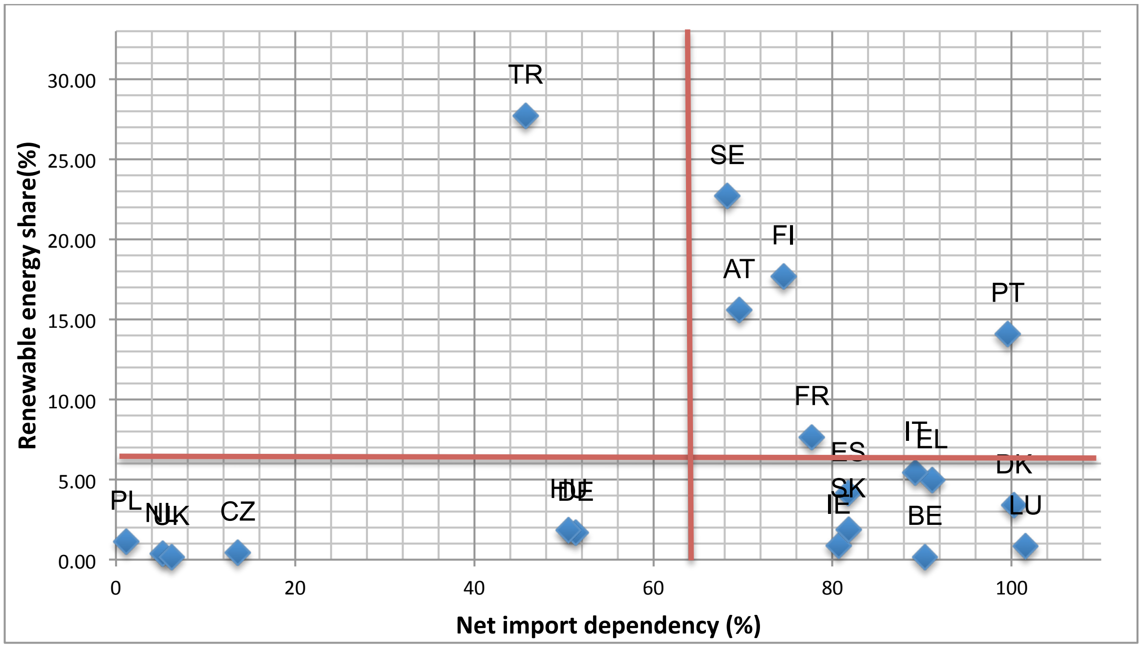

Figure 5- 51 Renewable energy versus net import dependency (%), 1980

As mentioned previously, indicators of this part are relevant to energy security and fuel mix. In terms of Figure 5-51 and 5-52, countries target the quadrant where the share of renewable energy is higher and the import dependency is lower. Turkey was the only country to achieve this in 1980; but in 2008 it shifted to a lower renewable energy share and a higher import dependency quadrant due to economic growth and increasing energy demand through the years. Sweden, Denmark and Finland are the countries, which are located themselves at the quadrant with higher renewable energy share and lower import dependency rate. It is possible to interpret that as countries' domestic energy supply increases (for instance an increase in renewable share of total energy supply), the import dependency decreases. For example, Luxembourg, Ireland, and Belgium have the lower level of RES share in TPES and higher import dependency whereas Sweden, Denmark, Finland present an opposite pattern as it can be seen from Figures 5-51 and 5-52.

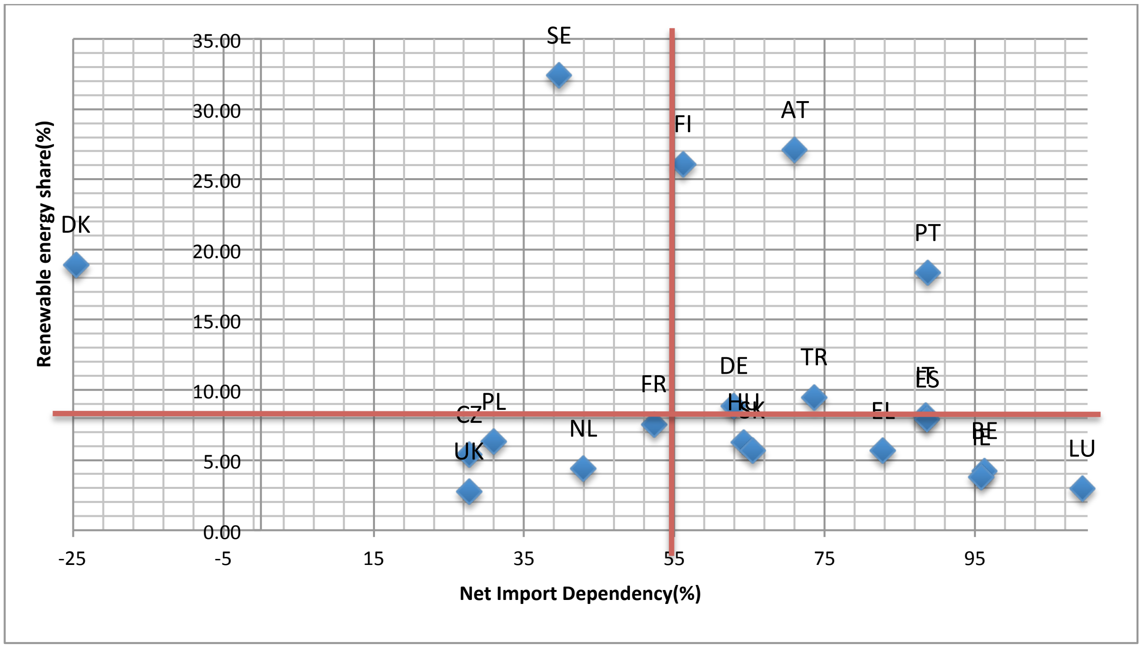

Figure 5- 52 Renewable energy share versus net import dependency (%) in 2008

Turkey has a great potential of renewable energy and if these potential sources such as hydropower, solar power, wind and geothermal energy are utilized, Turkey will be able to decrease her import dependency. Nevertheless, the current situation suggests the opposite. As mentioned previously, if domestic energy sources such as wood, spoils of animals and plants, hydroelectric or other renewable sources decrease, the import dependency continues to increase. Increasing amounts of natural gas and oil imports as major energy sources lead to the increase in net import dependency of Turkey (Soyhan, 2009).

5.3. Environmental Concerns

The third policy priority is the protection of the environment. Environmental concerns mainly focused on reduction of green house gases and land protection.

In this part we analyze the following indicators: GHG emissions from energy production and use per capita and GHG emissions from energy production and use per

GDP, ambient concentrations of air pollutants in urban areas and rate of deforestation attributed to energy use.

5.3.1. ENV1: Greenhouse gas (GHG) emissions from energy production and use, per capita and per unit of GDP

From the perspective of sustainable development, global warming is a result of increasing greenhouse gases in the atmosphere. The earth has warmed up to 0.6°C and oceans have risen by between 10 to 25 cm. All temperature records justify that global warming has accelerated for the last 25 years. Although EU has reduced its GHG emissions consistent with Kyoto Targets, these reductions are far from sufficient to keep average world temperature increases below 2 °C (EEA, 2010b). There is an urgent need to take action to decrease or at least stabilize GHG emissions. It is estimated that emissions would have to be cut immediately by 50 to 70% to stabilize the current CO_2 concentration levels otherwise the sea level and world temperature will continue to rise (EEA, 2010).

The purpose of calculating this indicator is to evaluate the direct impact of GHG emissions from energy production and use on climate change. We analyze per capita and per unit of GDP emissions from methane, carbon dioxide and nitrous oxide. Brief information about international commitments and agreements for EU and Turkey is presented in the following part in terms of understanding what kind of measures or legislations are introduced regarding environmental concerns. United Nations Framework Convention on Climate Change (UNFCCC), Kyoto Protocol, Vienna Convention, Montreal Protocol are some of the important meetings and The European Union Emission Trading Scheme (EU ETS) is an important regulation for environmental protection.

European Union accepted Kyoto Protocol in 2002 and EU 15 countries were committed to reduce GHG emissions between 2008 and 2012 by 8% on average, compared to base year (1990) emissions. EU 15 has managed to achieve to decrease her total GHG emissions from 100 to 93.1 in 2008 and EU 15 will likely to meet the mentioned goal (92) by the end of 2012. On the other hand, under the agreement of EU burden sharing commitment, EU 27 is also on her way to reduce GHG emissions by 20% by 2020 compared to 1990 levels. Turkey joined UNFCC in 2004 and ratified Kyoto Protocol in February 2009. As Turkey has non-Annex B status, she does not have a quantified obligation to reduce or limit GHG emissions. Turkey's status is due to her special circumstances such as her efforts to catch up with other developed countries and her economic growth leading to increased energy use and GHG emissions. National Climate Change Strategy (2010) document prepared by Ministry of Environment and Forestry pointed out that Turkey has short, medium and long-term targets to reduce carbon intensity of the economy. For instance, the carbon dioxide emissions will have been reduced by 7% by 2020 (The Ministry of Environment and Forestry, 2010). Turkey with her special status is the only Annex-I country that has not set any mitigation targets for the post 2012 period under the Copenhagen Accord. Moreover, Turkey asked to get sufficient international financial sources/funds to launch new technology that will help to limit the emissions. The current status suggests Turkey either to target an emission limit or maintain its Annex-I Party position without an emission target. In case Turkey puts an emission target, she will have access to Kyoto Protocol's Joint Implementation device that will enable her to access more carbon market revenues. Without an emission target, Turkey still has rights to use funds outside the UNFCCC framework such as World Bank or private sector entities funds (IEA, 2009). 'Council Conclusions - Post 2012 Climate Change agreement' in Copenhagen (2009) emphasized the importance of development theme for developing countries and pointed out that developing countries have rights to consider development as a primary goal and integrate mitigation and adaptation actions as an integral part of sustainable development by putting them into their national development strategies. Considering these purposes, EU is ready to support countries' development strategies both technically and financially (Martinez, 2009). This can be interpreted such as that EU

Council is ready to enhance cooperation with Turkey and support her in terms of technological research, development and ongoing adaptation efforts.

After briefly explaining the meetings and protocols that are valid for Turkey and EU, we have to mention another important issue about environmental concerns: the European Union Emission Trading Scheme (EU ETS) which was established in 2005. According to ETS, operators[24] receive emission allowances from their government, based on their country specific allowance rates and operators holding more allowances than their emission needs, can sell their surplus emissions to other operators or they can keep them to be used in the next year. Member states prepare a National Allocation Plan (NAP) that should be approved by the commission. These plans correspond to emission target that is to reduce GHG by 20% compared to 1990 levels by 2020. EU ETS is a domestic policy that aimed to reduce emissions in a cost efficient way. Operators have choices that either to reduce their own emissions or purchase carbon allowances from the European carbon market depending on whichever is cost efficient. EU ETS is interrelated with Kyoto aiming to comply with Kyoto Protocol's target (EEA, 2009).

In the light of current regulations and commitments mentioned above, we analyze Turkey and European Union countries accordingly. Comparing trends in Turkey and EU 15 and EU 27, we identify which countries achieve to decrease GHG emissions and committed to international agreements.

The GHG emissions per capita increase either due to an increase in GHG or due to a decrease in the amount of population. Similarly, the GHG emissions per GDP increases either due to an increase in GHG or due to a decrease in GDP. Data for Turkey shows that GHG per capita has significantly increased by 62% while population has relatively stayed moderate with 28% increase between 1990-2008 meaning that GHG emissions has increased throughout the period 1990-2008 in Turkey. GHG emissions per GDP has

[24] Operators are large emitters of CO_2.

not changed considerably throughout the period 1990-2008 which is around 4%, whereas GDP has doubled since 1980. Once again, we can conclude that GHG emissions increased more compared to increases in population and GDP.

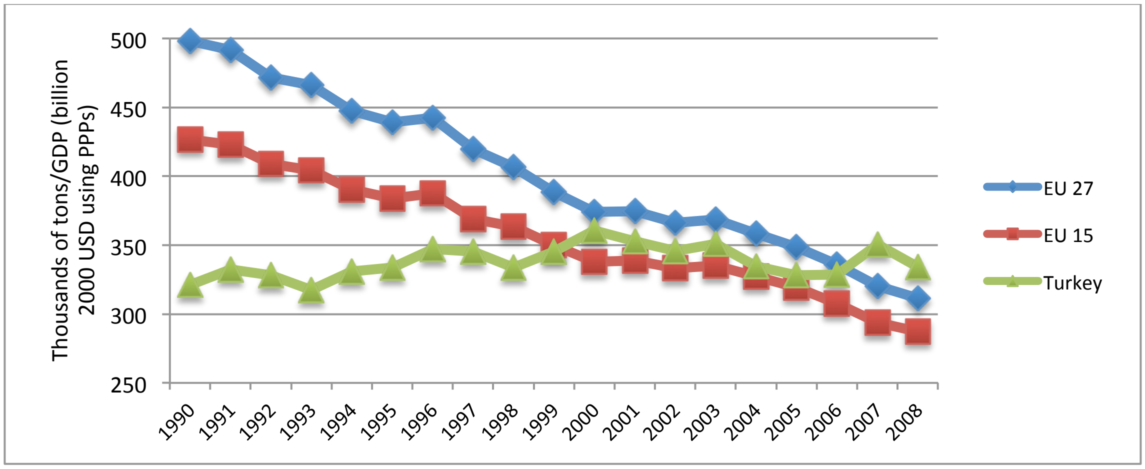

Figure 5- 53 GHG emissions per GDP

Figure 5-53 demonstrates GHG emissions per GDP for EU 15, EU 27 and Turkey. Turkey stayed below the EU 27 and EU 15 between 1990 and 1999. After 1999, the GHG emission per GDP has increased and exceeds that of the EU 15, and in 2007, the ratio is above the ratios of both EU 15 and EU 27. EU 15 and EU 27 managed to decrease their GHG emission intensities continuously since 1990 while Turkey has an increasing trend in terms of her GHG emission intensity during the same period.

EU 15 and EU 27 countries decreased their GHG emissions per capita by 13% and 12%, respectively between 1990-2008 as it can be seen in Figure 5.54. Emission intensities i.e. GHG/GDP also decreased between 1990 and 2008 with ratios of 33% and 38% for EU 15 and EU 27, respectively. There are mainly five factors leading to the decrease in emission rates for EU countries; energy efficiency improvements, increasing share of renewable energy use (such as increasing share of biomass), the fuel shift from coal or oil to gas and improvements in fuel efficiency in vehicles (EEA, 2009). Especially, EU 27 decreased GHG intensity by switching from solid fuels to gas and by increasing the share of nuclear and renewable energy (IEA, 2008).

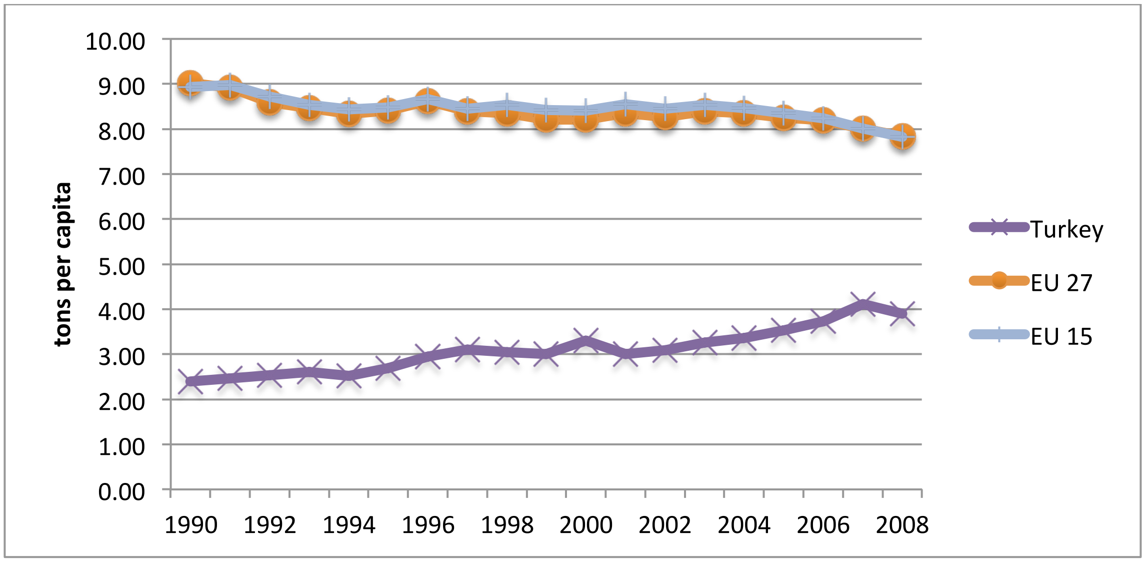

Figure 5- 54 GHG emissions per capita

Turkey has the lowest GHG emissions per capita among EU countries. The reason behind this low level of emissions can be explained by low level of final energy use per capita. Although, Turkey has the lowest level of GHG per capita, it is the country that has the largest increase in emissions during 1990-2006 (total emissions during this period has doubled). Moreover, the change in per capita emissions is also the largest in Turkey with a ratio of 49% (EEA, 2008). In Turkey, GHG emissions mainly result from electricity generation sector and wide use of carbon intensive coal and lignite (Karagöz and Bakırcı, 2010).

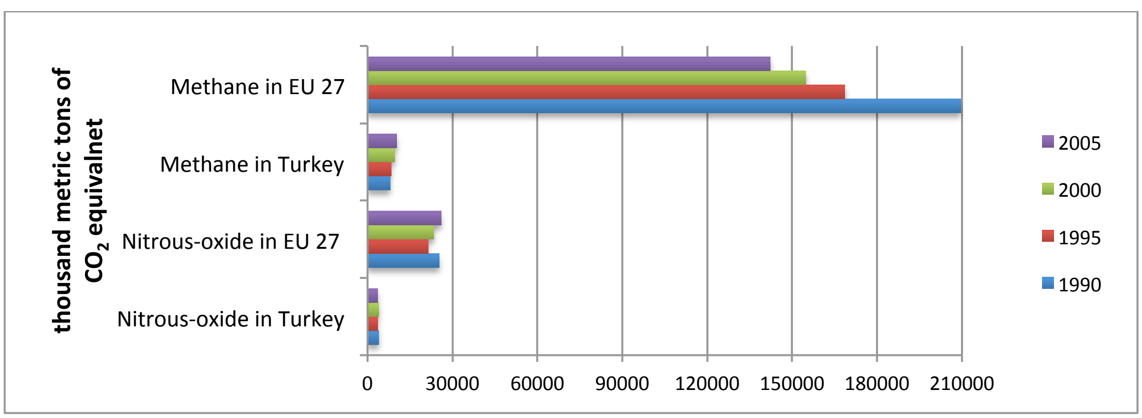

Figure 5- 55 N_2O and CH_4 emissions in energy sector in Turkey and EU 27

As mentioned in Chapter Four, GHG gases related to energy use are composed of carbon dioxide (CO_2), methane (CH_4), nitrous-oxide (N_2O) and fluorinated gases. Figure 5-55 demonstrates nitrous oxide and methane used in energy sector. Nitrous-oxide has declined by 8.78% during 1990-2005 in Turkey while it has increased by 2.32% in EU 27 countries during the same period. On the contrary, methane emissions have increased in Turkey by 29.72% and have decreased in EU 27 by 32.09% during 1990- 2005.

Comparing Turkey with other countries, one should pay attention to factors such as GHG emissions per capita and the size of population. For instance, in terms of GHG emissions per capita calculations, countries that have similar populations like Turkey, Germany, United Kingdom, Italy and France are taken together. From Figure 5-56, it is obvious that although it has a declining trend, Germany has still the highest rate of emissions per capita among these countries that is also above the averages of EU 15 and EU 27. Nevertheless, Germany managed to decrease her emissions per capita significantly by 24% between 1990 and 2008. United Kingdom, France, EU15 and EU 27 have also declining GHG emissions per capita during the same period. On the other hand, Italy, similar to Turkey has an increasing trend during the years as she increased emissions per capita by 2.5%. Although Turkey has the lowest emissions per capita, her increasing trend is significant. There is a considerable increase especially after 2001. The average emissions per capita between 1990 and 2008 is 3.09 (1000 tons/1000 population) and emissions per capita has increased by 63% in Turkey between 1990-2008 whereas all countries except Italy achieved to decrease their emissions per capita between 10% - 24%. The possible reasons of increased emissions in Turkey are economic growth in manufacturing industries and its increasing demand for electricity and heat, increasing transportation activities, increasing construction facilities and increasing size of households and their increasing demand for energy and electricity. Moreover, increasing number of private cars and new constructions in Turkey has increased the CO_2 emissions since 1990. Nevertheless, compared to EU 15 and EU 27 values, Turkey has significantly low rates. For instance in 2008 emissions per capita is 7.83 for EU 27 and 7.82 for EU 15 while it is only 3.91 for Turkey. Compared to European Union countries, the level of GHG emissions are lower but the rate of increase is higher. Turkey is a growing country with growing population and her adaptation to developed countries leads increased energy use and thus increased GHG emissions.

Our observations about the change in GHG emissions are also supported by other publications. For instance, National GHG inventory data report (2007) pointed out that the change in GHG emissions between 1990-2005 is 74.4% excluding LULUCF[25] and 75.9% including LULUCF for Annex I countries[26]. Among the gases, carbon dioxide contributes the most to GHG emissions. It increased by 0.6% during 1990-2005 and methane and nitrous-oxide emissions decreased by 18.5% and 20.8%, respectively (UNFCCC, 2007). These results support the results that we point out for EU 15 and EU 27. Turkey, on the contrary, exhibits an opposite trend, where both methane and nitrous-oxide emissions increased during 1990-2008.

[25]LULUCF is the acronym for land use, land-use change and forestry.

[26] Annex I countries are: Australia, Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Monaco, Netherlands, New Zealand, Norway, Poland, Portugal, Romania, Russian Federation, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine, United Kingdom and United States of America.

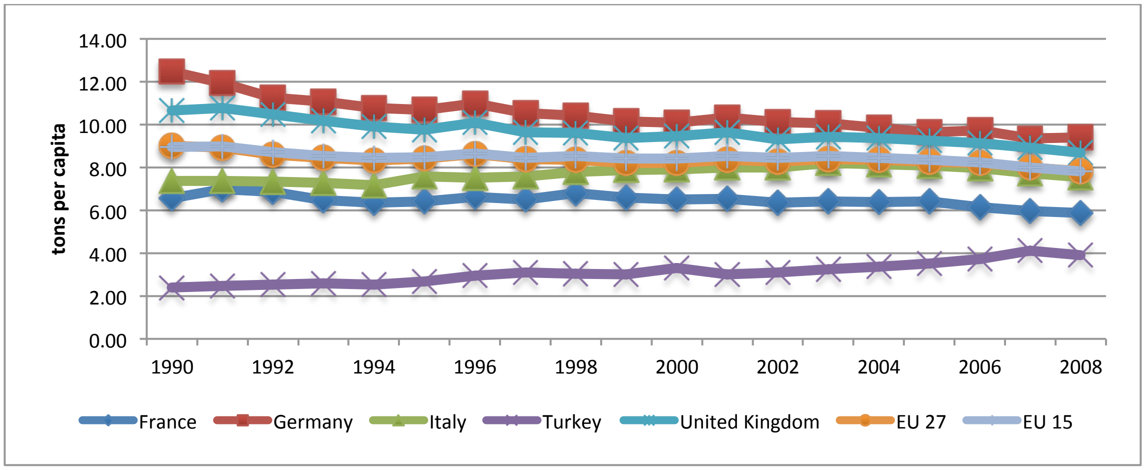

Figure 5-54 GHG emissions per capita for selected countries

As we do in TPES / GDP in ECO 2, in terms of analyzing GHG / GDP, we compare Turkey with Greece, Spain and Italy whose economic structures are similar. Except Turkey (3.95%), all countries managed to decrease their GHG emissions per GDP; Greece (-21.79%), Italy (-13.74), Spain (-10.78), EU 27 (-37.49%), EU 15 (-32.70%) during 1990-2008 as observed in Figure 5.56.

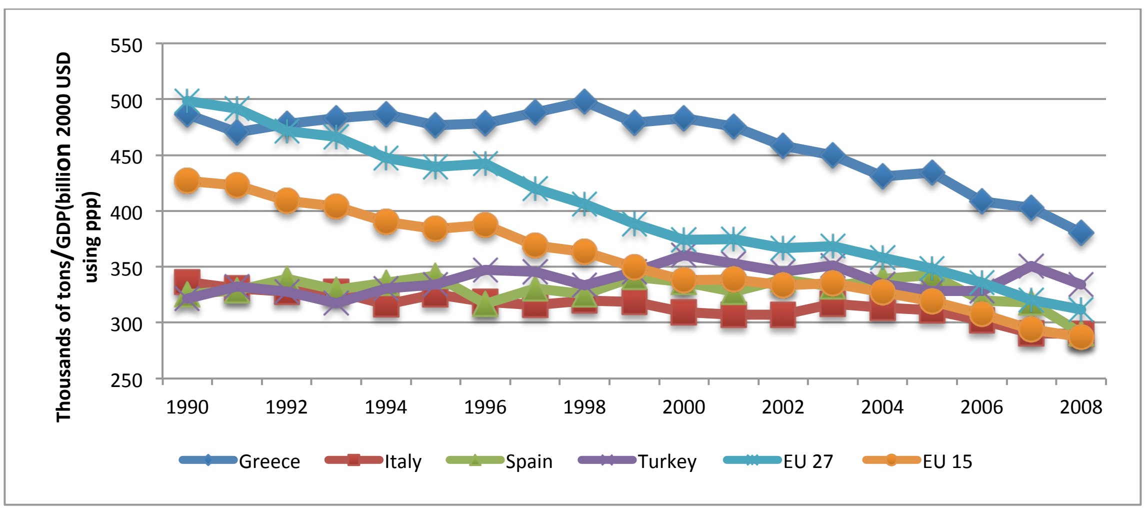

Figure 5- 56 GHG emissions per GDP

Data obtained from Eurostat help us to monitor the progress of countries regarding emission targets that was decided in Kyoto. The Table 5.3 presents annual total emissions of GHGs compared to Kyoto base year[27] that is 1990 and accepted as 100[28]. Although EU 15 accepted to decrease GHG emissions by 8% by 2008-2012, there is no such regulation for EU 27. Turkey also is not asked to decrease her GHG emissions and she is given a privileged status as mentioned before. Turkey is in non-Annex B status that does not have an obligation to reduce GHG emissions. According to targeted values in Table 5-3, Hungary, Slovakia, Poland, Czech Republic, Sweden, United Kingdom, France, Greece, Germany, Finland and Belgium managed to decrease their emissions successfully while Spain, Luxembourg, Denmark, Austria, Italy, Ireland, Portugal and Netherlands could not achieve the target values by the year 2008.

Table 5.3 Annual total emissions of GHGs and Kyoto targets of selected countries

	1990	1995	2000	2005	2008	Target
EU 27	:	:	:	:	:	:
EU 15	99.5	97	96.5	97.2	93.1	92
Belgium	98.4	102.6	99.3	97.1	91.4	92.5
Czech Republic	100.5	79	75.9	74.8	72.8	92
Denmark	99.4	110.1	98.5	92.1	92.1	79
Germany	99.9	89.4	83.1	79.3	77.7	79
Ireland	98.6	105.2	121.8	123.8	121.3	113
Greece	96.5	100.8	116.7	124.2	118.6	125
Spain	98.4	108.7	131.4	150.2	140	115
France	99.9	98.8	98.8	98.7	93.5	100
Italy	100	102.4	106.4	110.8	104.8	93.5

[27] The base year is 1990 and it is indexed to 100. All values are calculated accordingly.

[28] According to Kyoto Basket, methane, carbon dioxide, nitrous oxide and so-called F gases (hydro fluorocarbons, per fluorocarbons and sulfur hexafluoride) are accepted as greenhouse gases. These GHG emissions are expressed in units of CO_2 equivalents.

Luxembourg	99.6	78.7	75.2	100.8	94.9	72
Hungary	84.4	68.2	66.8	69.2	63.4	94
Netherlands	99.5	105.4	100.7	99.7	97.1	94
Austria	98.9	101	101.6	117.5	109.6	87
Poland	80.5	78.1	69.3	69.2	70.2	94
Portugal	98.6	116.3	135.2	144	130.3	127
Slovakia	102.6	74	68.3	69.5	67.8	92
Finland	99.1	99.7	97.3	96.4	98.8	100
Sweden	100.4	102.9	95.4	93.8	88.7	104
United Kingdom	99.4	91.7	86.6	84.3	80.9	87.5
Turkey	:	:	:	:	:	:

Source: Eurostat, 2009

Turkey ratified Kyoto in 2009 and it is the only country that is Annex I but has not committed to any GHG mitigation until 2012. Turkey is working to develop her post 2012 approach and commitments. For example, she set a unilateral quantitative target for CO_2 emissions for the energy sector (-7% reduction between 2009-2020), as defined in her 2009 National Climate Change Strategy (IEA, 2009). Turkey has taken part in the following activities after her accession to the UNFCCC since 2004: 'submission of the First National Communication of Turkey to the UNFCCC (2007); initialization of the preparation of the Second National Communication (2008); submission of National GHG emissions Inventories (2009), and establishment of the necessary governmental institutions for implementing climate change related activities, as well as extensive public awareness actions' (Ministry of Energy and Foresty, 2011). In addition, Turkey prepared National Climate Change Action Plan, National Adaptation Action Plan and National Strategy Paper on Climate Change that all aim to contribute to efforts to reduce the impacts of climate change. Considering sectorial policies and measures, in energy sector, Turkey adopted The Renewable Energy Law in 2005, the Energy

Efficiency Law adopted in 2007 and the Electricity Energy Market and Supply Security Strategy of Turkey in 2009 that targets to increase the installed capacity of wind power and promote solar power (Ministry of Energy and Foresty, 2007).

Although, there are many attempts to tackle climate change in energy, agriculture, forestry and industry in Turkey, we should be careful about the realizations/ implementations of these laws and measures that were introduced in Turkey. EISD indicators help us to evaluate whether these attempts are realized and change the current pattern in Turkey or not. Unfortunately, according to results of our selected indicators, we cannot claim that all these actions and attempts are realized efficiently.

5.3.2. ENV 2: Ambient concentrations of air pollutants in urban areas

Air pollution due to energy use in industry and power stations is one of the major concerns of sustainable energy. To improve living conditions and care for human health in urban areas, this indicator is a useful tool to monitor the trends and set up policy actions to identify hotspots in need of special attention, to understand current air quality, to asses the air quality policies, relationship between air pollution and health issue and to identify the level of air pollution that people exposed to in urban areas (IAEA, 2005b).

We analyze PM_{10} concentrations for Turkey and selected countries. Air pollution in Europe has generally decreased after 1990 due to decreased amounts of air pollutants such as PM_{10}, NO_2 and ozone. Although economic growth, changing population and level of energy intensity affect the emission trends, the decreasing trend in air pollutants in Europe is mainly due to introduction of abatement measures introduced by EU legislation. Legislations for large combustion plants and introduction of catalytic converters on light vehicles contribute to the reduction of primary and secondary particles (EEA, 2003).

In terms of European integration, Turkey has improved and harmonized its policies about air pollution according to European legislation. According to IEA (2009), the main legislation is the 'By-law on Ambient Air Quality Assessment and Management' (BAQAM) introduced in 2008. Considering EU Air Quality Framework Directive (96/62/EC) and its four daughter directives (1999/30/EC, 2000/69/EC, 2002/3/EC and 2004/107/EC), BAQAM sets air standards that are expected to be achieved by 2019. Apart from these legislations, there are also following legislations that Turkey put into effect: 'By-law on Air Pollution Control Arising from Heating' (2009), 'Controlling Exhaust Gases from Motorized Land Vehicles' (2005) and 'Reducing the Percentage of Sulfur in Certain Types of Fuel Oil' (2009) (IEA, 2009).

All these legislations aim to control air pollution from fossil fuel consumption; emissions from motor vehicles and old coal fired power plants (IEA, 2009). The level of total particulate formation differs between countries that led us to divide and graph countries in two groups. First group is composed of United Kingdom, Germany, Turkey, Italy, Spain and Poland whose total particulate level is far above the rest. The second group of countries has similar particulate levels compared to each other. In the first group, Germany, United Kingdom and Italy managed to decrease their level of particulates extensively compared to second group, during 1996-2007.

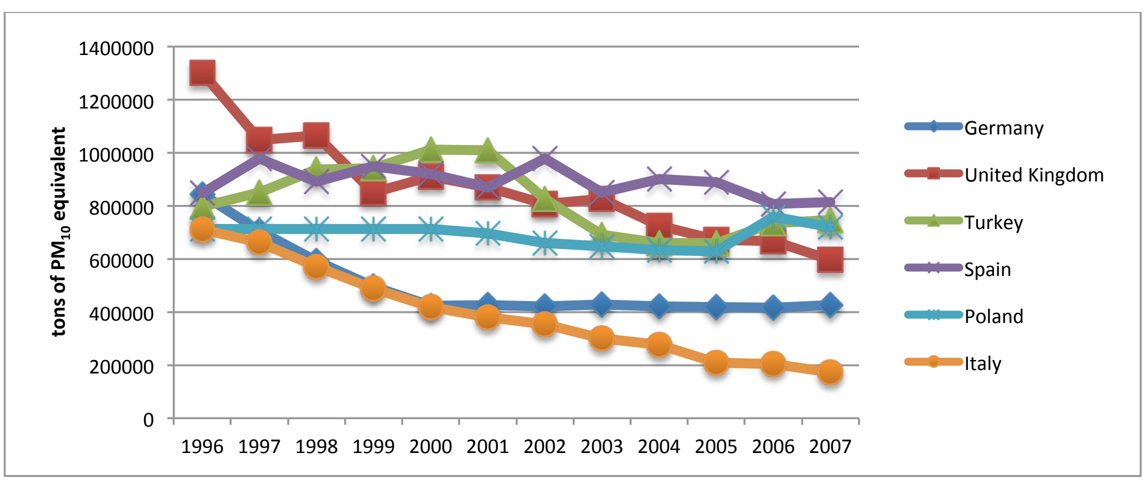

Figure 5- 57 Total particulate formation PM_{10} (High Emission Countries)

Figure 5.57 exhibits total particulate formation of Germany, United Kingdom, Spain, Poland, Italy and Turkey. Although these countries have higher levels of air pollutants, Germany, United Kingdom and Italy managed to decrease their total particulate formations significantly. Germany, United Kingdom, Spain, Italy and Turkey have decreased their PM_{10} emissions by 49%, 54%, 4%, 75% and 6%, respectively during 1996-2007. Poland, on the other hand, increased her PM_{10} emissions by 1% during the same period.

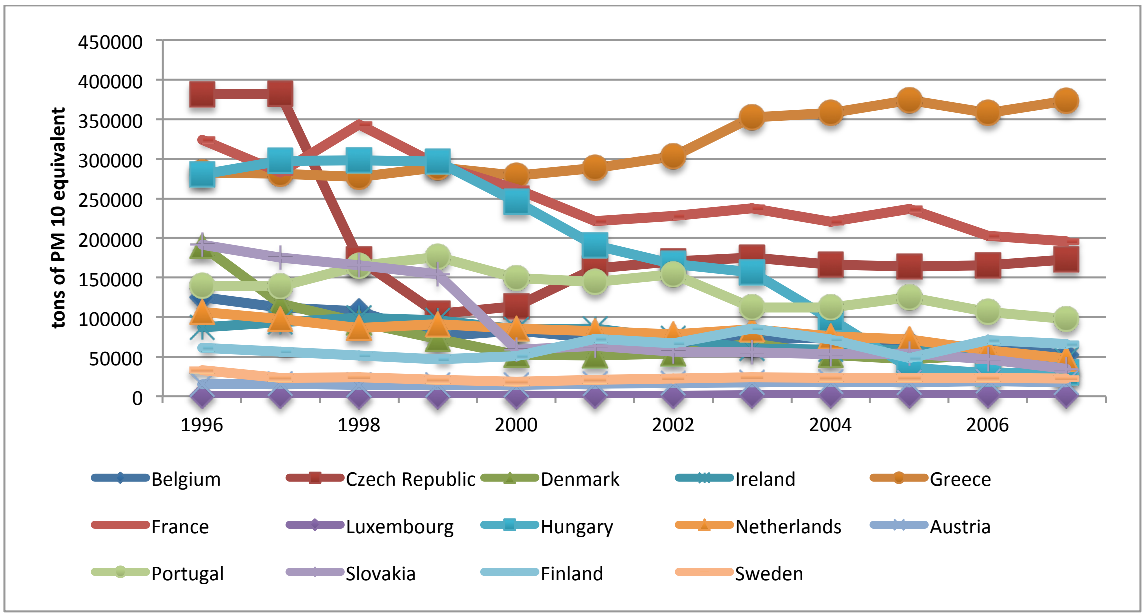

Figure 5- 58 Total particulate formation PM_{10} (Low Emission Countries)

Figure 5.58 is graphing PM_{10} emissions of second group of countries. Greece, Austria, Finland and Luxembourg increased their PM_{10} emissions whereas Hungary, Slovakia, Denmark, Belgium, Netherlands and Czech Republic managed to decrease the emissions during 1996-2007.

Regarding sustainable development goals, especially after 2001, there is a negative trend in total particulate formation that might be a demonstration of improved quality of air in both EU 15 and EU 27 and as it can be seen from Figure 5. 57, they achieved to decrease their levels by 41% and 38%, respectively.

Although, air pollution has slightly decreased in big cities due to switching from fuel oil and high sulfur coal to imported coal and gas used by households, the amount of air pollution is still increasing in Turkey (Ocak et al, 2004). The main components of air pollution can be categorized as population and production; energy and use of fuels and transport sector. In Turkey the air pollution in energy sector has mainly resulted from, combustion of coal, lignite, petroleum products and agricultural and animal wastes. In addition the main source of sulfur dioxide emissions is power plants. The air pollution in Turkey has mainly resulted from: use of fossil fuels having high levels of sulfur and ash content, old combustion technologies, out of date industrial premises, insufficient utilization of air pollution control devices, intensive urbanization and insufficient insulation practices. It is mainly because of combustion of coal, lignite, petroleum, natural gas, wood and agricultural and animal wastes. Thus air pollution became an important concern in Turkey (Toklu E. et al., 2010).

Emissions of carbon dioxide, sulfur dioxide and nitrogenous gases increased and government introduced 'Ambient Air Quality Assessment and Management (BAQAM)' in 2008 that limits sulfur dioxide, nitrous oxide and particulate matter from power plants. It is consistent with EU Air Quality Framework Directive and it aims to put standards for defined air pollutants. Nevertheless, cautions to prevent air pollution have not realized effectively yet (Karagöz and Bakırcı, 2010).

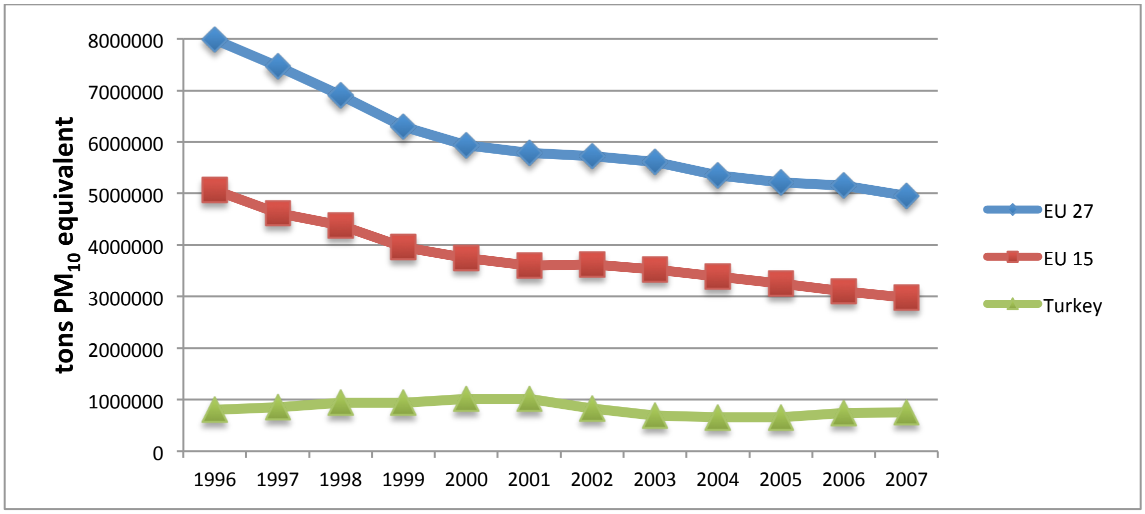

Figure 5-59 Total particulate formation PM_{10} for EU 27, EU 15 and Turkey

In order to achieve sustainable development regarding air pollution, Turkey should continue to monitor air pollution standards, ensure efficient and effective implementation of relevant regulations to improve air quality, living and health conditions. Old coal fired power plants are equipped with flue gas de-sulfurization[29] units and new regulations on emissions from motor vehicles and quality standards for motor fuels has improved. But still Turkey needs to reduce air pollution by implementing regulations effectively. IEA report suggested Turkey to put higher standards for cars, and large combustion plants and to put targets and road maps for increasing air quality (IEA, 2009).

5.3.3. ENV 6: Rate of deforestation attributed to energy use

The purpose of using this indicator is to find the change in the forest area over time due to energy needs. Deforestation can result from many different factors but we are interested in the rate of deforestation (RD) attributed to fuel wood that is the deforestation rate relevant to energy issue.

[29] De-sulfurization is the removal of sulfur or sulfur components from coal or fuel gas

Forests are most valuable multifunctional and renewable natural assets that have ecological, socio-economical and cultural roles in many countries. According to Energy, Transport and Environment Indicators Report (2008), forests and other wooded land cover 42% of the land area in Europe. The most densely forested countries are Finland (72.9%) and Sweden (68.7%), whereas the least forested are Ireland (10.7%) and Netherlands (10.8%). Turkey is one the countries that has the least forested area that is 14.7% of total size of the country (Eurostat, 2008). Therefore, forests are playing an important role in filtering pollutants, protect water resources, preserve the soil, increase the productivity, provide positive effect o climate and they can be used for recreation and touristic purposes (Atmış et. al., 2007). They also support biodiversity, employment and traditional uses. Deforestation is a current concern since forest health and natural processes of forest growth and regeneration are thought to be affected by human activities. Deforestation is a major concern for developing countries due to fuel wood harvesting. Fuel wood is one of the solid fuel biomass that is used for cooking, heating and generating electricity. It is important to combat deforestation to maintain the production of fuel wood and other non-fuel wood production. Besides that, increasing deforestation leads to increase of GHG emissions like carbon dioxide and biodiversity loss.

Wood, apart from its usage for cooking and heating is also used for commercial purposes such as fish drying, tobacco curing and brick baking in developing countries. In developed countries wood is used for energy generation. Recently, wood is considered to be an alternative for fossil fuels. Countries that have densely forested areas and wood processing industries form their energy policies accordingly. For instance Sweden and Finland are countries that use wood for industrial bio-energy needs. As bio-energy is one of the renewable energy sources, the fuel wood consumption is expected to increase in Europe by 2020 (FAO, 2008). On the other hand, due to urbanization, increase in income, decline in availability of wood sources and increase in alternative energy sources; the fuel wood consumption may decrease over time. The price of oil and fossil fuels is another important factor affecting the fuel wood usage. If prices of oil and fossil fuels increase, the demand for bioenergy will increase, as it is a substitute for these sources. But as mentioned before, GHG emissions from deforestation should also be taken into account. The approximate rate of GHG emissions from deforestation is 20% and the share of deforestation because of energy purposes is 5% (Naik, 2010). FAO (2008), revealed that clearing of grassland or forests to produce biofuels may result in losses of carbon that will take centuries to recapture. Therefore, production of bioenergy should be managed in a way not to result in losses of terrestrial carbon by forest removals. National energy strategies should be aware of country specific carbon and energy efficiencies of forests regarding cost effectiveness and environmental performance.

In terms of the indicator ENV 6 used to calculate rate of deforestation attributed to energy use, we find total rate of deforestation between 1990 and 2000 to have negative values for all countries except Belgium, Luxembourg and Slovakia. Positive values imply that forest area between these years has declined and negative values show that forest area has increased. Therefore, the forest area between these years decreased for Belgium, Luxembourg and Slovakia. Between 1990 and 2000, almost all countries increased their forest areas. Between 2000 and 2005, Germany and Luxembourg stayed the same regarding their forest area. For this second period Belgium and Slovakia achieved to increase their total forest areas. Again, all values for this period imply that forest area increased in almost all countries.

In Figure 5-60 and Table 5.4, we see that EU 27, Belgium, Czech Republic, Denmark, Spain, Poland, Slovakia and Sweden managed to increase their forest areas and decrease rate of deforestation whereas Greece, France, Italy, Hungary, Netherlands, Portugal, Finland, United Kingdom and Turkey are exposed to deforestation due to energy purposes and their forest areas decreased. The increased use of bioenergy might be the reason for increased deforestation and decreased deforestation rate might be due to decrease in production of fuel wood. Germany and Luxembourg, on the other hand, maintained their forest area during the period. This indicator focuses on deforestation caused by the harvesting of fuel wood that is attributed to energy use, not to the total rate of deforestation.

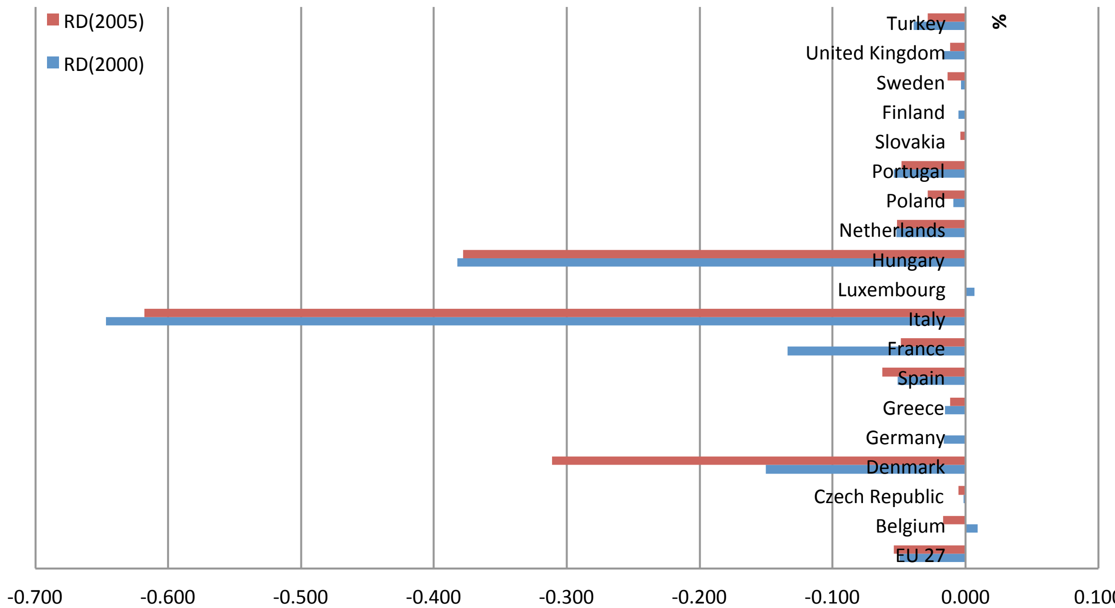

Figure 5- 60 Rate of deforestation attributed to energy use (%)

Table 6 Rate of Deforestation attributed to energy use

Decreased Deforestation			Increased Deforestation		
	RD (2000)	RD (2005)		RD (2000)	RD (2005)
EU 27	-0.050	-0.054	Germany	-0.017	0.000
Belgium	0.009	-0.017	Hungary	-0.383	-0.378
Luxembourg	0.007	0.000	Greece	-0.015	-0.012
Denmark	-0.150	-0.311	Portugal	-0.054	-0.048
Poland	-0.009	-0.028	Italy	-0.647	-0.618
Slovakia	0.000	-0.004	Finland	-0.005	0.000
Spain	-0.051	-0.063	France	-0.134	-0.049
Sweden	-0.003	-0.014	UK	-0.016	-0.012

Czech Republic	-0.002	-0.005	Netherlands	-0.052	-0.052
			Turkey	-0.039	-0.029

Biomass is one of the predominant renewable energy sources for EU member states and most of it consists of wood. Countries are encouraged to increase their renewable energy sources according to EU energy policy; they can use biomass in power generation, transport and heating sectors (Eurostat, 2009). Therefore, the reason behind the increasing rate of deforestation might be the increasing use of combustible renewable energy sources between 1990 and 2008 in Europe. We calculate the share of combustible renewable energy to TPES for 1990, 1995, 2000, 2005 and 2008 as can be seen from 5-61. The increasing trend justifies the increase in rate of deforestation.

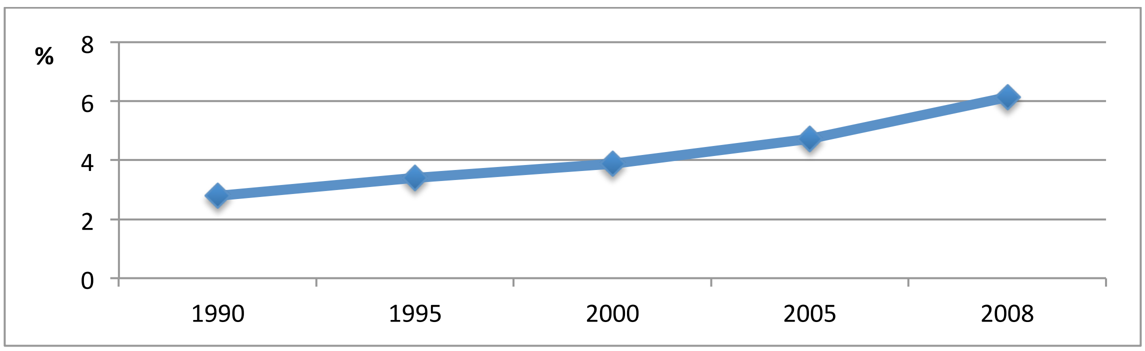

Figure 5- 61 Share of combustible renewable energy in TPES for EU 27

We can categorize the reasons of deforestation as: rural and urban pressures, forest land allocations (mining, tourism and construction of educational facilities), settlements in the forest, industrialization and infrastructure, supply of firewood and recreation. Among these causes, mining, industrialization and supply of firewood are energy related ones. The exploration of gold mining activities in Ida Mountains and coal mining activities are on the agenda. Outdoor coal production activities are still continuing in Turkey and industrial plants and facilities locate regardless of considering forest areas. Insufficient infrastructure of electricity, road and property features lead plants to locate near to forest areas. Another reason for deforestation is increased biomass. Using firewood as biomass is still a domestic heating source for poor people in Turkey that also increase the rate of deforestation (Atmış et. al., 2007). But the contribution of increased biomass to deforestation in Turkey is not significant.

As previously mentioned, deforestation is closely linked to GHG emissions. As deforestation increases, we expect GHG emissions to increase. The following Figures 5-62 and 5-63[30] demonstrate the positive relation between GHG emissions and deforestation rates. For instance Turkey, Greece and Italy have moved to northeast direction between 2000-2005 conforming that increased deforestation leads to increased GHG emissions in these countries. On the contrary, Poland, Denmark, Sweden and Belgium have moved to southwest directions that indicate decreased deforestation and decreased GHG emissions. None of the countries have moved to northwest direction conforming that GHG emissions have positive relation to the rate of deforestation.

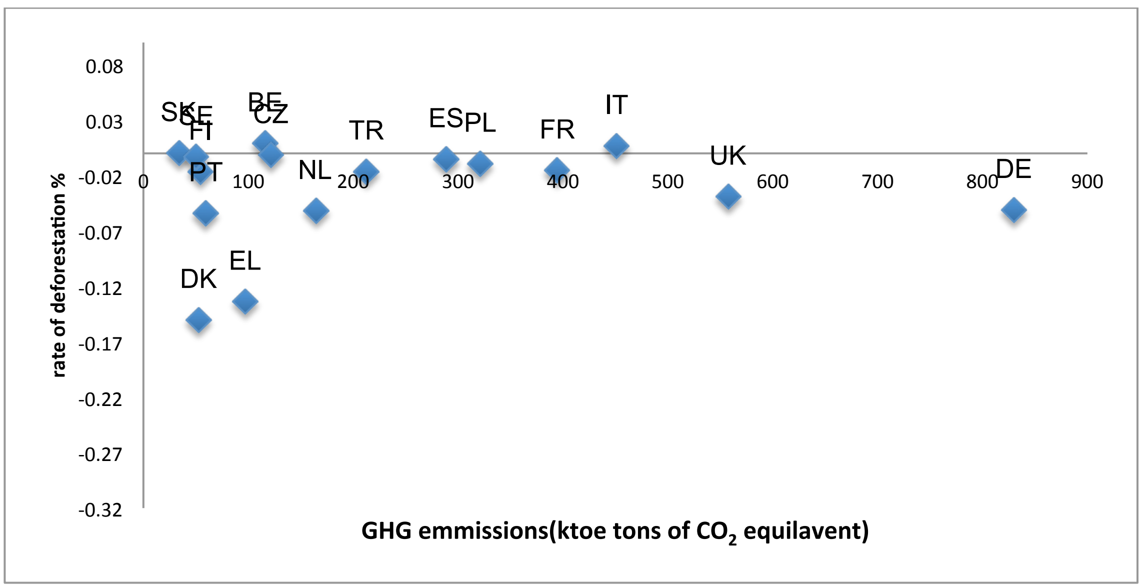

Figure 5- 62 GHG emissions and deforestation for 2000

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[30] For the purpose of a decent demonstration of graphic, we exclude Hungary (58%, -0.64) and Luxembourg (8%, -0.38) as they are outliers for Figures 5-62 and 5-63.

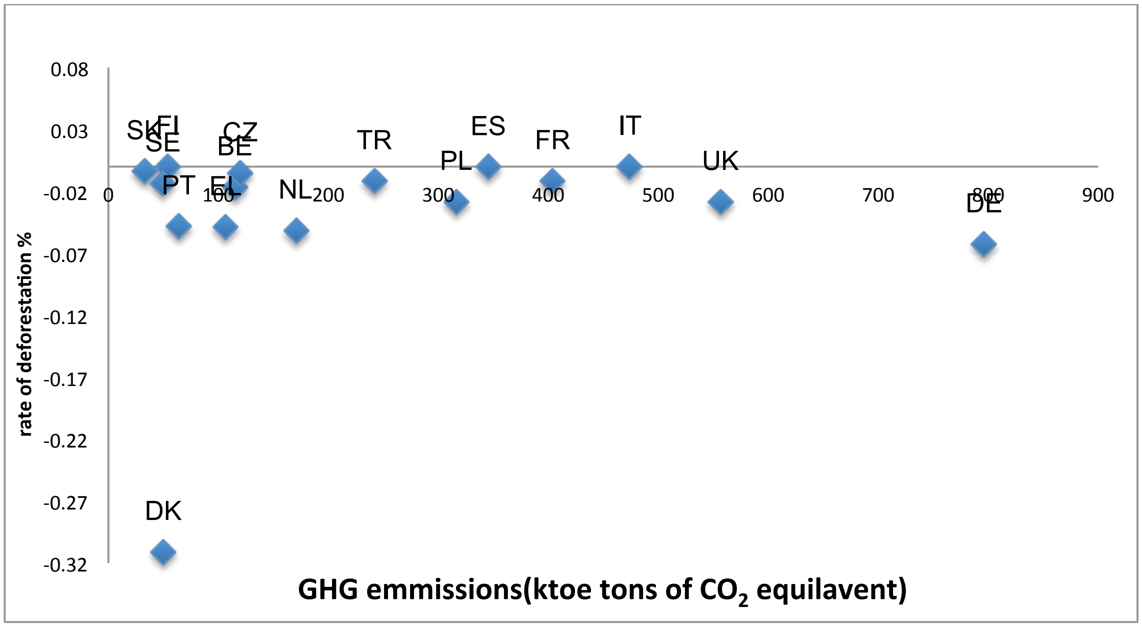

Figure 5- 63 GHG emissions and deforestation for 2005

Deforestation is the result of a process that is the change of forested lands to non-forest uses. Deforestation is one of the major reasons of enhanced greenhouse effect, since the increased deforestation rates decrease the removal of carbon dioxide from the atmosphere (Forest industries, 2010a). Deforestation contributes around 20% of global carbon dioxide emissions and there are ongoing attempts to reduce it by UNFCCC. We are concerned with deforestation related to energy purposes and the amount of forest area that has been used as fuel is important. In this perspective, developing countries should monitor their forest areas carefully.

The following scatter graphs Figures 5-64 and 5-65[31] demonstrate the relation between GDP per capita and deforestation in 2000 and 2005, respectively. We expect lower income countries to have higher deforestation rates because energy demand of the poor is supplied by using forests as energy sources. Therefore, we expect low income countries to cluster in the northwest direction and high income countries to cluster in

[31] As mentioned in Chapter Four, Austria and Ireland are excluded due to missing data. Luxembourg is also excluded because of GDP level for a decent graphical demonstration.

southeast direction. Countries with lower income that cluster in northwest are Portugal, Turkey, Slovakia, Poland and Czech Republic whereas countries with higher income that cluster in southeast are Denmark, United Kingdom, Netherlands, Italy, Sweden, Finland, France and Belgium. These figures confirm that increasing living standards have a negative effect on the rate of deforestation attributed to energy use. As welfare increases, access to reliable, cost effective and environmentally friendly energy increases and deforestation decreases.

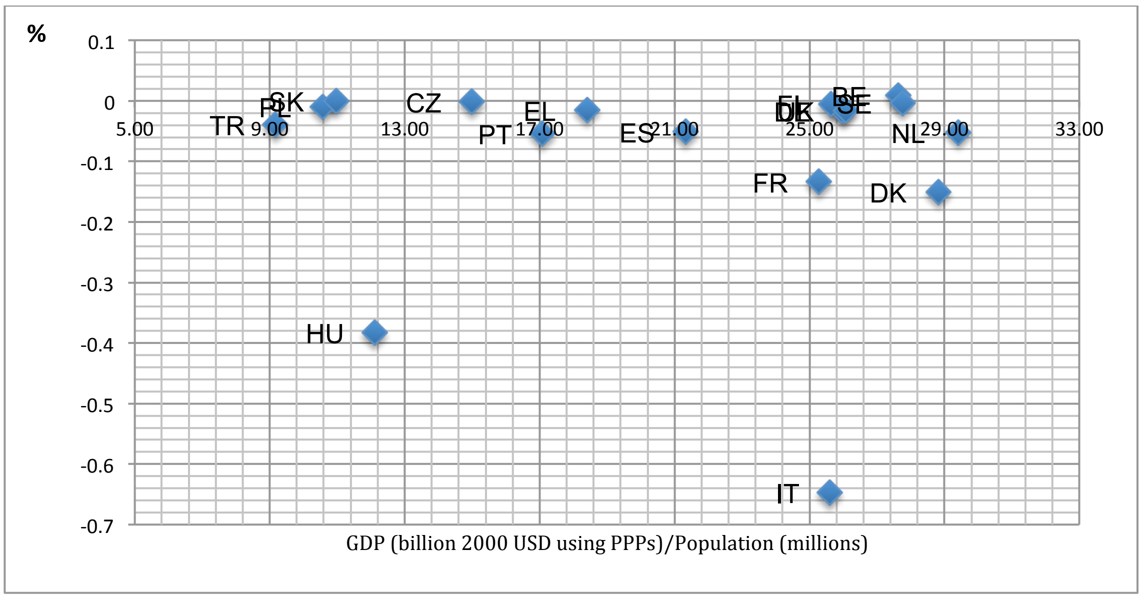

Figure 5- 64 GDP per capita and deforestation, 2000

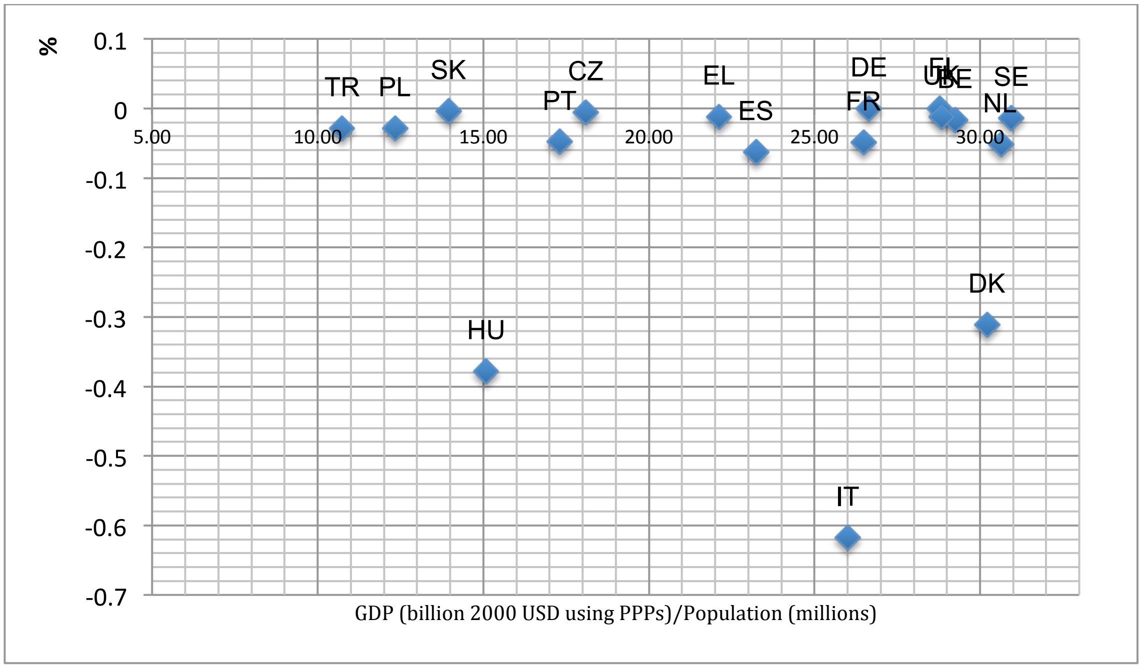

Figure 5- 65 GDP per capita and deforestation, 2005

5.4. Discussion

In the previous parts of this chapter, each indicator is calculated and graphed for Turkey selected EU countries, EU 15 and EU 27. Corresponding past and current energy policies are discussed to understand the behavior of the relevant indicator. In this part, we briefly discuss the results of all indicators and evaluate them regarding energy policies of Turkey. The priorities are categorized into three titles; energy efficiency and energy intensity; energy security and fuel mix; and environmental concerns. At the end of this chapter, Table 5.5 summarizes the results.

5.4.1. Energy efficiency and energy intensity

Relevant indicators taking place under the title of energy efficiency and energy intensity indicate that Turkey's efforts in decreasing energy intensity and improving energy efficiency are not satisfactory. We first evaluate energy and electricity use per capita in

Turkey and observe that both of them have increased during 1980-2008. The electricity per capita has a steeper increase compared to energy use per capita. Growing economy and increased energy demand of rapidly growing population, intense use of heating and cooling systems are all major reasons for higher energy and electricity use per capita. Moreover, the reason behind the increase in TPES per capita might be the increased natural gas and coal consumption in Turkey during 1980-2008.

Energy intensity of Turkey decreased slightly during 1980-2008 while electricity intensity increased by 136% in the whole economy. Electricity intensity in all (industry, agriculture and service) sectors increased but energy intensity increased only in agriculture and service sectors between 1980-2008. Decreased industrial energy intensity may be due to shift of economy from industry towards service sector or improvement in energy efficiency in industry. On the other hand, in 2000, Turkey increased its industrial intensity by 14.7% compared to 1990. In Turkey, the share of energy-intensive sectors in industry might have been increased during this period. Strong economic growth may lead to an increase in the demand for energy and this might have increased the use of energy which resulted in an increase in industrial intensities.

When we analyze the share of value added and energy intensity of a sector, we can claim that lower energy intensities with higher value added share imply energy efficiency in that sector. Although, agricultural energy intensities increased during 1980-2008 period in Turkey, compared to other countries, we can claim Turkey is more energy efficient in agriculture sector because of large share and lower energy intensity. On the other hand, electricity intensity in agriculture increased significantly. Introduction of new technologies and use of new equipments in agriculture may increase the demand for electricity. Service sector increased its the share in the economy and also increased the energy use but energy and electricity intensities did not decrease significantly. Thus, energy efficiency is also not attained in service sector. The increased energy and electricity intensities in service sector can be explained by extensive use of office equipments, heating and cooling systems, ventilation or other devices. Considering the share of agriculture and service sector in the economy, their increased energy consumption and increased energy and electricity intensities, we can claim that none of them achieve energy efficiency. Industrial energy intensity, on the other hand is increasing in Turkey. In order to decrease energy intensity, energy efficiency should be increased during transmission and distribution of energy; losses during energy transmission should be reduced; technological improvements that enable energy efficiency should be used (TMMOB, 2008).

Results of these indicators show us that in Turkey although government introduced many regulations and amendments about energy intensity and efficiency, the implications and expected results of these attempts could not be realized effectively. For instance, it aims to decrease level of energy intensities to OECD levels; decrease the import of fossil-fuel energy; and decrease the CO_2 emissions (TMMOB, 2008). Moreover, Turkey aims to reduce energy intensity by 15% by 2020 according to 2007 Energy Efficiency Law, yet the current statistics demonstrate that Turkey has not been successful to decrease energy intensities yet.

5.4.2.Energy security and fuel mix

Non-carbon energy sources are important in order to attain energy security, diversification of energy sources and environmental protection. Contrary to EU countries, the share of non-carbon energy sources in energy and electricity generation decreased in Turkey. There are several reasons why Turkey has low levels of non-carbon sources. To begin with Turkey has used carbon-based energy sources such as coal, lignite and petroleum dominantly both for energy production and electricity generation since 1980. Coal constitutes 24% of total energy sources in Turkey that has been used for electricity generation. Lignite, on the other hand, is another source that Turkey is dominantly producing. Non-carbon share in electricity generation is low because the majority of electricity is supplied from natural gas and coal. The share of fossil fuels in primary energy is high in Turkey. Thus, Turkey should decrease the share of fossil fuels in primary energy consumption regarding increasing price of fossil fuels and its negative impacts on environment (Güllü et al., 2001). Lastly as a combustible renewable energy and thus non-carbon energy source, biomass has been declining in Turkey, which also explains the decrease in non-carbon energy share in Turkey.

The share of renewable energy in Turkey has a downward trend. While TPES has tripled between 1980-2008, renewable energy supply has slightly increased during the same period. Thus, the share of renewables in TPES has decreased over the years. Turkey has a very high renewable energy potential in terms of geothermal energy, biomass, solar energy and wind power.

Wind power has been recently recognized as an alternative energy source for enhancing Turkey's energy mix. Energy Market Regulatory Authority (EMRA) published a wind atlas of Turkey in 2002 and it demonstrated the regions that have higher potential for wind power. Turkish private firms held the Wind Power Technology Platform in 2010 and announced a project called National Wind Power (MILRES). The project aims to reveal the wind potential in Turkey. Although Turkey has wind potential there are problems buffering the improvement of wind energy in Turkey. First of all, the current transmission infrastructure is not satisfactory to allow large scale developments to be connected to the power grid. Therefore, substantial upgrades are essential in terms of infrastructure and transmission of wind energy (GWEC, 2011). Second, the current government has been late to approve wind power projects. There are proposals to build wind farms with a total operating capacity of 8000 megawatts and they have been awaiting government approval (Energy Daily, 2011). Wind power in 2004

Hydroelectric potential is corresponding to 1% of the world and 16% of the European region and 65% of hydroelectric potential is not converted to energy (Soyhan, 2009).

All the relevant literature agreed that to increase domestic energy supply without environmental degradation renewable energy is the best alternative (Kaygusuz and Kaygusuz, 2002; Demirbaş, 2003; Ocak et al, 2004; Kılıc and Kaya, 2007; Pehlivan and Demirbaş, 2008; Şalvarlı, 2009; Karagöz and Bakırcı, 2010; Yüksel, 2010). There are ongoing attempts to promote renewable energy sources such as the Law on the Utilization of Renewable Energy Sources for the Purposes of Generating Electricity introduced in 2005 and strategies discussed in MENR report (2010). The main strategies can be summarized as follows:

■ 'Regarding the renewable energy resources that create an economic potential, the required precautions will be taken for the completion of the licensed projects within the projected term.

■ The production planning will be prepared through considering the developments in the renewable energy utilization potential in line with the advancements in technology and the arrangements in legislation.

■ For the maximum evaluation of the hydroelectricity potential of our country and the integration of this potential into the national economy through private sector, the precautions will continue being applied.

■ The cooperation required for the conduction of the studies for the improvement of the water resources suitable for the production of hydroelectricity, first of all on the basis of the basin with an integrated approach and with flexibility in the meeting of changing consumption demands will be accelerated.

■ The economic analysis criteria of hydroelectricity plants will be evaluated according to the conditions of the present day.

■ The studies required for the strengthening of the electricity transmission system to allow for the connection of a higher number of wind energy plants will also be accelerated.

■ In line with the protection purposes during utilization of the geothermal resources, their regeneration will be made and their renewable quality will be sustained.

■ The studies for the opening of geothermal areas suitable for electricity energy production for the private sector will be accelerated.

■ The technology development studies in the field of renewable energy resources will be given weight' (MENR, 2010; pp 19)

The outcomes of these attempts are still ambiguous because 'renewable energy share in energy and electricity' has a declining trend in Turkey. If we look at the growth rate of share of renewables in TPES for decades, 1980 - 1990, 1990 - 2000 and 2000 - 2008 the ratios are -34%, - 27.60% and -28.49%, respectively. The decreasing trend might be resulting from extensive replacement of natural gas as an alternative energy source, lack of financial resources and lack of proper lending facilities (Toklu E. et al., 2010). Increasing share of renewable energy is crucial for sustainable development. The combustion of fossil fuels releases toxic metals which cause environmental and health damage while hydro resources are more environmentally friendly as carbon dioxide emissions per unit of energy use is negligible. Renewable energy offers carbon free energy. Although renewable energy sources like hydro power energy may cause problems such as floods or loss of biodiversity, renewable sources still provide better solutions for energy production (Şalvarlı, 2009). To limit emissions and optimize energy efficiency is essential for sustainable development.

Our last indicator is the import dependency regarding energy security. Import dependency is one of the most crucial issues for Turkey. Rapidly growing economy and population cause energy demand to increase continuously. To ensure energy security, Turkey should diversify energy resources by focusing on domestic resources and pay specific attention to diversify foreign sources of oil and natural gas. Turkey is a net importer of natural gas and oil. It imports almost all of the oil and gas consumed. Therefore, it is crucial for Turkey to develop long-term relationships in the region and cooperate with other countries to diversify her import sources and routes.

In summary, increasing imports of natural gas and oil lead to increase net import dependency of Turkey. Turkey has increased the import dependency from 45% in 1980 to 74% in 2008.

There is a significant difference between periods 1980-1990 and 1990-2008 as growth of net import dependencies are on the average 16.38% and 38.35%, respectively. GDP growth rates for 1980-1990 and 1990-2008 are 66.57% and 101% respectively. GDP and import dependency increased in a parallel way. We can claim that economic growth triggered the import dependency because of increased energy and electricity demand. It is expected that the primary energy consumption will be increased and domestic energy production has its limits. Therefore, import dependency which is going to increase more, is a major concern for Turkish energy policy (Güllü et al., 2001). To reduce import dependency, Turkey should increase domestic energy production and renewable energy sources are the best alternatives considering both economic and environmental aspects.

5.4.3. Environmental concerns

Data for Turkey shows that GHG emissions per capita and GHG emissions per GDP increased between 1990-2008. There are several reasons of increased GHG emissions: economic growth and thus increased energy demand; increased private cars; construction facilities; and combustion of fossil fuels. Similarly, the air pollution in Turkey increased in terms of particulate matter PM_{10}. There are several reasons of air pollution in Turkey: use of fossil fuels (coal, lignite, petroleum, and natural gas), old combustion technologies and industrial premises, insufficient utilization of air pollution control devices, intensive urbanization and insufficient insulation practices.

The proposed mitigation measures for gas emissions that would decrease the GHG emissions and reduce air pollution are as follows: ‘use of low sulfur containing coal, control of NO_x by using low NO_x burners, use of electrostatic precipitators to control the emissions in terms of the quantity of ash particles, to comply with the international standards in terms of SO_2 and NO_x emissions (Demirbaș, 2003); decrease the use of insufficient and old technological industrial processes (Șalvarlı, 2009); and develop cleaner and renewable technologies and energy conversion technologies. These policies are expected to decrease air pollution and wastes produced by energy generation (Pehlivan and Demirbaș, 2008).

Lastly, rate of deforestation attributed to energy use in Turkey has increased comparing the ratio of 2000 to ratio of 2005. Mining, infrastructure development, the increased use of wood in households, and increase in the amount of biomass are some of the reasons of increased deforestation. Nevertheless, deforestation in Turkey has resulted mainly not because of energy purposes but due to urban pressures. Increased construction of educational facilities, tourism, recreation and settlements in forests lead deforestation to rise. Moreover, regulations about forest area lead deforestation such as Law no. 6831, Article 2B claiming that forest lands that have lost their forest character are determined to be suitable for agriculture, grazing or settlements for forest villagers (Atmış et. al., 2007).

Table 5.5 List of Results

			Turkey	**European Union**
ECO 1	1980-2008	TPES per capita	Increased	Increased
		TFC per capita	Increased	Increased
		Electricity consumption per capita	Increased	Increased
ECO 2	1980-2008	TPES per GDP	Stable	Decreased
ECO 6	1990-2008	Industrial energy intensity	Decreased	Decreased
		Industrial electricity intensity	Increased	Stable
ECO 7	1990-2008	Agricultural energy intensity	Increased	Stable
		Agricultural electricity intensity	Increased	Stable
ECO 8	1990-2008	Service sector energy intensity	Increased	Stable
		Service sector electricity intensity	Increased	Stable
ECO 12	1980-2008	Share of non carbon energy sources in TPES	Decreased	Increased
		Share of non carbon electricity sources in TPES	Decreased	Increased
ECO 13	1980-2008	Share of RES in TPES	Decreased	Increased

Continued

			Turkey	**European Union**
		Share of non carbon electricity sources in TPES	Decreased	Increased
ECO15	1980-2008	Net Import Dependency	Increased	Increased
ENV 1	1990-2008	Total Carbon Dioxide Emissions from the Consumption of Energy	Increased	Stable
		GHG emissions per GDP	Increased	Decreased
		GHG emissions per capita	Increased	Decreased
ENV 2		Total Particulate Formation PM10	Decreased	Decreased
ENV 6		Rate of Deforestation	Increased	Decreased

CHAPTER 6

CONCLUSION

In this study we conduct a comparative and descriptive analysis to answer the question whether Turkey achieves the sustainable development goals in terms of sustainable energy between 1980-2008. We compare Turkey with the selected European Union countries in terms of sustainable energy by using a set of energy indicators called Energy Indicators for Sustainable Development. We determine energy policy priorities of Turkey and European Union and construct a framework according to these policies. Our contribution is to apply EISD to Turkey and compare the results with EU countries which has not been done before. Although there have been studies applying EISD to countries and evaluating each country individually, we apply EISD to Turkey and compare the results with selected EU countries. We prefer to use energy indicators because they are useful tools to understand the general situation and changes in a country through time and they supply us information about the progress or lack of progress towards sustainable development. The main energy policy priorities of this study are energy efficiency and energy intensity; energy security and fuel mix; and environmental concerns. In the following, we present the results related to energy efficiency, energy intensity, energy security, fuel mix, renewable energy, import of energy, air pollution and deforestation. They are all discussed for Turkey and EU by the help of selected EISD.

We categorize the first part of this study as energy efficiency and energy intensity. Results of this study suggest that Turkey’s progress in decreasing energy intensity and improving energy efficiency is not satisfactory. The energy intensity of the whole Turkish economy has decreased by only 7% during 1980-2008 while this ratio is approximately four times larger in EU countries. When we compare the share of agriculture and service sectors in Turkish economy, according to their increased energy consumption and increased energy and electricity intensities, we can claim that none of them achieve energy efficiency targets. On the other hand, only industrial energy intensity, is improving slightly in Turkey. Moreover, the negative relation between energy intensity and GDP per capita proposes that economies with higher welfare have lower energy intensities and higher productivity. Our results show that although GDP per capita has increased in Turkey, the expected decline in energy intensity could not be attained. Another comparison is done between HDI and energy use per capita and the similar results are obtained. As HDI increases we expect energy efficiency to increase. In Turkey, HDI has increased during 1980-2008, implementing an increase in welfare, but an improvement in efficient energy use could not be observed because of extensive increase in energy use per capita. These indicators figure out that in Turkey, although governments have introduced several regulations about energy intensity and efficiency, the implications and expected outcomes of these attempts could not be realized effectively. For instance, Turkey aims to reduce energy intensity by 15% by 2020 according to the 2007 Energy Efficiency Law, but if we consider the performance of Turkey during 1980-2008, we can claim that Turkey will not be able to decrease energy intensities by 15% by 2020.

Energy security and fuel mix are the second energy policy priority title for Turkey and EU. The fuel mix is mainly composed of carbon-based energy sources and this trend is continuing in Turkey. Although the aim is to decrease the share of carbon energy sources in Turkey, we can observe that the share is very high compared to non-carbon energy sources. The share of renewable energy in Turkey does not demonstrate an expected increase because of use of natural gas as an alternative energy source and dominance of fossil-fuel based energy sources; financing barriers such as high capital requirements and high production costs during the construction of renewable energy plants; cost of technology such as high operating and maintenance costs of power plants; lack of financial resources and public awareness and unsuccessful commercialization of renewable energy (Ocak, 2004; Kılıç, 2007; Toklu, 2010).

Although the 'Law on the Utilization of Renewable Energy Sources for the Purposes of Generating Electricity' was introduced in 2005, we could not observe much implementation of these regulations.

It is not realistic for a modern industrialized country to achieve self-sufficiency in energy supply by its own. Therefore, import dependency is a critical issue regarding energy security. Turkey's import dependency has increased during 1980-2008, mainly due to increased amounts of import of natural gas and oil as major energy sources. We expect import dependency to decrease as renewable energy share increases in a country. As previously mentioned, in Turkey the share of renewables has not increased and the negative relation between net import dependency and share of renewables is valid for Turkey. In addition, when we look at the relationship between net import dependency and energy intensity, we expect energy intensity to decrease as import dependency increases. Nevertheless, in Turkey increasing import dependency does not have an expected effect on energy intensity.

The last energy policy priority title is environmental concerns including GHG emissions, air pollution and deforestation. In terms of environmental problems, GHG emissions per capita, GHG emissions per GDP and air pollution have increased in Turkey. GHG emissions increased due to economic growth, increased number of private cars, construction facilities and combustion of fossil fuels. The lack of mitigation technologies in industry, insufficient air pollution devices and increased urbanization led to increased air pollution in Turkey. Although Turkey ratified Kyoto Protocol, joined UNFCCC and introduced mitigation measures at national level, the implementation and realization of these regulations could not be achieved.

Deforestation is an important issue for sustainable development. The efficient land use and level of CO_2 emissions are all affected by deforestation. In Turkey, rate of deforestation increased in 2005 compared to the rate in 2000. The possible reasons for increased deforestation are increased amounts of biomass, extensive use of wood by households, agricultural purposes and increased mining and infrastructure development. In Turkey, extensive urban pressures like mining, construction of educational facilities, increased tourism, settlements in forest, industrialization and infrastructure, supply of firewood and recreation are the main reasons of deforestation (Atmış et. al., 2007). Especially, mining and industrialization and infrastructure are the energy related causes of deforestation. Biomass and use of wood by the households also affect deforestation but they have a downward trend during the period of analysis.

We also analyze the positive relation between GHG emissions and deforestation, such that increasing deforestation lead to increase in GHG emissions since deforestation contributes to CO_2 emissions. This pattern can be observed in Turkey as both deforestation and GHG emissions increased. The last relation we discuss is deforestation and GDP per capita. The extensive use of non-commercial use of energy sources in low income countries lead deforestation to increase. As the usage of wood increases we expect deforestation to increase. Nevertheless, we cannot claim that there is a direct relation between GDP per capita and deforestation rate for Turkey because GDP per capita increased in Turkey but deforestation did not decrease in 2005 compared to 2000.

Analysis of energy indicators points out important issues. Sustainable development indicates that economic growth should be consistent with environmental goals and a healthy environment is essential for the maintenance of continued economic growth (Meadocrowth, 2000). Both environmental and economic problems are interrelated in terms of poverty reduction, equity and use of natural resources in a sustainable way (UN, 1992). Where sustainable development once implied ecological sustainability, it is now commonly promoted as economic sustainability: sustaining the growth in material consumption' (Lele, S. M, 1991). Sustainable development is not an obstacle for economic growth. Turkey, on the other hand, could not achieve to comprehend the relation between economic growth and environmental concerns. Economic growth always takes the first place and environmental concerns remain at the back seat. The decoupling between economic growth and sustainable development is still valid for Turkey. The reasons of the decoupling in Turkey and solutions to that problem can be a further research question.

Secondly, there are determined energy policy priorities for Turkey under the name of efficiency, security and environment. These topics are discussed and take part in Turkish energy policy but; as indicators demonstrate, Turkey could not attain any of them during 1980-2008. Although there are many regulations, legislations or amendments in both national and international level, the implementation and realization of these could not be achieved. The possible reasons would be the lack of sanctions, lack of effective structural design of regulations or lack of public awareness which must be studied in detail in future research.

Lastly in this study, we find out that progress of Turkey in terms of sustainable energy is not satisfactory compared to progress of selected European Union countries. Climate changes, increased oil prices, wars, the oil spill in the Gulf of Mexico, Fukushima incident, and structural changes taken part in emerging countries all emphasize the importance of sustainable energy production and consumption because for all, energy plays a central role (Huge J. et. al., 2011). Considering these, improvement of sustainable energy is essential not only for Turkey but also for all countries. Throughout the study, Turkey has demonstrated a significantly different pattern than EU 15 and EU 27 in terms of energy indicators. Turkey has generally followed a pattern that is not desirable in terms of sustainable development and sustainable energy whereas EU 15 and EU 27 have managed to satisfy the required behaviors in the concept of sustainable development. However, it should be kept in mind that in this study Turkey is compared to European countries. Turkey and selected EU countries are different from each other in terms of economic development, population growth, and energy use and production patterns. In developing countries like Turkey because of economic growth, adaptation efforts to capitalist economy, increasing population and lower level of energy use all lead to higher rates of increase in energy use and other related indicators. In other words, the levels of almost all indicators are lower in Turkey but the rates of increase are higher compared to selected EU countries. EU countries are saturated in terms of energy use and the levels of energy indicators are high but the rates of increase are slower and lower compared to Turkey.

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APPENDICES

APPENDIX 1

Social				
Theme	**Sub-theme**	**Energy Indicator**		**Components**
Equity	Accessibility	SOC1	Share of households (or population) without electricity or commercial energy, or heavily dependent on non-commercial energy	– Households (or population) without electricity or commercial energy, or heavily dependent on non-commercial energy – Total number of households or population
	Affordability	SOC2	Share of household income spent on fuel and electricity	– Household income spent on fuel and electricity – Household income (total and poorest 20% of population)
	Disparities	SOC3	Household energy use for each income group and corre-sponding fuel mix	– Energy use per household for each income group (quintiles) – Household income for each income group (quintiles) – Corresponding fuel mix for each income group (quintiles)
Health	Safety	SOC4	Accident fatalities per energy produced by fuel chain	– Annual fatalities by fuel chain – Annual energy produced

Economic				
Theme	**Sub-theme**	**Energy Indicator**		**Components**
Use and Production Patterns	Overall Use	ECO1	Energy use per capita	– Energy use (total primary energy supply, total final consumption and electricity use) – Total population
	Overall Productivity	ECO2	Energy use per unit of GDP	– Energy use (total primary energy supply, total final consumption and electricity use) – GDP
	Supply Efficiency	ECO3	Efficiency of energy conversion and distribution	– Losses in transformation systems including losses in electricity generation, transmission and distribution
	Production	ECO4	Reserves-to-production ratio	– Proven recoverable reserves – Total energy production
		ECO5	Resources-to-production ratio	– Total estimated resources – Total energy production
	End Use	ECO6	Industrial energy intensities	– Energy use in industrial sector and by manufacturing branch – Corresponding value added
		ECO7	Agricultural energy intensities	– Energy use in agricultural sector – Corresponding value added
		ECO8	Service/ commercial energy intensities	– Energy use in service/ commercial sector – Corresponding value added
		ECO9	Household energy intensities	– Energy use in households and by key end use – Number of households, floor area, persons per household, appliance ownership
		ECO10	Transport energy intensities	– Energy use in passenger travel and freight sectors and by mode – Passenger-km travel and tonne-km freight and by mode

Economic				
Theme	**Sub-theme**	**Energy Indicator**		**Components**
	Diversification (Fuel Mix)	ECO11	Fuel shares in energy and electricity	– Primary energy supply and final consumption, electricity generation and generating capacity by fuel type – Total primary energy supply, total final consumption, total electricity generation and total generating capacity
		ECO12	Non-carbon energy share in energy and electricity	– Primary supply, electricity generation and generating capacity by non-carbon energy – Total primary energy supply, total electricity generation and total generating capacity
		ECO13	Renewable energy share in energy and electricity	– Primary energy supply, final consumption and electricity generation and generating capacity by renewable energy – Total primary energy supply, total final consumption, total electricity generation and total generating capacity
	Prices	ECO14	End-use energy prices by fuel and by sector	– Energy prices (with and without tax/subsidy)
Security	Imports	ECO15	Net energy import dependency	– Energy imports – Total primary energy supply
	Strategic Fuel Stocks	ECO16	Stocks of critical fuels per corresponding fuel consumption	– Stocks of critical fuel (e.g. oil, gas, etc.) – Critical fuel consumption

Environmental				
Theme	**Sub-theme**	**Energy Indicator**		**Components**
Atmosphere	Climate Change	ENV1	GHG emissions from energy production and use per capita and per unit of GDP	– GHG emissions from energy production and use – Population and GDP
	Air Quality	ENV2	Ambient concentrations of air pollutants in urban areas	– Concentrations of pollutants in air
		ENV3	Air pollutant emissions from energy systems	– Air pollutant emissions
Water	Water Quality	ENV4	Contaminant discharges in liquid effluents from energy systems including oil discharges	– Contaminant discharges in liquid effluents
Land	Soil Quality	ENV5	Soil area where acidification exceeds critical load	– Affected soil area – Critical load
	Forest	ENV6	Rate of deforestation attributed to energy use	– Forest area at two different times – Biomass utilization
	Solid Waste Generation and Management	ENV7	Ratio of solid waste generation to units of energy produced	– Amount of solid waste – Energy produced
		ENV8	Ratio of solid waste properly disposed of to total generated solid waste	– Amount of solid waste properly disposed of – Total amount of solid waste
		ENV9	Ratio of solid radioactive waste to units of energy produced	– Amount of radioactive waste (cumulative for a selected period of time) – Energy produced

Environmental				
Theme	**Sub-theme**	**Energy Indicator**		**Components**
		ENV10	Ratio of solid radioactive waste awaiting disposal to total generated solid radioactive waste	– Amount of radioactive waste awaiting disposal – Total volume of radioactive waste

Source: IAEA, 2005 pp. 12-15.