PROMITHEAS – 4

Knowledge transfer and research needs for preparing mitigation/adaptation policy portfolios

(Contract No. 265182)

Mitigation / Adaptation scenarios and Climate Change policy portfolios for Turkey

Authors: Nuray Guler AKALIN, Deniz SARI, Dr. Bilgin HILMIOGLU
TUBITAK-Marmara Research Center - Environment Institute

Co-authors: Dr. Popi KONIDARI, Anna FLESSA M.Sc.
National and Kapodistrian University of Athens - Energy Policy and Development Centre

Kocaeli, 2012

This document is part of the relevant report prepared for the FP7 funded project "PROMITHEAS-4: Knowledge transfer and research needs for preparing mitigation/adaptation policy portfolios", coordinated by Prof. Dimitrios MAVRAKIS, Energy Policy and Development Centre (Greece). The whole report contains twelve (12) documents for each one of the emerging economies that participate in the project: Albania, Armenia, Azerbaijan, Bulgaria, Estonia, Kazakhstan, Moldova, Romania, Russia, Serbia, Turkey and Ukraine.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

ABBREVIATIONS

Abbreviation	Full name
BAU	Business As Usual
CDM	Clean Development Mechanism
CEI	Cost Efficiency Index
CER	Certified Emission Reduction
COP	Conference of the Parties
DMI	State Meteorological Services
EBRD	European Bank for Reconstruction and Development
EC	European Commission
EE	Energy Efficiency
EIE	General Directorate of Electrical Power Resources Survey and Development Administration
EMRA	Energy Market Regulatory Authority
ERU	Emission Reduction Unit
ESCO	Energy Service Company
ET	Emission Trading
EU	European Union
EUA	European Union Emission Allowance
EVD	Energy efficiency consultancy companies
FAO	Food and Agriculture Organization
FIT	Feed In Tariffs
GHG	Greenhouse Gas
GO	Governmental Order
IEA	International Energy Agency
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
JI	Joint Implementation
LEAP	Long range Energy Alternatives Planning System
LULUCF	Land Use, Land Use Change and Forestry
MENR	Ministry of Energy and Natural Resources
MoEF	Ministry of Environment and Forestry (restructured in June 2011)
MoEU	Ministry of Environment and Urbanism
NGO	Non-Governmental Organization
NIR	National Inventory Report
OECD	Organisation for Economic Co-operation and Development
OPT	Optimistic
PES	Pessimistic
R&D	Research and Development
RES	Renewable Energy Sources
SEE	South East Europe
SEECOF	South East Europe Climate Outlook Forum
TEIAS	Turkish Electricity Transmission Corporation
TNO	Transmission Network Operator
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WMO	World Meteorological Organization

INTRODUCTION

Objectives of the Turkish climate change policy

Turkey became a party to the United Nations Framework Convention on Climate Change (UNFCCC) on 24 May 2004, ten years after the Convention was set into force in 1994. This delay was caused by the fact that initially Turkey was included as a developed and OECD[1] country[2] in both Annexes[3] of the UNFCCC. Decision (26/CP.7) of Conference of the Parties-7 (COP7) that was held in Marrakech in 2001 deleted Turkey from Annex II - but the country remained as an Annex-I Party of the UNFCCC - and recognized the special circumstances of the country as being different from that of the other Annex I countries of the Convention[4]. This decision entered into force on June 28, 2002[5] and was repeated in Decision 1/CP.16, of COP16 held in Cancun in 2010[6]. More recently, Decision 2/CP.17 of COP17 in Durban in 2011[7], expresses the agreement of the Parties to continue with the discussion on modalities for the provision of support for mitigation, adaptation, technology development and transfer, capacity-building and finance to those Annex I Parties to the UNFCCC, like Turkey, that are recognized being in a different situation compared to the others.

"The Bill on the Endorsement of Turkey's Ratification of the Kyoto Protocol to the UNFCCC" was adopted in the General Assembly of the Turkish Grand National Assembly on February 5th, 2009[8] and Turkey ratified Kyoto Protocol on August 29th, 2009, 4 years after it came into force (16th of February 2005). The country was not included in Annex B of the Protocol[9] which presents the defined quantified emission limitation or reduction commitments of each country. Turkey does not have a quantified emission limits or reduction commitments for the first commitment period (2008-2012) under the Protocol.

Objectives of the national climate change policy are encountered in the following Strategies and Plans. More specifically at the:

- *Electricity Energy Market and Supply Security Strategy* (No. B.02.1.DPT.0.05.01-107 / 1701, Date of issue: 21 May 2009, Republic of Turkey, 2009), the country intends to increase the share of Renewable Energy Sources (RES) in electricity generation up to at least 30% by 2023. The country is planning to achieve this target by year 2023 through the following:
    - Increasing the installed wind energy power to 20000MW;
    - Exploiting fully the technical and economically available hydroelectric potential of the country (216 TWh/yr, and 140 TWh/yr, respectively (Capic M. et al., 2012);
    - Using the geothermal potential of 600MW;

[1] Organisation for Economic Co-operation and Development
[2] http://iklim.cob.gov.tr/iklim/AnaSayfa/BMIDCS.aspx?sflang=en
[3] Annex I includes West-European countries, East-European and former Soviet Countries which have adapted market-economy and OECD countries, while Annex II includes only OECD countries. Turkey was considered as a developed country in these annexes (http://www.mfa.gov.tr/united-nations-framework-convention-on-climate-change-_unfccc_-and-the-kyoto-protocol.en.mfa)
[4] http://www.mfa.gov.tr/united-nations-framework-convention-on-climate-change-_unfccc_-and-the-kyoto-protocol.en.mfa
[5] http://www.mfa.gov.tr/united-nations-framework-convention-on-climate-change-_unfccc_-and-the-kyoto-protocol.en.mfa
[6] http://unfccc.int/files/na/application/pdf/07a01-1.pdf
[7] http://unfccc.int/resource/docs/2011/cop17/eng/09a01.pdf
[8] Law No. 5836 on the Ëndorsement of Turkey;s Ratification of Kyoto Protocol to the UNFCCC, Official Gazette no. 27144, date Februray 17, 2009 and adoption by the Council of Ministers of the Cabinet Decree (No. 2009/14979) on 13 May 2009 (http://iklim.cob.gov.tr/iklim/AnaSayfa/BMIDCS.aspx?sflang=en)
[9] Turkey and Kazakhstan are Annex I Parties to the UNFCCC, but do not have commitments inscribed in Annex B to the Kyoto Protocol - http://unfccc.int/resource/docs/2011/sbi/eng/inf02.pdf

- Ensuring the maximum utilization of solar energy (380 billion kWh per year[10]).

Also, the Strategy indicates that:

- The country target is to increase the share of nuclear power plants in electricity energy up to at least 5% by the year 2020, and to increase it even further in the longer run.
- Reducing the share of natural gas in electricity generation to below 30%.

- *"National Climate Change Strategy (2010-2020)(MoEF, 2010)"* which was published in 2010, the country set a wide range of targets for energy, transportation, industry, waste, land use, agriculture and forestry, adaptation, technology development and transfer and capacity building. The quantitative objectives included in the Strategy are the followings::
  - 30% increase of the share of RES in total electric power generation by year 2023. This objective is the same with that of the previous strategy.
  - 7% reduction of Greenhouse Gas (GHG) emissions from electricity generation compared to the amount estimated in the Reference Scenario by year 2020. The Reference scenario is presented at the First National Communication of the country to UNFCCC in 2007.
  - 104 sanitary landfill facilities will be established and 76% of the municipal wastes will be disposed at these by 2012.
  - 2.3 million hectare area will be afforested and rehabilitated within the scope of National Afforestation Campaign for the time period 2008 –2012. It is expected that 181.4 million tons of carbon will be absorbed by the Turkish forest land until 2020, in addition to the amount of carbon absorbed by existing sinks.
- *"Strategic Plan of the Ministry of Energy and Natural Resources (2010-2014) (MENR, 2010)"* the country intends to achieve the following targets:
  - 20% reduction of the primary energy density by 2023 compared to the amount in 2008; the intermediate target is 10% up to 2015;
  - ensure by 2013 the installed capacity of: i) 3,500 Mega Watt (MW) domestic coal thermal plants; ii) 5000MW hydroelectric plants;
  - ensure by 2015 the installed capacity of: i) 10000MW wind power installations; ii) 300MW geothermal energy plants;
  - By the year 2015, the foreign crude oil and natural gas production will be redoubled in comparison to the production amounts in 2008.
- *"National Climate Change Action Plan, 2011-2023"* of the Ministry of Environment and Urbanization, published in 2011, presents more detailed targets up to 2023 unless defined differently (MoEU, 2011):
  - 5% biofuel can be added to other types of fuel in the country;
  - 75% of biodegradable wastes are expected to be disposed by landfills in 2015,and 50% no earlier than 2018 and by 35% till 2025;
  - Establish integrated solid waste disposal facilities across the country, and dispose 100% of municipal wastes in these facilities, until the end of 2023;
  - Termination of uncontrolled disposal of wastes 100% ;

[10] http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=gunes_EN&bn=233&hn=&nm=40717&id=40733

- Reduce nationwide electricity distribution losses to 8%;
- Decrease annual energy consumption in the buildings and premises of public institutions by 10% until 2015 and by 20% until 2023;
- At least 20% of the annual energy demand of new buildings met via renewable energy resources as of 2017;
- Reduce GHG emissions in new settlements by at least 10% per settlement in comparison to existing settlements (which are selected as pilot and the GHG emissions of which are identified until 2015) ;
- Increasing the share of railroads in freight transportation (which was 5% in 2009) to 15% and in passenger transportation (which was 2% in 2009) to 10% by 2023;
- Increasing the share of seaways in cabotage freight transportation (which was 2,66% in ton-km in 2009) to 10%, and in passenger transportation (which was 0.37% in passenger-km in 2009) to 4% as of 2023;
- Decreasing the share of highways in freight transportation (which was 80.63% in ton-km in 2009) below 60%, and in passenger transport (which was 89.59 in passenger-km in 2009) to 72% as of 2023;
- Increase the amount of carbon sequestered in forests by 15% of the 2007 value by 2020 (14500 Gg in 2007, 16700 Gg in 2020);
- Reduce deforestation and forest damage by 20% of the 2007 values by 2020;
- Increase the amount of sequestered carbon as a result of agricultural forestry activities by 10% of the 2007 values by 2020;
- Identify the amount of sequestered carbon in pastures and meadows in 2012, and increase carbon stock 3% by 2020;
- Identify the quantity of carbon stored in settlement areas in 2012, and increase stored carbon 3% by 2020 through green planting.

- *"Energy Efficiency Strategy, 2012-2023" of the Ministry of Energy and Natural Resources, published in 2012, presents more detailed energy efficiency targets up to 2023 (MENR, 2012):*
  - The reduced energy intensities in each industry sub sector will be decreased in the rates determined with the sector collaborations without being at least 10% for each sub sector within the 10 years.
  - In year 2023 the heat insulation and energy efficient heating systems providing current standards will be used in all commercial and service buildings.
  - At least one fourth (1/4) of building stock in the year 2010 will be constructed as sustainable building by the year 2023.
  - The market transformation of lamps, refrigerators and electrical motors over the minimal energy efficiency class shall be completed until at the end of 2012 and however market transformation of heating/cooling systems and other energy efficient products will be accomplished in parallel to the EU implementations.
  - The total average cycle efficiency of the coal thermal power plants around the country including waste heat recovery will be increased over 45% by the year 2023.

- Some measures about the subject of demand side management will be developed for decreasing the electrical energy intensity at least 20% until the year 2023.
- The small vehicles carrying passenger and load (M1/N1 category) will meet the provisions of secondary legislation which would be produced in the direction of the EU legislation related to CO_2 emissions, the transport master plans in big cities shall be prepared and put into force.
- The use of bio-fuels obtained from biomass sources or synthetic fuels in transportation will be promoted.
- Annual energy consumption in the public enterprises buildings and facilities will be decreased as ten percent (10%) by the year 2015 and as twenty percent (20%) by the year 2023.
- The institutional structure, capacity and mutual cooperation of implementing organizations will be strengthened until the end of 2012.
- The number of certified energy managers will be increased up to at least five thousand (5000) persons and the number of energy efficiency consultancy companies (EVD) expertized in industry sectors will be increased up to fifty (50) companies in the country general by the end of the year 2015.
- The number of original design and/or product, which would be commenced to be manufactured based on domestic R&D results, will be at least fifty (50) by the year 2023 in the areas of energy efficiency and renewable energy resources.
- The awareness and encouragement activities carried on as part of the "National Energy Efficiency Movement" will be promoted with the collaboration of public sector, private sector and NGOs.
- In the context of sustainable financing mechanisms except the public for the applications related to energy efficiency and renewable energy sources, the works of developing the infrastructure of carbon trading and carbon market will be completed.

The national climate policy of the country will be affected by the following memberships:

- Turkey is an observer to the Energy Community, but along with Moldova and Ukraine, it formally expressed its interest in full membership[11]. Moldova became a full fledged member as of 1 May 2010, Ukraine officially acceded the Energy Community on 1 February 2011. Countries with full membership will apply European Union (EU) directives related to the use of Renewable energy sources (RES) and the promotion of energy efficiency.
- Turkey is a candidate country for EU membership following the Helsinki European Council of December 1999. Accession negotiations started in October 2005 with the analytical examination of the EU legislation. On 18 February 2008 the Council adopted a revised Accession Partnership with Turkey[12]. Until now, negotiations have been opened on 13 chapters (Science and research, Enterprise and industry, Statistics, Financial control, Trans-European networks, Consumer and health protection, Intellectual property law, Company law, Information society and media, Free movement of capital, Taxation, Environment and Food safety, veterinary and phytosanitary policy), one of which (Science and research) was provisionally closed (EC, 2011).

11 http://www.energy-community.org/portal/page/portal/ENC_HOME/ENERGY_COMMUNITY/Stakeholders/Observers

12 http://ec.europa.eu/enlargement/candidate-countries/turkey/relation/index_en.htm

Spectrum of climate change mitigation options for Turkey

Turkey's total GHG emissions including Land Use, Land-Use Change and Forestry (LULUCF) reached 323 Mt in 2010. Emissions grew by 9.1% compared to levels of 2009 and by just over 147% compared to 1990 levels (NIR, 2012). The emissions from the energy sector had the largest portion with 88.20% in the total emissions of 2010. The share of the emissions from the industrial process is 16.68%, the waste 11.09%, the agriculture 8.39% and LULUCF 24.36% (NIR, 2012).

The main source of GHG emissions from the energy sector is electricity production. The installed capacity of electricity production reached the amount of 49.52 GW in 2010 with 10.63% increase from 2009 and about 3 times higher than the 1990 values. In 2010, natural gas had a very high share of 46.5% in electricity production, which was followed by coal (26.06%), hydro and geothermal (24.8%), other renewable (1.60%) and oil (1.0%) (NIR, 2012).

Gross electricity consumption (equal to gross generation + import – export) was 194.1 TWh with annual decrease of 2% for the year 2009, and 210.4 TWh with annual increase of 8.4% for the year 2010. Net consumption (internal consumption, grid losses and power theft excluded) is 156.9 TWh for the year 2009 and 169.4 TWh for 2010 (TEIAS, 2011).

Turkey focuses on mitigation and adaptation measures for the energy sector which is the major source for its GHG emissions. The share of hydropower, wind and other renewable sources have been increasing due to the Renewable Energy law that was introduced in 2005 and amended with incentives in 2011. Turkey has defined targets for reducing energy intensity. The Energy Efficiency Law was set into force in 2007. As a result of this Law 75 million CO_2-eq tones of emissions will be avoided until 2020. Also, Turkey has targets related with rehabilitating power plants and utilizing low carbon content fuels. In accordance with the Regulation on Heat Insulation in Buildings which was published in 2006, buildings are insulated to reduce heating and cooling needs. Besides these measures, the country is running public awareness campaigns on energy efficiency (MoEF, 2010d).

Exploitation of RES

Turkey has significant renewable energy potential. The country is ranking seventh in the world for its geothermal resources, while it has over 1% of the world's hydropower potential (EBRD, 2009). Turkey's total realizable RES potential is equal to the 13% of the EU-27 total potential and the country is ranking fifth after Germany, France, Spain and United Kingdom (Sirin S.M. and Ege A., 2012). Solar power, wind and biomass are plausible options for renewable energy source in Turkey (EBRD, 2009).Renewable energy supply in Turkey is dominated by hydropower and biomass, but due to environmental and scarcity-of-supply concerns biomass use was restricted mainly for residential heating. Total renewable energy supply declined from 1990 to 2005, because of a decrease in biomass supply. As a result, the composition of renewable energy supply has changed and wind power is beginning to claim market share (Kaygusuz K., 2010).

Biomass

Biomass sources include agriculture, forests, animals, organic urban waste, etc. This type of RES has great potential to provide improved rural energy services based on forest and agricultural residues. Its share of total energy consumption is still high in Turkey. The amount of the energy potential and annual potential are approximately 32 Mtoe (Million tons of oil equivalents) and 117 Mt, respectively (Capic M. et al., 2012). In 2008, the total amount of energy obtained from biomass sources was 66 thousand toe[13].

13 http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=biyoyakit_EN&bn=235&hn=&nm=40717&id=40736

The amount of biogas that can be produced in Turkey, considering its animal waste potential, is reported as 1.5 to 2 Mtoe. From approximately 8.6 Mtoe of waste potential, 6 Mtoe is used for heating[14].

Turkey's biomass potential is 2000 MW which is equal to 14000 GWh of generation capacity annually (MENR, 2012). In 2010, the total installed capacity of biomass was 44 MW, which corresponds to 2.2% of the potential (MENR, 2012). Turkey aims to increase in 2023 the installed capacity to 2000MW which is equal to the total potential (MENR, 2012).

Hydropower

One of the national energy assets is the huge hydroelectric resource (Capic M. et al., 2012). The share of hydropower in total electricity generation was about 32% in 2010 (TEIAS, 2011). The Turkish gross hydropower potential, which is a function of topography, geology and hydrology, is about 433 TWh/yr. This amount corresponds to 1.1% of the total hydropower potential of the world and 8.8% of European hydropower potential (Capic M. et al., 2012). Almost half of the gross potential is technically exploitable, but the most realistic estimations consider the technical and economical hydropower potential at 216 TWh/yr, and 140 TWh/yr, respectively (Capic M. et al., 2012).

In terms of installed capacity the hydroelectric potential is 36000 MW - equivalent with 144000 GWh of generation capacity annually (MENR, 2012). In 2010, the total installed capacity of hydro power was 15831 MW, which is 44% of the economically viable hydroelectric potential (TEIAS, 2011). The country aims at utilizing in electricity generation all hydroelectric potential that is technically and economically viable by the year 2023[15].

Solar

The solar energy potential evaluations made by the General Directorate of Electrical Power Resources Survey and Development Administration (EIE) based on the data measured by the State Meteorological Services (DMI) during the period 1966-1982 revealed the following[16]:

- The annual average total insulation duration is 2640 hours (7.2 hours/day).
- Average annual solar radiation is 1311 kWh/m²-year (3.6 kWh/m²day).
- Total solar energy potential in Turkey is 380 billion kWh per year.

The average sunshine duration is 7.2 h/day and the solar radiation is 309.6 cal/cm^{2}day. In the geographical region of Turkey, especially, the Southeast Anatolia is a major region for sunshine duration and solar radiation, 8.2 h/d and 344.8 cal/cm^{2}d, respectively (Capic M. et al., 2012).

The solar potential of the country is 50000 MW which corresponds to 7500 GWh of generation capacity annually (MENR, 2012). There was no installed capacity by the end of 2010 (MENR, 2012). Turkey aims to increase the installed capacity to 3000MW in 2023 (MENR, 2012).

Solar energy has been mainly used for heating water. Currently, roof-top solar panel installations used for this purpose are roughly 12 million m^2 (Topkaya S. O., 2012).

Wind

The country has significant wind energy potential due to topography (many mountains), and geography (location between the colder European and warmer Asian and African

[14] http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=biyoyakit_EN&bn=235&hn=&nm=40717&id=40736

[15] http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=hidrolik_EN&bn=232&hn=&nm=40717&id=40737

[16] http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=gunes_EN&bn=233&hn=&nm=40717&id=40733

systems) (Capic M. et al., 2012). The wind sources of Turkey are concentrated in the western and southern regions. The sea fronts of the Aegean, Marmara, Mediterranean, and Black Seas, and some places of the Southeast Anatolian belt have a high wind potential, with an average speed of 4.5-10 m/s (Capic M. et al., 2012).

The country ranks 1st in the world in terms of highest growth rate in wind energy plants and only 15% of its potential has been utilized up until now (EBRD, 2009). The total wind potential is approximately 88000 MW (MoEF, 2007) and economically viable wind potential is approximately 48000 MW equivalent to 60000 GWh of generation capacity annually (MENR, 2012). However, wind energy potential in Turkey is largely unutilized, with only 802.8 MW in use by 2009[17] and 1320 MW in use by 2010 (TEIAS, 2011). Turkey aims to increase the installed capacity to 20000MW in 2023 (MENR, 2012).

After the introduction of the RES Law, the approved overall capacity of wind farm projects is 3363 MW, and 1100 MW of the capacity is under construction[18].

Geothermal

The geothermal energy potential in Turkey is estimated to be about 31500 MW with approximately 80% of this potential located in Western Anatolia of Turkey (Capic M. et al., 2012). There are 470 wells in Turkey and 187 geothermal fields have been discovered[19].

About 1500 hot and mineral water resources (spring discharge and reservoir temperature) have temperatures ranging from 20 to 242°C (Capic M. et al., 2012). Turkey has extensive geothermal resources that are used for heating of residences, district heating, greenhouse heating, and for spas. A total of 260 spas in Turkey are using geothermal water for balneological purposes. The geothermal heating is equivalent to supplying energy to 201000 residences (Capic M. et al., 2012).

600 MW of the geothermal energy is suitable for electricity generation but it is assessed to increase up to 1500 MW[20].

The total installed geothermal capacity used in Turkey was about 94.2MW by the end of 2010 (TEIAS, 2011; MENR, 2012). Turkey aims to use the entire potential (600 MW) for electricity generation in 2023 (MENR, 2012).

Energy efficiency

It is estimated that Turkey holds an energy-saving potential of 30% in the building, 20% in the production industry, and 15% in the transportation[21]. For the purpose of making use of this potential the Energy Efficiency Law in 2007 and the Regulation on Increasing Efficiency in the Use of Energy Sources and Energy in 2008 were enacted by the Ministry of Energy and Natural Resources.

Energy sector

- Increase capacity and efficiency of existing thermal plants by rehabilitation activities. There is no exact estimation of reduction value.
- Increase incentives given by MENR for energy efficiency applications by 100% until 2015;

[17] http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=ruzgar_EN&bn=231&hn=&nm=40717&id=40734
[18] http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=ruzgar_EN&bn=231&hn=&nm=40717&id=40734
[19] http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=jeotermal_EN&bn=234&hn=&nm=40717&id=40735
[20] http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=jeotermal_EN&bn=234&hn=&nm=40717&id=40735
[21] http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=enerjiverimliligi_EN&bn=217&hn=&id=40719

- Increase the average cycle efficiencies of existing coal-fired thermal power plants until 2023;
- Reduce nationwide electricity distribution losses to 8%.

Residential Building

The target is to reduce the annual energy consumption by 20% until 2023 in buildings and premises of public institutions but the amount of the reduction is not defined for each measure. The measures are:

- Improvement of insulations in buildings;
- Replacement of conventional light bulbs with energy efficient ones;
- Promotion of the use of energy efficient household equipments;
- Development of rules for new buildings such as energy performance, use of RES.

Public and commercial services Sector

- Conventional incandescent light bulbs have been replaced with efficient ones since 2008 and the use of efficient bulbs will continue.

Industrial Sector

- Making legal arrangements for energy efficiency and limitation of GHG emissions;
- Limiting GHG emissions originating from energy usage (including electrical energy share) in the industry sector;
- Develop and use new technologies for limitation of GHG emissions in the industry sector until 2023.

Transport Sector

Regulation on increasing of energy efficiency at transport sector (Official Gazette No: 26901, 9 June 2008) under the Energy Efficiency Law has many measures to increase efficiency, but no estimations. More specifically:

- Provide priority to the block railway for freight transport;
- Implementation of travel demand management, intermodal transportation system, traffic management and electronic road guidance systems for effective transportation systems;
- Promotion of public transport systems (especially rail systems) in urban areas; Regulation of the traffic signal system taking into account efficiency;
- Provide priority to using LED lamps in traffic signal systems;
- Increase awareness of consumers about fuel economy and CO_2 emissions of passenger cars;
- Requirement of economical driving techniques training for freight transport drivers.

Fuel switch

Most of these options refer to:

- 5% biofuel can be added to other types of fuel in the country ("National Climate Change Action Plan, 2011-2023");
- Increase use of RES for electricity production;
- Start use of nuclear energy for electricity production.

Mitigation through emission trading

Clean Development Mechanism (CDM)

Turkey has no commitments under the Kyoto Protocol and therefore is not eligible to participate.

Global emission trading

Turkey cannot participate in the flexibility mechanisms (CDM, Joint Implementation (JI) and Emission Trading (ET)) of the Kyoto Protocol, so it has taken a position in the voluntary carbon market and projects have been implemented in voluntary carbon market since 2005.

By the publication of the Communication on Registry Operations of GHG Emission Projects (published in the Official Gazette dated 7 August 2010 and numbered 27665) (MoEF, 2010(c)), a carbon registry system is established to increase the value of carbon assets in Turkey. The registration can be made through "http://www.karbonkayit.cob.gov.tr" web site within the Ministry of Environment and Urbanism. The carbon registry was initially established by the Ministry of Environment and Forestry, but the Ministry of Environment and Urbanism has implemented after the Ministries were restructured in June 2011. Number and types of the projects are presented in Tables 1 and 2 (MoEF, 2010 (b); MoEF 2011 and Turkmenoğlu E., 2012).

Table 1: Voluntary Carbon Market Profile in Turkey.

	August 2010*	**January 2012****
Number of registered projects	109	201
Estimated annual GHG reduction	Approximately 8 million tones of CO_2	Approximately 12 million tones of CO_2
Estimated market volume	83.2 million $	

* Gold Standard, VCS, VER+, Ecosystem Marketplace
**Gold Standard, VCS

Table 2: Type of projects.

Type	**Number**	**Percentage**
Hydro	50	46%
Wind	49	45%
Waste	6	5%
Geothermal	3	3%
Biogas	1	1%

Other mitigation options

None.

Spectrum of adaptation needs in Turkey

Turkey's National Climate Change Adaptation Strategy and Action Plan (Draft) (MoEU, 2011) quotes that "impacts of the climate change pose danger on the national sectors which depend on natural resources and especially water". These sectors are industry, forestry, energy, tourism and especially agriculture since has 75% water utilization throughout the country and is the most vulnerable to climate change.

Turkey will be negatively affected particularly by increased forest fires, water shortages, drought, erosion and ecological alterations as a result of changes in its climate. Reductions in crop yield, reduced hydropower potential, increased mortality due to heat waves and

increased number of people exposed to vector and water borne infectious diseases will be main consequences of the climate change impacts[22].

A. Energy sector

The energy sector is particular sensitive to climate change due to impacts on: i) the availability of cooling water for power generation; ii) the potential for hydropower, wind and solar power; iii) the productivity of crops for bio-energy; iv) the energy use for heating and cooling in households (Pilli-Sihvola P., et al., 2010; Isaac M., van Vuuren D.P., 2009). More specifically:

Gas-fired power plants

An increase in temperature due to climate change influences the gas turbines performances, leading to a decrease in generation or higher fuel consumption (Schaeffer R. et al., 2012). The area averaged annual mean temperature increase for Turkey was estimated to be around 2-3 °C based on SRES A2 (Onol and Semazzi, 2006). 32.43% of installed capacity of electricity generation plants was the natural-gas power plants and 45.36% of the electricity was generated from the natural-gas power plants in 2011 (EÜAŞ, 2011 (a)). So, the increase in temperature due to climate change influences the natural-gas power plants in Turkey.

Thermal power plants

Thermal power plants require significant amounts of water making them vulnerable to fluctuations in water supply. Each kWh generated via steam cycle requires 90-100L of water (Schaeffer R. et al., 2012). Power plants will increasingly compete with other water users (agriculture and public supply) in water-stressed areas (Schaeffer R. et al., 2012).

It is estimated that especially east and sought parts of Turkey will have severe reductions in water resources (MoEF, 2007). So, many thermal power plants will be vulnerable to effects of climate change.

Hydropower

Hydropower generation depends directly on the availability of water resources. Reservoir storage capacity can compensate for seasonal or annual variations in water inflow (Schaeffer R. et al., 2012).

In Turkey, the share of hydropower in total electricity generation is about 32% in 2010 (TEIAS, 2011) and climate change threats the capacity of hydropower plants. So, In Turkey's National Climate Change Adaptation Strategy and Action Plan (Draft) indicates the need of taking into account the climate change adaptation issues for planning of renewable energy resources, as hydraulic and geothermal (MoEU, 2011).

Energy Demand sectors

One of the energy demand sectors that will be affected by climate change impacts is the residential sector (households). The energy use of the residential sector regarding heating and cooling depends on temperature (Isaac M., van Vuuren D.P., 2009). Because of households and services demand is approximately 50% (Energy Balance Table, 2010) in Turkey, climate change issues should be taking into account in demand projections.

B. Agriculture sector

Agriculture sector is very important for the economy of the rural areas in Turkey. Wheat is the most important cereal crop grown in Turkey, followed by barley and maize (FAO, 2010). The cereal yields will be limited by low water availability, restricted rainfall, high evapotranspiration, heat stress and the short duration of the grain-filling period which makes

[22] http://www.wcc3.org/wcc3docs/pdf/HL_turkey.doc

irrigation important for crop production. Possible changes in water demand and supply for irrigation in Çukurova plain, one of the most productive regions of Turkey, as a consequence of climate change may have serious implications for the country's food security and economy (Yano T. et al., 2007).

It is estimated that national yields will be negatively affected from -3.8% to -10.1% and significant crop mix changes will occur. As an overall result total crop production will decrease by 2% to 13% in 2050 due to the drought caused by climate change (Dellal İ. et al., 2011). Also, climate change induces a drastic decrease in wheat exports and an increase in corn imports. Turkey will experience a 1% welfare loss of the GDP due to agriculture (Dellal İ. et al., 2011). A large proportion of current Turkish croplands will undergo declining suitability from 2030 onwards. In 2030, approximately 75%-95% of current croplands will experience declining suitability[23]. The majority of studies show that yields of maize decline with climate change[24].

The estimated negative effects of climate change on water resources (water scarcity) will be directly related with irrigation needs (MoEF, 2010 (d)).

The adaptation needs for this sector include (MoEU, 2011):

- Integration of adaptation strategies for agriculture and food security policies;
- Development and dissemination of R&D activities about effective management of product, soil and water;
- Development of "Soil and Land Data Base System" and "Land Information System" taking into account climate change effects;
- Development and monitoring of disaster analysis for agricultural drought;
- Determination of socio-economic impacts of climate change in this sector;
- Development of effective water management system for agriculture;
- Protection of physical, chemical and biological characteristics of soil against climate change effects;
- Increase awareness about climate change impacts and adaptation approaches for agriculture sector.

C. Forestry sector

The total forestry area increased from 21.1 million hectares in 2004 to 21.2 million ha in 2006 and then to 21.6 million hectares in 2010 (Ozturk M. et al., 2010; Forestry Statistics, 2010). It is estimated that the forestry area will be 22 million hectares in 2015[25]. Macquis, scrubs, weeds and open ranges with very few or no vegetation cover add up to 53% of the total surface area of Turkey (MoEU, 2011). 99% of these forests belong to the state and 19% (4.1 million ha) include conservation forests such as; national parks, protected areas and other protected forests, the rest (17.1 million ha) are commercial forests (Ozturk M., 2010). In 2006 approximately 10 million ha of these forests were productive, whereas nearly 11 million ha were unproductive (Ozturk M. et al., 2010). The productive and degraded parts of the forests were 52% and 48% respectively in 2010 (Forestry statistics, 2010). Up till now 1.9 million ha have been afforested through artificial regeneration (Ozturk M. et al., 2010).

The forest fires are the most important elements threatening the forests in Turkey, in particular the forests in the Mediterranean region are under an intense threat in summer

[23] http://www.metoffice.gov.uk/media/pdf/l/k/Turkey.pdf

[24] http://www.metoffice.gov.uk/media/pdf/l/k/Turkey.pdf

[25] http://web.ogm.gov.tr/BilgiServisleri/orm_varligi/orman_varligimiz.pdf

season (Ozturk M. et al., 2010). One of the main reasons is air temperature rise and global warming, decrease in the level of moisture in the air (10%), high speed winds. Despite all the technical and administrative measures taken, from time to time forest fires become a national disaster (Ozturk M. et al., 2010).

Adaptation needs for the forestry sector (MoEU, 2011)" are:

- Review the existing strategies in the context of the current adaptation to the effects of climate change;
- Determination and monitoring the impacts of climate change on species living in forest areas;
- Determine land-use change in forest areas because of climate change;
- Monitoring the health of forest ecosystems;
- Increase R & D studies about identification and monitoring of the effects of climate change on protected areas;
- Taking into account climate change adaptation activities in the socio-economic development of forest villagers;
- Determination and monitoring the effects of climate change to mountain, steppe, inland water, marine coastal ecosystems;
- Integrate adaptation to climate change into marine and coastal management;
- Increase preventive measures in combating forest fires and development of early warning systems.

D. Water Resources

Turkey is expected to have a warmer, more arid and more vague climate pattern in terms of precipitation in the near future and it has been foreseen that the new expected climate pattern will cause a decrease in water resources in the future of Turkey. Drought circumstances and water shortage in Turkey have reached a critical point in many sectors not only for agriculture and energy production but also in terms of water resources management which includes irrigation, potable water and other hydraulic systems and activities (MoEU, 2011).

Several global- and national-scale studies project that droughts in Turkey could increase in frequency and magnitude with climate change, with the greatest potential impacts projected for the south of the country[26].

IPCC in 2007 reported that water-stressed basins are located in northern Africa, the Mediterranean region, the Middle East, the Near East, southern Asia, northern China, Australia, the USA, Mexico, north-eastern Brazil and the west coast of South America. Turkey is also located in the Mediterranean Basin, therefore will be highly vulnerable to the impacts of climate change.

Onol and Semazzi, 2006 have run RegCM3 to develop future simulations of climate for the next century based on SRES A2 emission scenario and the results showed the absolute change in precipitation for Turkey. In general, precipitation decreases along the Aegean and Mediterranean coasts and increases along the Black Sea coast of Turkey.

Water budget modelling studies were conducted for Gediz and Buyuk Menderes Rivers which are two major and closely located river basins in western Anatolia along the Aegean Sea. It is estimated that nearly 20% of surface water in the basins will decrease by year 2030. This percentage will increase to 35% and more than 50% in 2050 and 2100 respectively. The

[26] http://www.metoffice.gov.uk/media/pdf/l/k/Turkey.pdf

decreasing surface water potential of the basins will cause water stress among agricultural, domestic and industrial users. Besides of the water stress, the irrigation water demand will increase because of the increasing potential crop evapotranspotation (up to 10% and 54% for the years 2030 and 2100 respectively) by the result of climate change (MoEF, 2007).

Some regions of Turkey will likely suffer from drought in the future, while others from floods. Ultimately, the climate change component has an incremental effect, likely to make extreme floods more frequently in some areas in Turkey (Tahmiscioglu M. S. et al., 2006).

Adaptation needs for the water resources and disasters mentioned in "Turkey's National Climate Change Adaptation Strategy and Action Plan (Draft) (MoEU, 2011)" are:

- Integrate the adaptation of water resources to climate change to the water resources management policies;
- Strengthening capacity and inter-agency cooperation and coordination to adapt to impacts of climate change;
- Improve existing systems for monitoring effects of climate change and set also new systems;
- Determination of climate change effects on water resources and coastal management, development of adaptation options, carry out periodic revisions based on monitoring results;
- Management of water resources on the base of watershed approach and integrated way;
- Determination of risks from climate change-related disasters such as flood, avalanche, landslide;
- Review of legislation related with natural disasters due to climate change;
- Increase the capacity of local authorities for combating to climate change-related disasters and exercises;
- Development of community-based disaster management system to fight against climate change;
- Increase public awareness about disasters and their effects.

BUSINESS – AS – USUAL SCENARIO (2000 – 2050)

Description of BAU scenario

General comments

The policy portfolio of BAU scenerio includes the already implemented until 31.12.2010 policy instruments related with climate change issues. The main points for the BAU scenario are:

- RES applications, notably hydro and wind, increased considerably after RES Law entered into force in 2005. However, the Law had problems about administrative hurdles, increasing wholesale prices and growing local opposition particularly against small hydroelectric plants (Sirin S.M. and Ege A., 2012).
- Turkey does not have an organized commercial and domestic photovoltaic program (Benli H., 2013). Although, there is a good potential for PV applications in the local market, currently no large scale solar power plants exist in Turkey, so there is a need for new projects (Benli H., 2013).
- Urgency to cover increasing energy demand and lack of funds led the government to take measures that favor reliable technologies with short construction time, low risks and low capital costs. Therefore private investors preferred gas powered plants mostly (Sirin S.M. and Ege A., 2012). Geothermal sources still remain undeveloped since cost for a new natural gas plant is just half of a new geothermal plant (Benli H., 2013).
- Also, tariffs are still low compared to other EU countries, although multiple tariffs are envisaged by the amended RES Law (Sirin S.M. and Ege A., 2012).
- RES investors encounter major administrative barriers related with authorization, licensing and construction of projects (Sirin S.M. and Ege A., 2012).
- Technology development and localization of RES technologies are other problematic issues in Turkey's RES policy (Sirin S.M. and Ege A., 2012).
- The Energy Efficiency Law exploits the efficient use of energy and covers administrative structuring, energy auditing, financial instruments and incentives, awareness raising and the establishment of an Energy Service COmpany (ESCO) market for energy efficiency (EE) services (Okay E. et al., 2008).
- No CDM projects are completed, because Turkey cannot participate in the flexible mechanisms of the Kyoto Protocol. However, 109 projects were registered before 31 December 2010 in Voluntary Carbon Market and the estimated annual GHG reduction is approximately 8 million tones of CO_2-eq (MoEF, 2010 (b); MoEF 2011).
- No adaptation measures are implemented.

Policy portfolio for this scenario

Mitigation

The policy instruments related with mitigation measures are the following:

Laws for RES

Law No. 4628 on Electricity Market (published in the Official Gazette: dated 3 March 2001 - numbered 24335,) and its amended version Law No. 5784 on Electricity Market (published in the Official Gazette: dated 26 July 2008 and numbered 26948)

In the context of this law, those individual and corporate entities that are to build electricity generation facilities from RES having maximum installed capacity of 500 kW are exempted from licensing obligations and setting up a company. Moreover, by this law Energy Market Regulatory Authority (EMRA) was founded and private sector entrepreneurs were allowed to build and operate power plants by receiving a license from EMRA (Baris K. and Küçükali S., 2012). This law focused only on administrative and grid connection problems and had no financial incentives (Sirin S.M. and Ege A., 2012).

Law No. 5346 on Utilization of Renewable Energy Sources for the Purpose of Generating Electricity (published in the Official Gazette: dated 18 May 2005 and numbered 225819)

The Law introduced three (3) mechanisms to expand RES utilization. These mechanisms were: feed-in tariff (starting from 2007; not be less than 5 euro cents/kWh and not exceeding 5.5 euro cents/kWh); certification of RES (similar to GO in EU Directive) and grid-accession priorities (Sirin S.M. and Ege A., 2012).

Law No. 5686 on Geothermal Resources and Natural Mineral Waters (published in the Official Gazette: dated 13 June 2007 and numbered 26551)

It aims to regulate procedures and principles related to the effective exploration of geothermal and natural mineral water resources, research, development, production, preservation, the owner rights of these resources, and how these resources will be used in economic and environment friendly way.

Laws for energy efficiency

Law No. 5627 on Energy Efficiency (published in the Official Gazette: dated 2 May 2007 and numbered 26510)

This law includes principles and procedures to increase energy efficiency in energy generation, transmission, distribution and consumption phases at industrial establishments, buildings, power generation plants, transmission and distribution networks and transport, raising energy awareness in the general public, and utilizing renewable energy sources.

It also sets the rules for energy management in industry and in large buildings, project support, energy efficiency consultancy companies, voluntary agreements, etc. It affects industry, power plants, transmission and distribution systems, buildings, services and transport[27].

The following regulations were published within the context of the Law:

Regulation on energy performance in buildings (Official Gazette No: 27075, 5 December 2008)

The policy instruments of the regulation are:

- Implementation of effective energy management in industrial facilities and buildings;
- Introducing energy and insulation standards for new buildings;
- Energy Identity Certificates for new buildings;
- Installation of RES at new buildings, with an initial investment cost consistent with energy economics, with payback periods of 10 years for new buildings with floor space less than 20000 m^2 and 15 years for new buildings with floor space greater than 20000 m^2.

27 http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/bcfe8957cb2c8b2ac12578640051cf04/$file/turkey.pdf

Regulation on Eco-Design Requirements for Energy Related Products (Official Gazette No: 27722, 7 October 2010)

The purpose of this Regulation is to determine the framework of design conditions of energy related products. So, it helps to achieve the sustainable development by energy efficiency, environmental protection and security of energy supply.

Regulation on increasing of energy efficiency at transport sector (Official Gazette No: 26901, 9 June 2008)

The regulation describes mitigation measures related with transportation such as: Promotion of railway; Implementation of travel demand management, intermodal transportation system, traffic management and electronic road guidance systems for effective transportation systems; Promotion of public transport systems; Regulation of the traffic signal system taking into account efficiency; Awareness activities about fuel economy, CO_2 emissions of cars and eco-driving.

Laws for emission trading

Law No. 4990 on the convenience of Turkey's enterance to the UNFCCC (published in the Official Gazette dated 21 October 2003 and numbered 25266)

With this law, Turkey's participation in the UNFCCC was approved and Turkey became a party to the UNFCCC in 2004.

Law No. 5836 on the convenience of Turkey's enterance to the Kyoto Protocol for the UNFCCC (published in the Official Gazette dated 17 February 2009 and numbered 27144)

With this law, Turkey became Party to the Kyoto Protocol on August 26, 2009.

Therefore, Turkey does not have a quantified emission limits or reduction commitments in the first commitment period (2008-2012) under the Protocol and Turkey cannot participate in the flexibility mechanisms (CDM, JI and ET). There is no other law or regulation for Clean Development Mechanism. Projects have been implemented only in voluntary carbon market. The Ministry of Environment and Urbanism published the Communication on Registry Operations of GHG Emission Projects (published in the Official Gazette dated 7 August 2010 and numbered 27665), and established a registration system for these projects.

Main characteristics of this policy portfolio

In BAU scenario, it is assumed that the key drivers will continue on their historical trends. The main outcomes of this scenario are:

Hydropower, wind and geothermal are the RES used for electricity generation in Turkey. The total capacities of hydro, geothermal and wind were 15831.2 MW, 94.2 MW and 1320.2 MW respectively in 2010 (TEIAS, 2011). Also, solar, geothermal and biomass are used for heating purposes.

1828742 conventional incandescent light bulbs were replaced with 1758954 energy efficient ones in 2008 resulting to a reduction of 102 MW of electricity usage[28].

Energy-efficient lamps were dispensed at primary schools with "Hand-in-Hand for Energy Efficiency (ENVER) Movement". 4800000 lamps were dispensed in 43 provinces from December 2008 to April 2009[29].

109 projects were registered before 31 December 2010 in Voluntary Carbon Market and the estimated annual GHG reduction is approximately 8 million tonnes of CO_2-eq (MoEF, 2010 (b) and MoEF 2011).

[28] http://www.enerji.gov.tr/BysWEB/DownloadBelgeServlet?read=db&fileId=47707
[29] http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=enerjiverimliligi_EN&bn=217&hn=&id=40719

The efficiency of thermal power plants increased significantly, from 34% in 1998 to 43 percent in 2009. That increase is linked to the growing share of gas combined cycles in thermal electricity production; in 2009 they represented 28% of the thermal capacity[30].

General investment support programmes had an indirect positive impact on energy efficiency. However, there are no direct tax incentives to encourage end-use energy efficiency, nor is there any other kind of direct financial incentives (Kotcioglu İ., 2011).

The Electricity Market Law (Law. No. 4628, in March 2001) is the first promotion instrument towards electricity generation from renewable energy sources in Turkey (Baris K. and Küçükali S., 2012).

The additonal incentives offered by the Amended Law on Utilization of Renewable Energy Sources for the Purpose of Generating Electrical Energy (published in the Official Gazette dated 8 January 2011 and numbered 27809). The Amendment Law introduces significant amendments to improve the incentive mechanism, encourage renewable energy investment opportunities and the different feed in tariffs for different RES types. The Amended Law will not be used as policy instrument in the BAU scenario, because it entered into force after 31 December 2010.

Law on Energy Efficiency entered into force in April 2007. The measures under the Law will be taken into account in the BAU scenario. In addition, general investment support programmes also have an indirect positive impact on energy efficiency (Kotcioğlu İ., 2010).

30 http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/bcfe8957cb2c8b2ac12578640051cf04/$file/turkey.pdf

Key assumptions

The categories of the key parameters are common for all scenarios and are divided as follows:

Demographics

According to the "2010 World Population Prospects" of the United Nations, it is expected that the Turkish population will increase for the period 2011-2050. The average annual rates of changes for the population regarding three variants are presented. The version "medium variant" of the population projections will be used for the BAU scenario in Table 3 and shown in Figure 1.

Table 3: United Nations projections for the Turkish population (UN, 2010).

	Average annual rate of change (%)							
Variant	2005-2010	2010-2015	2015-2020	2020-2025	2030-2035	2040-2045	2045-2050	2050-2055
Medium	1.31	1.14	0.95	0.78	0.48	0.21	0.21	-0.04

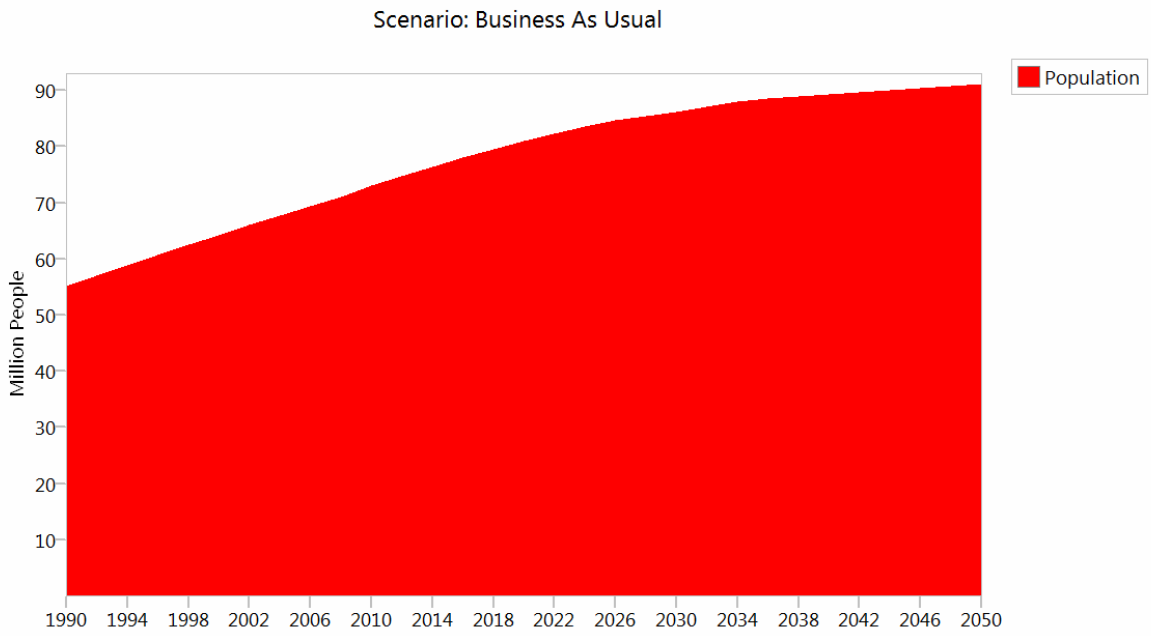

Figure 1: Demographics: Population.

Economy

Gross Domestic Product

GDP is characterized as a key driver of energy demand in all regions (World Energy Outlook 2010, IEA).

Table 4: Projections for the Turkish GDP (IMF, 2011).

Year	2011	2012	2013	2014	2015	2016	2017
Annual percent change of GDP (%, constant prices)	8.503	2.969	3.528	4.002	4.259	4.414	4.447

For the *BAU scenario* the GDP growth rate remains constant until year 2050 based on projections of Table 4 above. GDP real (IMF, 2011) growth is illustrated in Figure 2.

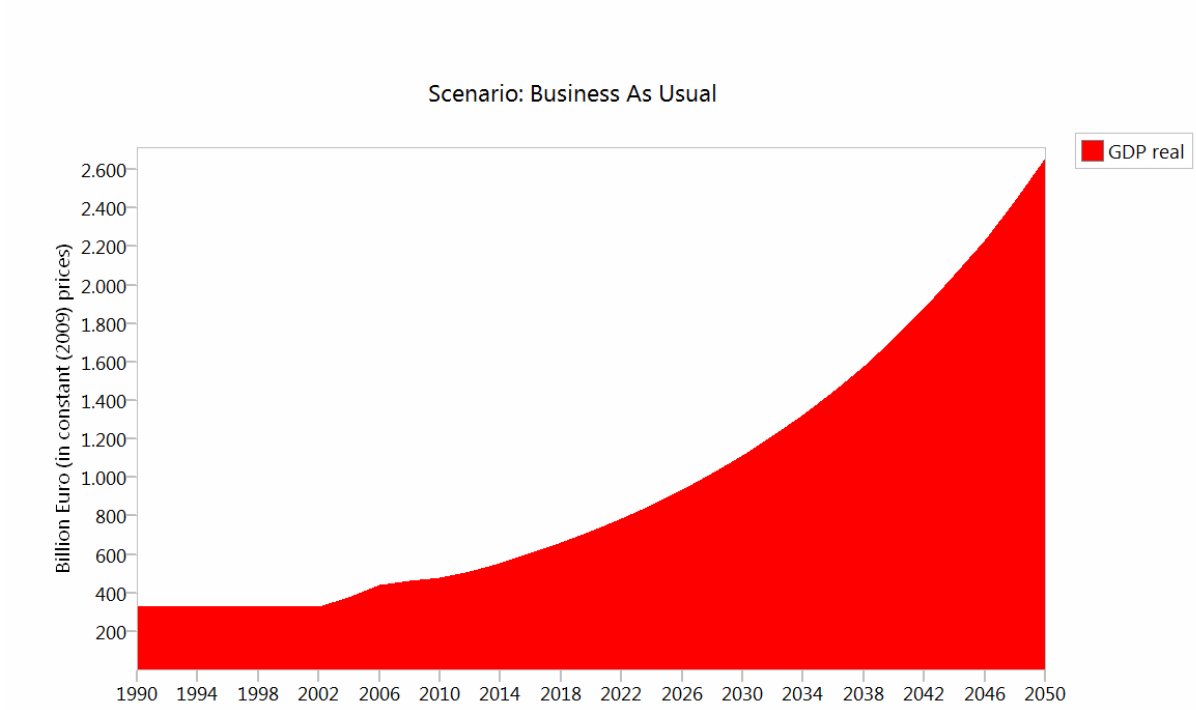

Figure 2: Economy: GDP real (IMF, 2011).

GDP per capita

Projections of this key driver are based on those of GDP and population. LEAP calculates them automatically based on the projections of the other two key drivers as they are defined for each scenario.

GDP distribution per sector

The GDP distribution per sector was based on the historical data. This distribution was assumed the same for the BAU scenario and shown in Figure 3.

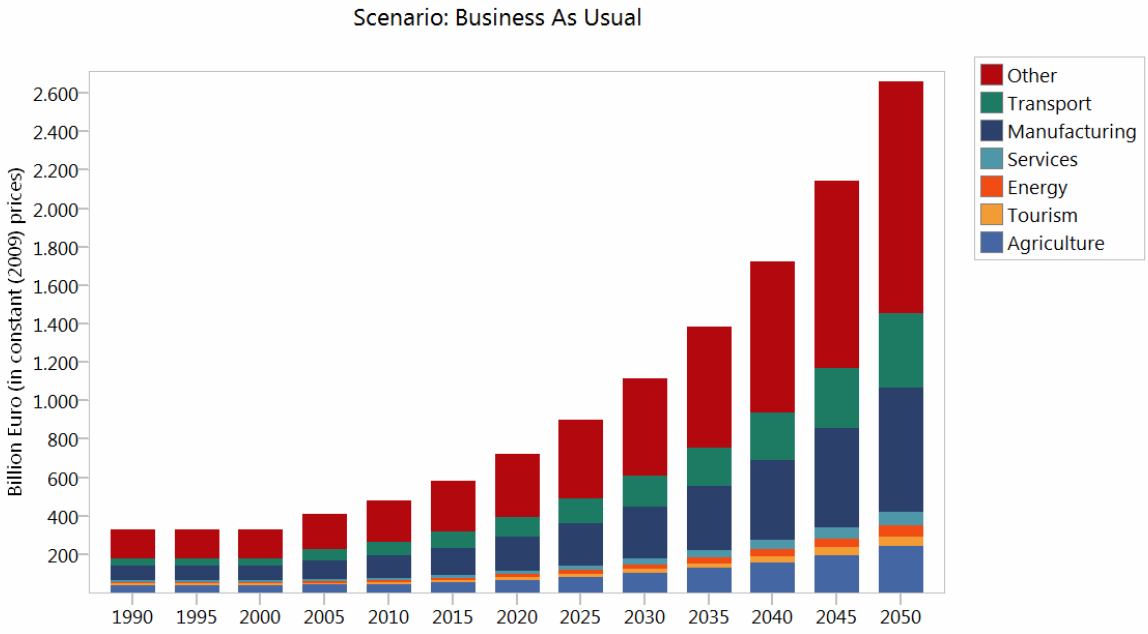

Figure 3: GDP distribution per sector.

Average annual household income

The growth rate of this variable is assumed to be equal to the growth rate of GDP per capita and illustrated in Figure 4.

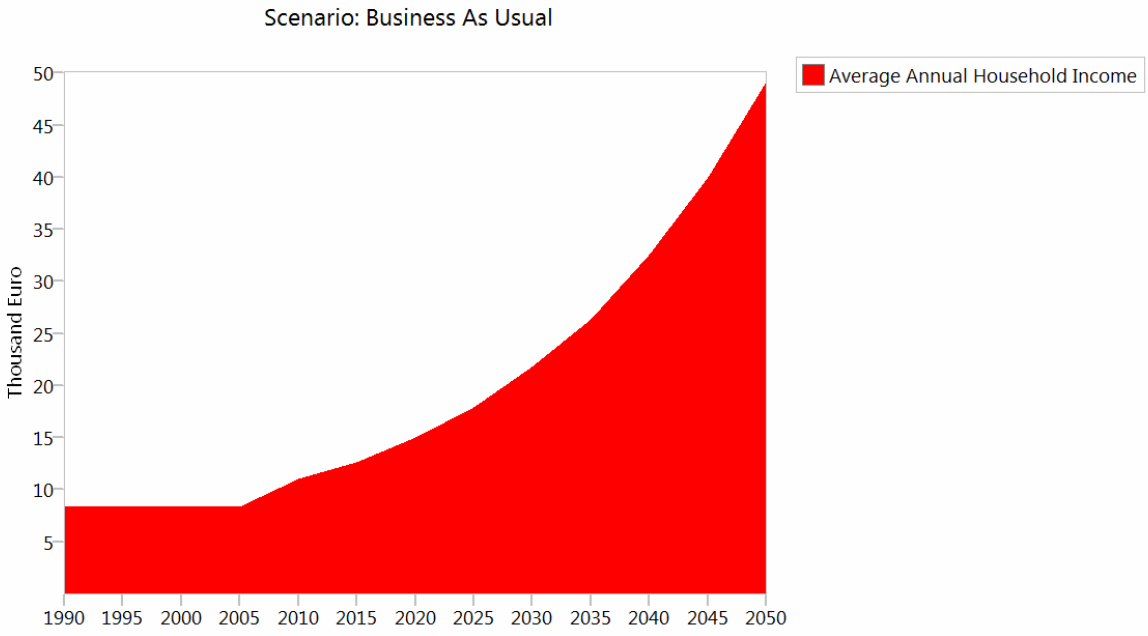

Figure 4: Average annual household income.

Gini coefficient

Measures of income inequality are based on data on people's household disposable income. The data on the Gini coefficient will be used for assessment of policy portfolios in AMS method.

Industry

The Turkish Industry has played a central role in the economy. The manufacturing industry has competitive strength because of geographical position near to the markets, developed infrastructure and telecommunications systems, human resources. The major Turkish manufacture industries are:

- Automotive and auto parts industries;
- Machinery industry;
- Electrical machinery industry;
- Electronics industry;
- Iron & steel industry;
- Shipbuilding;
- Chemical industry;
- Medical products;
- Textiles and clothing;
- Jewellery;
- Leather;
- Ceramic industry;
- Glass industry;
- Furniture;
- Carpets and kilims.

The mining industry also plays one of the greatest roles in Turkish economy. The country has got the greatest mine resources for most minerals in the world. The major produce minerals are boron, marble, basalt, feldspar, magnesite, perlite, pumice, barite and bentonite. Turkey is also significant producer of ferrochromium and steel.

In Turkey, since the energy strategy targeting comprehensive liberalization and establishment of competitive markets, the country attaches great importance to the establishment of an energy sector which functions in rational way. The energy production strategy is development of comprehensive well-functioning sectors. It requires both ensuring establish security and supply for essential elements[31].

The construction sector is also one of the managing sectors in economical growth of Turkey. Many investments have been realized in recent years. During the developing process of construction firms, they have designed, built and operated almost all kinds of projects, such as dams, hydroelectric power plants, thermal power plants, industrial plants, motorways, airports, large housing projects, and touristic resorts.

The more detailed information about Turkey's economic according to sector profiles can be supplied from The Undersecretariat of the Prime Ministry for Foreign Trade, Republic of Turkey Ministry of Industry and Trade and Republic of Turkey Ministry of Finance.

Climate Statistics

Review of information about the region

A number of global and regional, climate and hydrology models have been developed to assess temperature, precipitation and runoff levels for different climate scenarios (IPCC, 2007; SINTA, 2008; SEECOF, 2010; CC-waters, 2011).

[31] The Ministry of Economy, 2011, http://www.tcp.gov.tr/

For the boreal zone and until the end of the 21st century temperatures are projected to increase 3.5-5°C along with significant increases in yearly precipitation up to 40% (Lidner M. et al., 2010). For the temperate continental zone the annual mean temperature is expected to increase by 3-4°C and up to 4.5°C in the Black Sea region, while annual precipitation is expected to increase by up to 10%. These projections are until the end of the 21st century (Lidner M. et al., 2010).

For the Mediterranean zone the annual mean temperature is expected to increase by 3-4°C, while the yearly rainfall is expected to decrease by up to 20% until the end of the 21st century. Changes in frequency, intensity and duration of extreme events are likely to result in more hot days, heat waves, heavy precipitation events and fewer cold days (Lidner M. et al., 2010). This is also the conclusion of the research work of Giannakopoulos C. et al. in 2009 for the Mediterranean region. More specifically they estimate that the region will be drier in 2030-2060 with a 10-20% drop in annual rainfall. The largest increases are found in summer days and tropical nights for the Mediterranean basin[32] (Giannakopoulos C et al., 2009). Therefore, one additional month of summer days is expected. More energy will be required for cooling, while less energy is required for heating.

Reduction in the annual amount of precipitation in combination with the increase of the mean annual temperature has the following consequences:

- Reduction of water resources and availability (IPCC, 2007);
- Reduction of the irrigated areas;
- Changes in crop suitability and productivity (IPCC, 2007);
- Reduction of the hydropower and nuclear activity;
- Changes in the forest areas (IPCC, 2007).

For the South East Europe region, the mean annual temperatures are likely to increase more than the global mean and range between 2.2-5.1°C at the end of this century. The warming in South East Europe (SEE) region is likely to be largest in summers, annual precipitation is very likely to decrease in most of the region, and the risk of summer drought is likely to increase.

Precipitation

Annual precipitation quantity of Turkey depends on the distance form coasts, influence of wind and altitude of the area. The rainiest region appears to be the Black Sea area and the most arid is the Southeast region of the country. Annual amount of the precipitation is above 1000 millimeters on the west and east coasts. The autumn and winter are seasons which most of the precipitation falls in (MoEF, 2007).

Onol and Semazzi, 2006 have run RegCM3 to develop future simulations of climate for the next century based on SRES A2 emission scenario and the results shows the absolute change in precipitation for Turkey. In general, precipitation decreases along the Aegean and Mediterranean coasts and increases along the Black Sea coast of Turkey.

For the *BAU scenario* the annual precipitation change was considered to follow its historical growth.

Temperature

Review of information about the region

Modeling results showed an increase in annual temperature in Europe of 0.1 to 0.4°C/decade (IPCC, 2007). The rates of the projected changes differ across seasons, with much higher temperature changes expected during winter months (Lioubimtseva E., Henebry G.M., 2009).

[32] Morocco, Algeria, Tunisia, Lybia, Egypt, Jordan, Turkey, Greece, Serbia, Italy, France, Spain, Portugal

All studies for the Mediterranean region indicate a trend towards higher temperatures (Garcia – Ruiz J. M. et al., 2011). These reports conclude in a temperature increase over the entire basin in the last 100 years that ranges from 1 to 4.5°C (Garcia – Ruiz J. M. et al., 2011). Expected annual changes for the South East Europe region vary from +2.5°C to up to more than +4.5°C (Alexandrov V. et al., 2010).

Under the RCP 8.5 pathway the temperature is expected to rise up to 6°C by 2050, while at the RCP 3 the temperature is expected to rise from 2.4 to 2.8°C (Hoegh-Guldberg Hans, 2010). These projections are consistent with projections about the B2 and A1 scenarios of IPCC that coincide with the aforementioned RCPs (Umweltbundesamt, 2008). The temperature increase is linked with forest fire risks, crop productivity. Balkans and Turkey are vulnerable to this risk (Giannakopoulos C et al., 2009).

Review of information about Turkey

The West and South regions of Turkey are under the affects of Mediterranean climate. Summers are hot and dry, and winters are cool and rainy in there. The Northeast Anatolia is under the influence a continental climate. According to this climate regime, summers are short and cool, and winters are long and intense. The Central Anatolian Plateau has the characteristics of a steppe climate. The properties of steppe climate show arid and hot summers, and cold winters (MoEF, 2007).

Regional climate projections for Turkey show that in the wintertime, projected temperature increase is higher in the eastern half of the country. But, in the summer, this pattern is reversed and the western half of the country, especially the Aegean region, will experience temperature increases up to 6 °C (MoEF, 2007).

The aforementioned estimations and calculations were taken into consideration for the scenarios. For the *BAU scenario* the assumption is that the mean temperature will increase 2.4°C by 2050.

Frequency of extreme events

Flash Floods

Review of information about the region

The increasing volume of floods and peak discharge would make it more difficult for reservoirs to store high runoffs and prevent floods (IPCC, 2007). They create adverse effects on ecosystems or sectors of society (human safety and health, water management, agriculture, energy, insurance, tourism and transport) (WMO, 2009).

Risk of floods increases in northern, central and Eastern Europe (IPCC, 2007). Increase in intense short-duration precipitation in most of Europe is likely to lead to increased risk of flash floods (IPCC, 2007). Increasing flood risk from climate change could be magnified in impermeable surface due to urbanization and modified by changes in vegetation cover in small catchments (IPCC, 2007).

World Bank initiated the Hotspots Project which identified southeastern Europe as a major natural disaster hazard for hotspots, exposed simultaneously to floods, droughts, forest fires, wind storms, heat waves, earthquakes and landslides (FAO, 2010). This situation was also verified by the South East European Climate Change Framework Action Plan for Adaptation.

Review of information about Turkey

While some regions of Turkey will likely feel more the effects of the drought in future, some parts will be affected from the floods. Ultimately, the climate change component has an incremental effect, likely to make extreme floods more frequently in some areas in Turkey (Tahmiscioglu M. S. et al., 2006).

According to data taken from General Directorate of State Hydraulic Works, the number of floods increased in 2009 and 2010. The average number of floods was approximately 20 between the years of 2000-2008, but it was 84 in 2009 and 110 in 2010.

For the *BAU scenario* the assumption is that the mean number of flash floods will be same.

Heat Waves

Review of information about the region

Projected heat waves[33] could become more frequent, more severe and longer lasting with climate change. According to IPCC over the last 50 years hot days, hot nights and heat waves have become more frequent and could affect the health status of millions of people in some parts of the world, particularly those with low adaptive capacity (Cueto C.O.R. et al., 2010). Modeling results showed a very likely increase in the intensity and frequency of summer heat waves in Europe (IPCC, 2007; IPCC, 2008).

Several authors pointed out the increase in the frequency of heat waves due to climate changes for the next decades (Cueto C.O.R. et al., 2010; Luber G. et al., 2008). Authors pointed also the high mortality that is associated with extreme heat events (Luber G. et al., 2008).

Review of information about Turkey

Not available. Also, there are no historical data about the frequency of heat waves.

Frost days

Review of information about the region

In Europe, the number of cold and frost days has decreased in most parts of Europe over the past 100 years (Umweltbundesamt, 2008). The number of frost days impacts crops by (a) affecting the growing season length and (b) damaging crops from either early or late growing season frost events.

Review of information about Turkey

Not available. Also, there are no historical data about the number of frost days.

Water resources

Review of information about the region

Water availability in the Mediterranean basin is scarce and mainly dependent on runoff from mountain areas which supply the 50-90% of the total discharge of this basin (Garcia-Ruiz M. J. et al., 2011). By 2020 the Mediterranean region and Eastern Europe may expect runoff decreases up to 25% (Umweltbundesamt, 2008). Summer runoff in southern Europe may decrease by up to 50% by 2050.

Review of information about Turkey

According to the data of the years 1935 and 2008; Turkey's water budget is calculated. Considering the average surface water run-off which is 186 billion m^3/year with the surface runoff of 7 billion m^3/year coming from neighboring countries, the total surface run-off within the country reaches to the amount of 193 billion m^3/year. On the other hand, the average amount of ground-water leakage is 41 billion m^3/year. However, not all the renewable water resources can be utilized because of economic and technical reasons. Exploitable portions of surface run-off including inflow from ordering countries, and groundwater are 98 and 14 billion m^3/year, respectively. Thus, the total of economically exploitable water resources

[33] Heatwave is an extended time interval of abnormally and uncomfortably hot weather lasting from several days to several weeks (Umweltbundesamt, 2008).

potential amount to 112 billion m^3/year. The 25 hydrological basins in Turkey have a total surface water run-off of 193 billion m^3/year (DSI, 2009).

Water budget modelling studies were conducted for Gediz and Büyük Menderes Rivers which are two major and closely located river basins in western Anatolia along the Aegean Sea. It is estimated that nearly 20% of surface water in the basins will decrease by year 2030. This percentage will increase to 35% and more than 50% in 2050 and 2100 respectively (MoEF, 2007).

Due to lack of data for realizing the historical trend of the key driver, any assumptions could not be adopted.

Surface waters

Review of information about the region

Annual runoff increases in northern Europe and decreases in central, Mediterranean and Eastern Europe (IPCC, 2007).Annual average runoff is projected to increase in northern Europe (north of 47°N) by approximately 5 to 15% up to 2020s and 9 to 22% up to 2070s for the SRES A2 and B2 scenarios. In southern Europe (south of 47°N) runoff decreases by 0 to 23% up to 2020s and by 6 to 36% up to 2070s (IPCC, 2007).

Review of information about Turkey

Not available.

Groundwater

Groundwater recharge is likely to be reduced in central and eastern Europe with a larger reduction in valleys and lowlands. Groundwater levels of many aquifers around the world show a decreasing trend over the past few decades, but it is mainly attributed to groundwater pumping/use that surpasses groundwater recharge rates (IPCC, 2008).

Further decreases in groundwater levels are projected because the lower recharge is (partly) caused by a shorter length of the recharge season and the drop in water retention as snow (DG Environment, 2007). While an increase in winter rainfall could in principle increase groundwater recharge, saturated soil conditions could mean more immediate surface sun-off of water instead of infiltration into the ground (DG Environment, 2007).

Review of information about Turkey

Not available.

Total renewable freshwater resources

In many countries, climate change impacts on freshwater resources will probably affect sustainable development, efforts for the reduction of poverty and child mortality (IPCC, 2008).

Review of information about Turkey

Not available.

Policies and Measures

Feed – in – tariff system

For the BAU scenario, there are no feed-in-tariffs.

Subsidies

In Turkey, the organizations who have an agreement with local Energy Office receive subsidies for their energy saving projects (Energy Efficiency Law).

Land management

Surface of arable land

The arable land was based on the historical data. This distribution was assumed the same for the BAU scenario.

Surface of forest land

The forest land was based on the historical data. This distribution was assumed the same for the BAU scenario.

Global trends

Crude oil price

Projections for the crude oil prices regarding the Reference scenario of the IEA, World Energy Outlook 2010 will be used.

Natural gas price

For the natural gas prices the following forecasts are encountered in the relevant literature.

Coal price

Coal prices increase from 65$ per tonne in 2006 to 120$ in 2015, then fall to 85$ in 2030, compared with 110$ in 2030 in the Reference Scenario — a reduction of 23%.

EUA price

Projections about the EUA price will be used based on the relevant literature.

ERU price

The average CER price was 18€/tCO_2 based on the first 11 months of 2008 (Rotfub W. et al., 2009). The same growth rates that are adopted for the EUA price will be used for the CER price also.

Adaptation

Water Use

Review of information about Turkey

We assume that there is no change for BAU scenario.

Household water use

Review of information about the region

The increase in household water demand (ie for garden watering) and industrial water demand, due to climate change is likely to be rather small, e.g., less than 5% by the 2050s at selected locations (IPCC, 2008).

Review of information about Turkey

Not available. For the *BAU scenario* the annual household water use was considered to follow its historical growth.

Water use for agriculture

Review of information about the region

Agriculture is a significant water user in particular for irrigation (DG Environment, 2007). Irrigation water use depends on: the extent of the irrigated area, crop type, cropping intensity and irrigation water-use efficiency (IPCC, 2008). According to FAO projections, developing countries, with 75% of the global irrigated area, are likely to expand their irrigated areas by 0.6% per year until 2030, while the cropping intensity of irrigated land is projected to increase from 1.27 to 1.41 crops per year and irrigation water-use efficiency will increase slightly (IPCC, 2008). These estimates exclude climate change which is not expected to affect agriculture before 2030.

Agriculture will need to adapt to due to the increasing water demand for irrigation in southern Europe (IPCC, 2007).

Review of information about Turkey

Agriculture has approximately 75% water utilization throughout the country and is the most vulnerable to climate change (MoEU, 2011).

No other data is available.

Water use for industry

Review of information about the region

Water stress is expected to increase over central and southern Europe (IPCC, 2007). Summer flows may be reduced up to 80% (IPCC, 2007).

Review of information about Turkey

Not available. For the *BAU scenario* the annual household water use was considered to follow its historical growth.

Water use for energy production

Cooling water

Review of information about the region

Cooling water for electricity production mainly concern Western Central and Eastern countries. Decreases in water abstraction can be expected from the possible replacement of older power stations by newer plants in the next thirty years (DG Environment, 2007).

Review of information about Turkey

According to data taken from TurkSTAT, the cooling water use increased after 2006. But no data is available for future projections.

Hydropower needs in water

Review of information about the region

River discharge is likely to be affected by climate change resulting in important impacts on water availability for instream usage, particularly for hydropower generation. The results for Europe from the use of a macro-scale hydrological model indicate that by the 2070s the electricity production potential of hydropower plants that will still exist at the end of the 20th century will increase (assuming IS92a emissions) by 15–30% in Scandinavia and northern Russia. The current rates are between 19% (Finland) and almost 100% (Norway) of electricity is produced by hydropower (Lehner et al., 2005). Decreases of 20–50% and more are found for Portugal, Spain, Ukraine and Bulgaria, where currently between 10% (Ukraine, Bulgaria) and 39% of the electricity is produced by hydropower (Lehner et al., 2005). For the whole of Europe (with a 20% hydropower fraction), hydropower potential is projected to decrease by 7–12% by the 2070s (IPCC-2008).

The hydropower potential of Europe is expected to decline on average by 6% but by 20 to 50% around the Mediterranean by the 2070s (IPCC, 2007). Several member States have reported reduction in hydroelectricity production due to drought events (Finland, France, Portugal, Spain) (DG Environment, 2007). As hydroelectricity production is related to the amount of water stored in the upper reservoirs, the production level can be lower during a drought. Peak demands then need to be satisfied by other means available in a short term (gas turbine, etc) (DG Environment, 2007).

Review of information about Turkey

Not available.

Energy Demand

Turkey's energy demand framework is comprised of the sectors: households and services, industry, agriculture and transport. Assumptions about these sectors are described in details in the next sessions.

Households and Services

About 27.91% of households and services in Turkey use coal, 22.16% natural gas and 11.72% wood as their primary source of heat, while 25.51% use electricity and 12.7% other (Energy Balance Tables, 2010). It is estimated that Turkey holds an energy-saving potential of 30% in the buildings. As aforementioned, Turkey has a target to reduce energy consumption by improvement of insulations, replacement of conventional light bulbs with energy efficient ones, promotion of the use of energy efficient household equipments and development of rules for new buildings such as energy performance and use of RES.

The most important key driver for heat demand in the residential sector is the average household income. According to the 2010 survey for the household budget, the average consumption for heating and electricity was 11.6% of the total household consumption corresponding to 10.4% of the total income (IPA, 2012). For calculation of heating expenditures an average 60m^2 apartment is considered by the Regulatory Energy Agency (IPA, 2012). Energy demand in household and services projection for 2050 is presented in Figure 5.

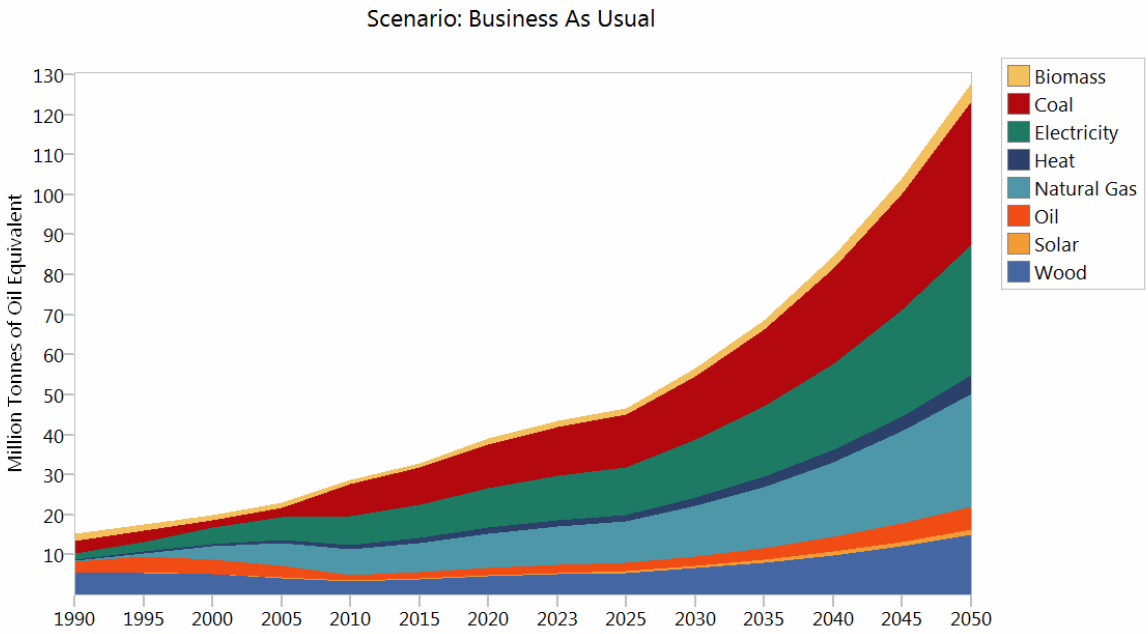

Figure 5: Demand: Households and Services.

Agriculture

Agriculture is the main user of land and water and therefore one of the most vulnerable sectors in the region's economy (Schlickenrieder J. et al., 2011).

Agriculture has 75% water utilization throughout the country and is the most vulnerable to climate change (Turkey's National Climate Change Adaptation Strategy and Action Plan (Draft) (MoEU, 2011)).

The assumption for the growth rate of energy demand in the BAU scenario is that it follows the growth rate of GDP.

Fuel shares are considered to be the same across the years since no policy instrument is applied. Energy demand in agriculture projection for 2050 is shown in Figure 6.

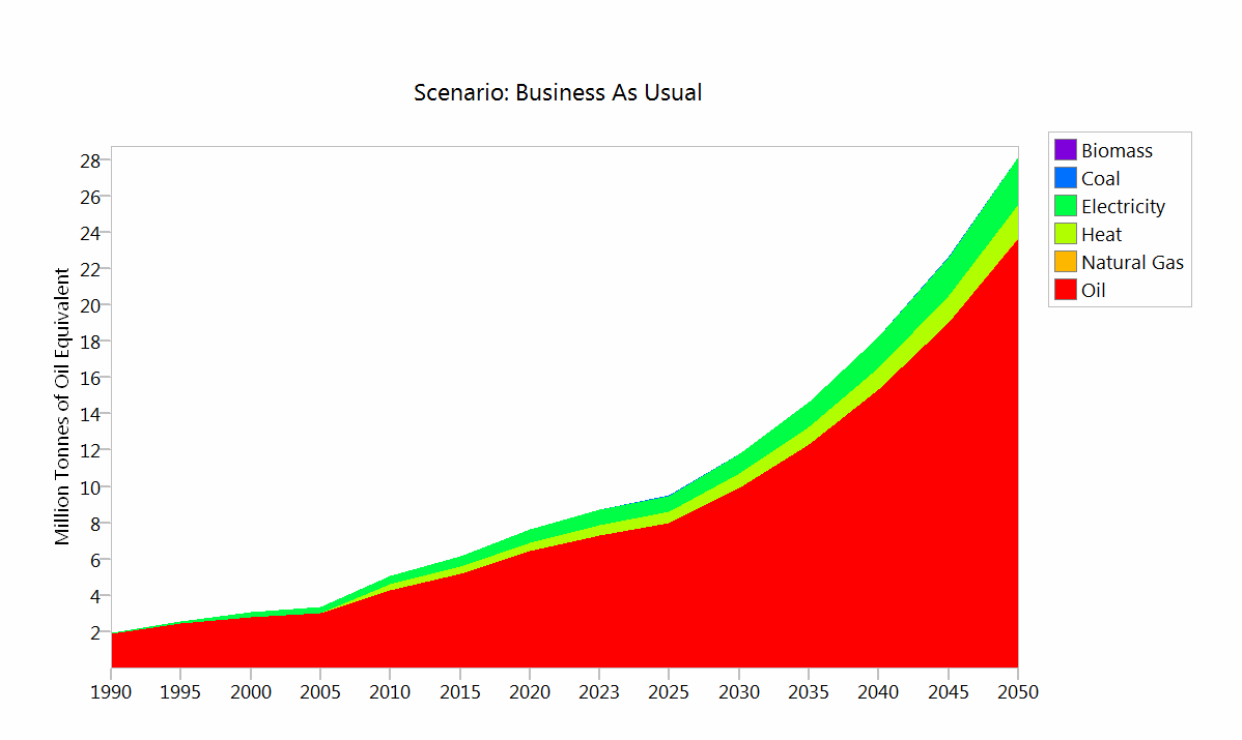

Figure 6: Demand: Agriculture.

Industry

Assumptions for BAU concern growth rate of activity level and growth rate of energy demand equal to growth rate of GDP. Fuel shares are considered steady since no policy instrument is applied. The projection of energy demand in industry is given in Figure 7.

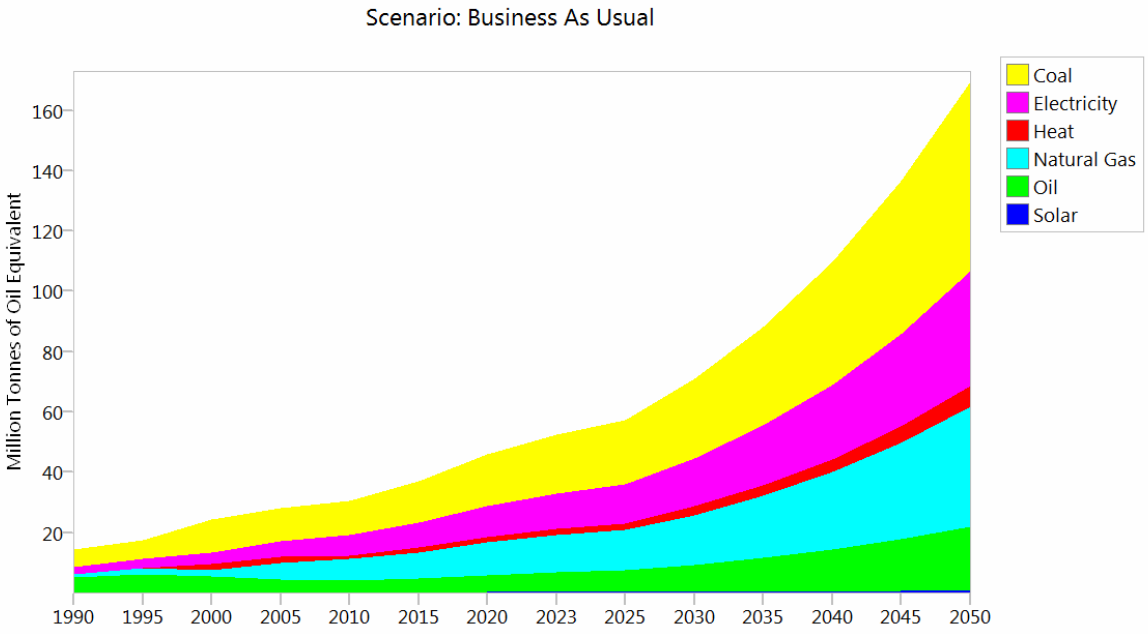

Figure 7: Final Energy Demand in Industry.

Transport

The reduction in fuel consumption that can be achieved by following an eco-driving course, in the current vehicle fleet, ranges from 5 to 25% directly after the course (TNO, 2006)(UKERC, 2009). The magnitude of the short term effect is strongly dependent on the original driving style of the driver - the more uneconomic the behaviour was to start with, the greater the effect. On average the impact is about 10 % (Kampman B. et al., 2009). The fuel savings typically outweigh the costs, making this a very cost effective measure. For heavy duty vehicles the effects a year or more after the training are estimated at 5% to 7% (Kampman B. et al., 2009).

Assumptions for BAU concern growth rate of energy demand equal to growth rate of GDP). The projections of energy demand in transport sector and transport sector per fuel for 2050 are shown in Figure 8 and 9.

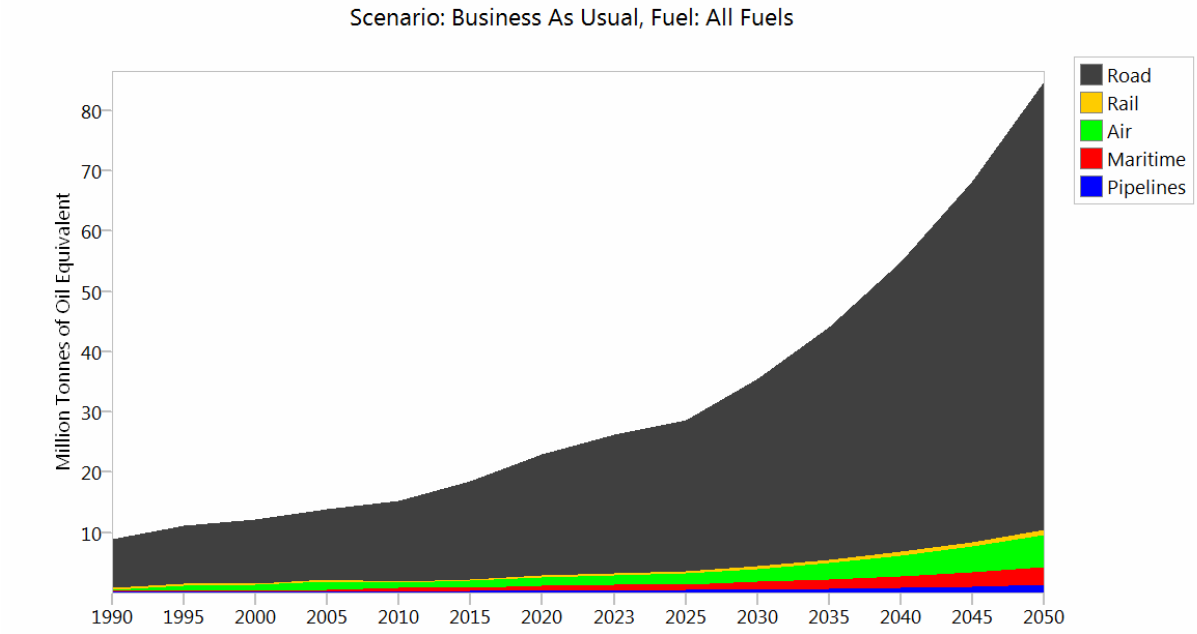

Figure 8: Final Energy Demand in Transport Sector.

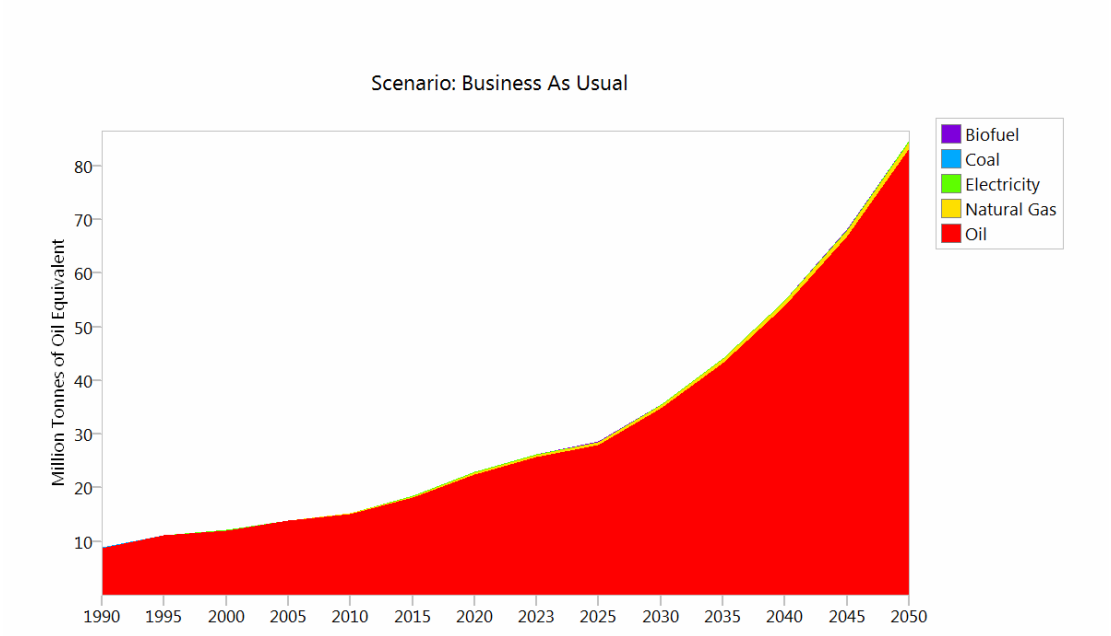

Figure 9: Final Energy Demand in Transport Sector per Fuel.

Due to inefficiency of LEAP to simulate the process of hydro pump storage, we added the electricity consumption of this process in Demand branch under the above sectors. Since no policy measure is expected to be taken concerning energy savings or fuel switch, the energy demand is expected to increase almost 3% annually, following the trend of GDP.

Transformation

Transmission and Distribution losses

Review of information about this category

There is a small increase in line resistance with increasing mean temperatures coupled with negative effects on line sag and gas pipeline compressor efficiency due to higher maximum temperatures (IPCC, 2007).

Review of information about Turkey

Losses in the transmission and distribution of electricity are 15% in 2009 and Turkey is among countries with lowest performances in EU[34]. The country has targets to decrease losses.

Electricity generation

Electricity generation in Turkey is performed with EUAŞ and private sector.

Coal transformation

Since in coal reserves of Turkey the majority is lignite, the process performed is coal drying in order to get coal with higher heating value.

Oil Refining

Due to the lack of data about the future of the sector, it is assumed that no change will occur in the BAU scenario.

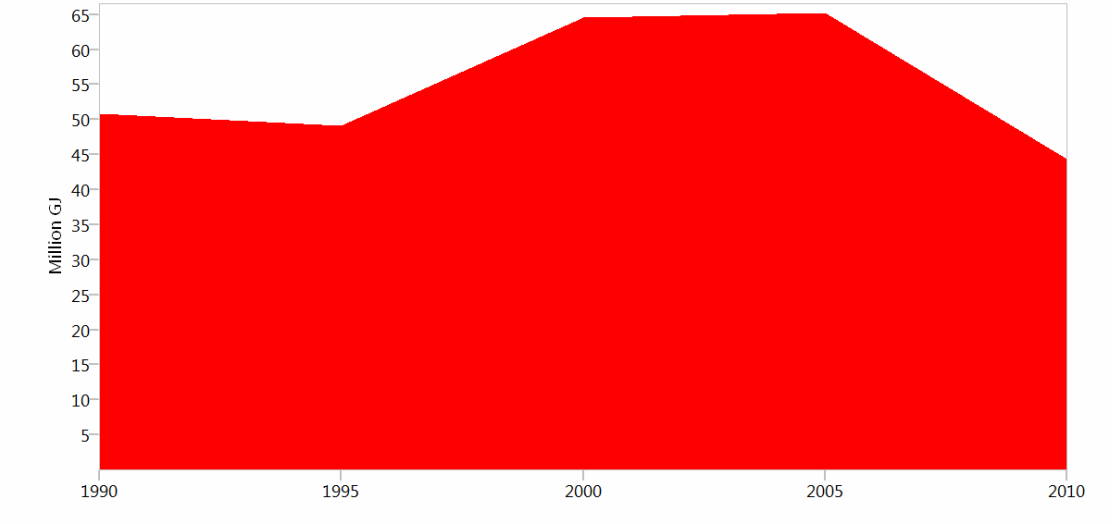

Figure 10: Historical production of Oil Refining in Turkey.

34 http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/bcfe8957cb2c8b2ac12578640051cf04/$file/turkey.pdf

Global warming potential (GHG emissions)

The below graph shows the GHG emissions which are attributed to each "energy consuming" sector.

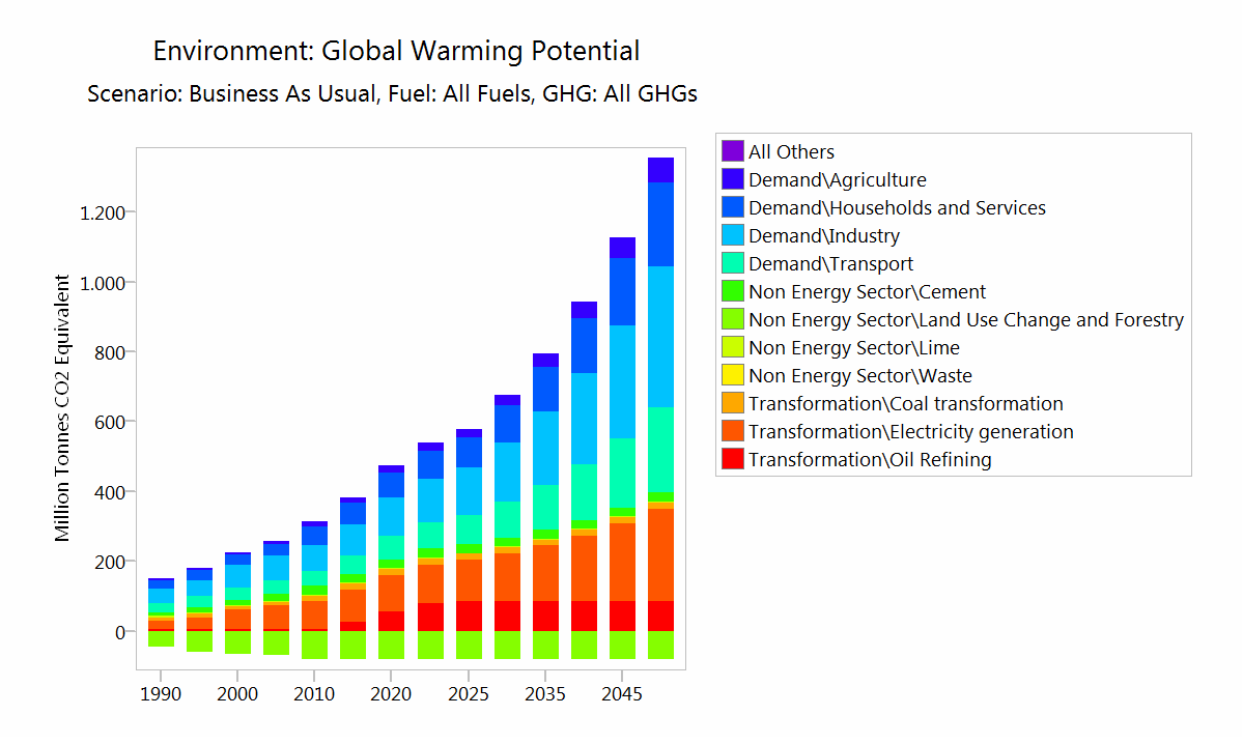

Figure 11: GHG emissions per sector.

References

Alexandrov V. et al, 2010. Global Environmental Change: Challenges to Science and Society in Southeastern Europe, DOI 10.1007/978-90-481-8695-2_13, Spinger Science+Business Media B.V. 2010

Climate Change and Impacts on Water Supply (CC-WaterS) - International Study for SE Europe in progress (two of three years completed), 18 Institutions from SE Europe, May 2009 – May 2012. Available online at http://www.ccwaters.eu/index.php?option=com_content&view=article&id=48&Itemid=54&56b00064c3e6beb26da3b96d1578b92a=caac98a9a4248cd115a194c70c97a142

Cueto Garcia O. Rafael, Martinez Tejeda Adalberto, Ostos Jauregui Ernesto, 2010. Heat waves and heat days in an arid city in the northwest of Mexico: current trends and in climate change scenarios. Int. J. Biometeorol. 54: 335-345, DOI 10.1007/s00484-009-0283-7

DG Environment, 2007. Water scarcity and Droughts, Second Interim Report – June 2007. Available at: http://ec.europa.eu/environment/water/quantity/pdf/comm_droughts/2nd_int_report.pdf

FAO, 2010. Global Forest Resources Assessment 2010, Main report. FAO Forestry paper 163. ISBN 978-92-5-106654-6. Available at: http://www.fao.org/docrep/013/i1757e/i1757e.pdf

Giannakopoulos C., Sager Le P., Bindi M., Moriondo M., Kostopoulou E., Goodess C.M., 2009. Climatic changes and associated impacts in the Mediterranean resulting from 2oC global warming. Global and Planetary Change, 68, pp. 209-224.

Hoegh-Guldberg Hans, 2010. Changing Global Scenarios, background paper 1, Climate Change and the Florida keys, July 1, 2010. Socio-economic Research and Monitoring program Frolida keys, National Manrine Sanctuary (FKNMS), National Atmospheric and Oceanic Administration (NOAA), available at: http://sanctuaries.noaa.gov/science/socioeconomic/floridakeys/pdfs/changingscenarios.pdf

IPA, 2012. The European Union's IPA 2010 Programme For the Republic of Serbia, Sustainable Development in the Energy Sector, Mid-term Kyoto Protocol Implementation Plan in the Serbian Energy Sector, Part 2 (of 4): Development energy sector and greenhouse gas scenarios 2020. Interim draft, January 30th, 2012, available at: http://www.sudes.rs/wp-content/uploads/2011/06/SuDES-Part-2-draft-300112.pdf

Kampman Bettina, Rijkee Xander, Pridmore Alison, Hulskotte Jan, 2009. EU Transport GHG: Routes to 2050? Operational options for all modes (Paper 4), 18th December 2009. Available at: http://www.eutransportghg2050.eu/cms/assets/EU-Transport-GHG-2050-Paper-4-Operational-options-18-12-09-FINAL.pdf

Lioubimtseva E., Henebry G.M., 2009. Climate and environmental change in arid Central Asia: Impacts, vulnerability and adaptations. Journal of Arid Environments 73, 963-977.

Luber George, McGeelin Michael, 2008. Climate Change and Extreme Heat Events. American Journal of Preventive Medicine 2008: 35(5). DOI: 10.1016/j.amepre.2008.08.021

Schlickenrieder Jeremy, Quiroga Sonia, Diz Agustin, Iglesias Ana, 2011. Impacts and adaptive capacity as drivers for prioritizing agricultural adaptation to climate change in Europe. Economia Agraria y Recursos Naturales. ISSN: 1578-0732. Vil. 11,1. pp. 59-82. Available at: http://aeea.webs.upv.es/aeea/ficheros/Revistas/EARN_11_1/EARN_Revista_completa_vers28_10_11.pdf#page=59

International project SINTA (Mediterranean project, participants: Euro-Mediterranean Center for Climate Change from Bologna, University of Belgrade Institute of Meteorology, and the Hydro-Meteorological Service of Serbia), 2007-2008. Available online at http://www.earth-prints.org/handle/2122/4675

South East Europe Climate Outlook Forums (SEECOFs), 2008-2010, [Available online at http://www.google.rs/search?hl=sr&source=hp&q=climate+change+seecof&btnG=Google+%D0%BF

%D1%80%D0%B5%D1%82%D1%80%D0%B0%D0%B3%D0%B0&meta=&gbv=2&oq=climate+change+seecof&aq=f&aqi=&aql=&gs_sm=s&gs_upl=1280l1323l1l0l17334l23l23l11l5l3l0l2971346l4l0

Umweltbundesamt, 2008. Impacts of climate change on water resources – adaptation strategies for Europe.Texte 32/08, ISSN: 1862-4804. Available at: http://www.umweltdaten.de/publikationen/fpdf-l/3630.pdf

OPTIMISTIC (OPT) SCENARIO (2000 – 2050)

Description of OPT scenario

General comments

The Opt scenario is structured by: i) the mitigation/adaptation policy instruments that the country has set into force after 1st January 2011; ii) additional policy instruments in line with the EU climate change policy that can be adjusted to the needs and priorities of the examined country[35], iii) the maximum exploitation of the potential of the country in energy efficiency and renewable energy sources and iv) improvement of network capacity

Turkey is an observer to the Energy Community[36] and a candidate country for EU membership following the Helsinki European Council of December 1999.

This scenario is linked with stringent climate policy options and relatively high need for adaptation policy instruments to handle minimum climate change impacts for Turkey. The whole spectrum of mitigation options and adaptation needs as presented in the previous sessions will be taken into account. The main characteristics of this policy portfolio are the promotion of Renewable Energy Sources, the introduction of energy efficiency measures in all sectors, the implementation of adaptation activities based on the expected needs.

Policy portfolio for this scenario

Existing policy instruments

The policy instruments that form the policy portfolio of the BAU scenario are also included in this scenario, but with the following modifications due to the update of certain Laws.

Law No. 5346 on Utilization of Renewable Energy Sources for the Purpose of Generating Electricity (published in the Official Gazette: dated 18 May 2005 and numbered 225819) and its amended version Law No. 6094 on Renewable Energy (published in the Official Gazette: dated 8 January 2011 and numbered 27809)

The purposes of the Amended Law are to promote the use of RES for electricity production, to put these sources into the economy by reliable, economical and quality manner, to increase the diversity of sources, to reduce GHG emissions, to protect the environment and to develop this sector so as to fulfill these objectives.

Turkey made major changes in RES Law in 2011 to overcome existing problems and to increase RES investments. The first major change is the establishment of "*Renewable Energy Support Mechanism*" which is applied to plants commissioned between 2005 and 2015, and enables these plants to benefit from feed-in tariffs for ten years (Sirin M.S. and Ege A., 2012). The tariffs implemented in the "*Renewable Energy Support Mechanism*" are 7.3US cents/kWh (10.17 Euro cents/kWh) for hydro and wind; 10.5 US cents/kWh (14.63 Euro cents/kWh) for geothermal, 13.3 US cents/kWh (18.53 Euro cents/kWh) for biomass and solar.

The Law sets the additional value added to the tariff if the investors use domestically manufactured equipments in their plants. The additional amount of the tariffs changes between 1.0-1.3 US cents/kWh for hydro; 0.6 to 1.3 US cents/kWh for wind; 0.6 to 3.5 US

[35] Albania, Moldova, Serbia and Ukraine are Contracting Parties of the Energy Community and have committed to comply with the EU energy policy (http://www.energy-community.org/portal/page/portal/ENC_HOME). This commitment concerns also climate change policy due to policy instruments that support the usage of technologies for energy efficiency and renewable energy sources. Armenia and Turkey are observers to this Treaty.

[36] http://www.energy-community.org/portal/page/portal/ENC_HOME/ENERGY_COMMUNITY/Stakeholders/Observers

cents/kWh for solar; 0.7 to 1.3 US cents/kWh for geothermal, 0.4 to 2.0 US cents/kWh for biomass.

Also, the Law allows for the construction of renewable energy plants in protected regions (such as national and natural parks, natural monuments, protected regions, conserved forestry, wildlife development zones, special environmental protection zones and natural protected areas) with the permissions obtained from the Ministry of Forestry and Water Affairs and the Ministry of Environment and Urbanism.

Regulation on increasing efficiency in the use of energy resources and energy (Official Gazette No: 28097, 27 October 2011)

The regulation on Increasing Energy Efficiency in the Use of Energy Resources and Energy put in place authorizations and certifications for universities, engineering organizations and energy consultancy companies to support energy efficiency projects in industry through voluntary agreements.

Additional policy instruments

A. Mitigation

Policy instruments for the promotion of RES

Although the FIT system was established by the Amended RES Law, the incentives are still low compared to EU countries (Sirin M.S. and Ege A., 2012). FIT incentives should be increased and tax-reliefs and subsidy programs should be provided.

Economic policy instruments are the most commonly used types of climate change policy operational costs are considered for promoting investments in Turkey for all types of RES.

Policy instruments for energy efficiency

Turkey has many targets related with energy efficiency aforementioned in previous sessions. The following policy instruments could be added so as to reinforce the up to now set of policy instruments for the promotion of EE. They are presented per sector.

For households

Building code – The introduction of a building code will impose additional requirements for securing energy savings. The set of standards regarding the manner under which a building needs to operate so as to be energy efficient will lead to GHG emission reductions.

Energy efficiency standards – The implementation of stricter energy standards for household appliances (for lighting, refrigerators, air-conditioning) will lead to additional energy savings.

As the targets of Energy Efficiency Strategy (2012-2023), administrative sanction will be applied to the buildings exceeding the defined minimum value of CO_2 on the Energy Identification Certificate.

For transport

Policy instruments for improving the energy efficiency through the change of transport modes and the introduction of innovative vehicle technology can be used.

Regulatory policy instruments defining the: i) percentage of rail mode over road mode will allow GHG emission reductions; ii) percentage of biofuels used in the sector will lead to energy savings. From the EU set target of 5.75% share of biofuels in the total energy consumption of the transport sector, the percentage is increased for this scenario at 10% in 2020.

Subsidies for the purchase of new technology cars will assist citizens and simultaneously will contribute to the objectives of the national climate policy.

Also, Turkey will strengthen the institutional structure, capacity and mutual cooperation of implementing organizations until the end of 2012 according the Energy Efficiency Strategy.

Policy instruments for emission trading

EU ETS

The determination of an administrative and regulatory framework for the CDM will allow Turkey to sell permits and ensure technology and knowledge transfer towards the country. The existing policy instrument (selling permits at the voluntary market) does not satisfy the second objective regarding technology and knowledge transfer.

In the context of sustainable financing mechanisms related to energy efficiency and renewable energy sources, the infrastructure of carbon trading and carbon market shall be established. Additionally, through the CDM the country could have the opportunity to promote RES and EE projects.

B. Adaptation

Policy instruments for the agricultural sector

Financial policy instruments

Subsidies or tax exemptions for farmers oriented to the purchase of irrigation equipment or for changing plantations so as to handle climate change impacts will allow them to adapt partially.

Regulatory instruments

The introduction of a policy instruments that defines the percentage of arable land or of water use are also taken into consideration.

Dissemination policy instruments for climate change

Raising awareness campaigns for climate change (energy efficient behavior, eco-driving, walking, bike-cycling modes).

Main characteristics of this policy portfolio

This policy portfolio sets stringent mitigation targets in all sectors. It is oriented towards Turkey's 2023 aforementioned targets. The additional measures were proposed for implementation according to the EU climate policy since Turkey is a candidate country for EU membership.

Key assumptions

The categories of the key parameters are common for all scenarios and are divided as follows:

Demographics

In the *Optimistic scenario,* the average annual rate of changes for the Turkish population is assumed as in the BAU Scenario.

Economy

Gross Domestic Product

For the *OPT scenario* the GDP and GDP growth rate are the same as BAU scenario and GDP growth rate remains constant until year 2050 based on projections of IMF.

GDP per capita

Projections of this key driver are based on those of GDP and population. LEAP calculates them automatically based on the projections of the other two key drivers as they are defined for each scenario.

GDP distribution per sector

The GDP distribution per sector was assumed same as the BAU scenario.

Average annual household Income

The annual household income is assumed as same as BAU scenario. The growth rate of this variable is assumed to be equal to the growth rate of GDP per capita.

Gini coefficient

The data on the Gini coefficient will be used for assessment of policy portfolios in AMS method.

Industry

Description is the same as in BAU.

Climate Statistics

Precipitation

For the Opt scenario precipitation was reduced by an annual growth rate of -10% according to the optimistic estimations for the Mediterranean region.

Temperature

For the Opt scenario the assumption is a higher increase at 15.96°C by 2050.

Frequency of extreme events

Flash Floods

For the Opt scenario the assumption is that the mean number of flash floods will be same by 2050.

Heat Waves

Due to no historical data about the frequency of heat waves, no assumptions were adopted.

Frost days

Due to no historical data about the frequency of frost days, no assumptions were adopted.

Water resources

Due to lack of data for realizing the historical trend of the surface waters, groundwater and Total renewable freshwater resources, any assumptions could not be adopted.

Policies and Measures

Feed – in – tariff system

According to the Amended Renewable Energy Law (published in the Official Gazette dated 8 January 2011 and numbered 27809, Law No. 6094), the sale tariffs for a maximum term of 10 years from its operation date are as follows:

- Hydroelectric power plants: 0.073$/kWh (10.17 Euro cents/kWh);
- Wind power plants: 0.073$/kWh (10.17 Euro cents/kWh);
- Geothermal power plants: 0.105$/kWh (14.63 Euro cents/kWh);
- Biomass power plants: 0.133$/kWh (18.53 Euro cents/kWh);
- Solar power plants: 0.133$/kWh (18.53 Euro cents/kWh).

For the Opt scenario, the FITs mentioned above will be used as beginning and they follow the time development of the costs as they are presented by RES technology type.

Subsidies

In Turkey, the organizations who have an agreement with local Energy Office receive subsidies for their energy saving projects (Energy Efficiency Law). Due to the lack of data about the value of total subsidies, any assumptions couldn't be adopted.

Land management

For the Opt scenario the arable land was reduced by an annual growth rate of 1%; the orchands and vineyards land were reduced by an annual growth rate of 1%; the meadows and pasture land was increased by an annual growth rate of 3% and the irrigated land was increased by an annual growth rate of 2%.

The forest land was assumed to reach 22 million hectare by 2015 for the OPT scenario.

Global trends

Crude oil price

Projections for the crude oil prices regarding the Reference scenario of the IEA, World Energy Outlook 2010 will be used.

Natural gas price

Projections for the crude oil prices regarding the Reference scenario of the IEA, World Energy Outlook 2010 will be used.

Coal price

As in BAU.

EUA price

As in BAU.

ERU price

As in BAU.

CER price

As in BAU.

Adaptation

For the *OPT scenario* the annual household water use was considered to increase by an annual growth rate of 0.5%; the annual industrial water use was considered to increase by an annual growth rate of 0.2% and the cooling water use was considered to increase by annual growth rate as same as the energy demand.

Energy Demand

Turkey's energy demand framework is comprised of the sectors: households and services, industry, agriculture and transport. Assumptions about these sectors are described in details in the next sessions.

Households and Services

It is estimated that Turkey holds an energy-saving potential of 30% in the buildings. For OPT scenario, it was assumed to achieve this goal by 2023. Energy demand in household and services projection for 2050 is shown in figure 12.

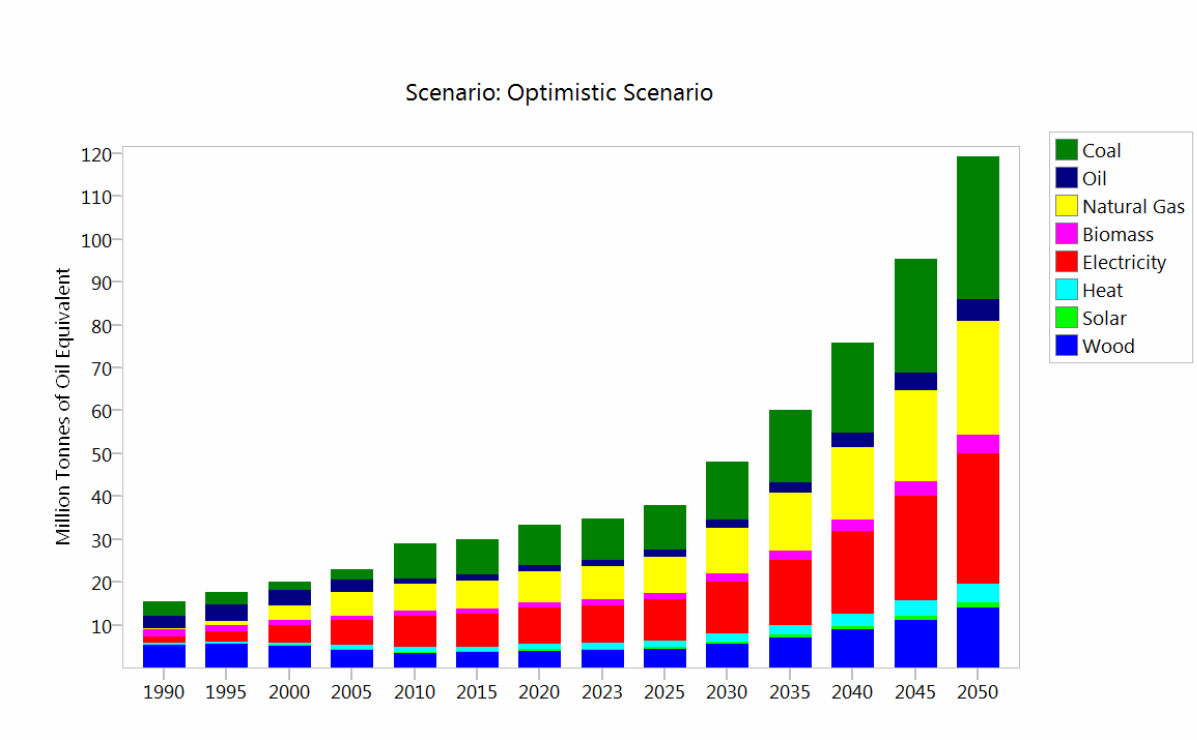

Figure 12: Final Energy Demand in Households and Services.

Agriculture

There is no additional measure for agriculture in OPT.

Industry

It is estimated that Turkey holds an energy-saving potential of 20% in the industry. For OPT scenario, it was assumed to achieve this goal by 2023. The projection of energy demand in industry for 2050 is given in Figure 13.

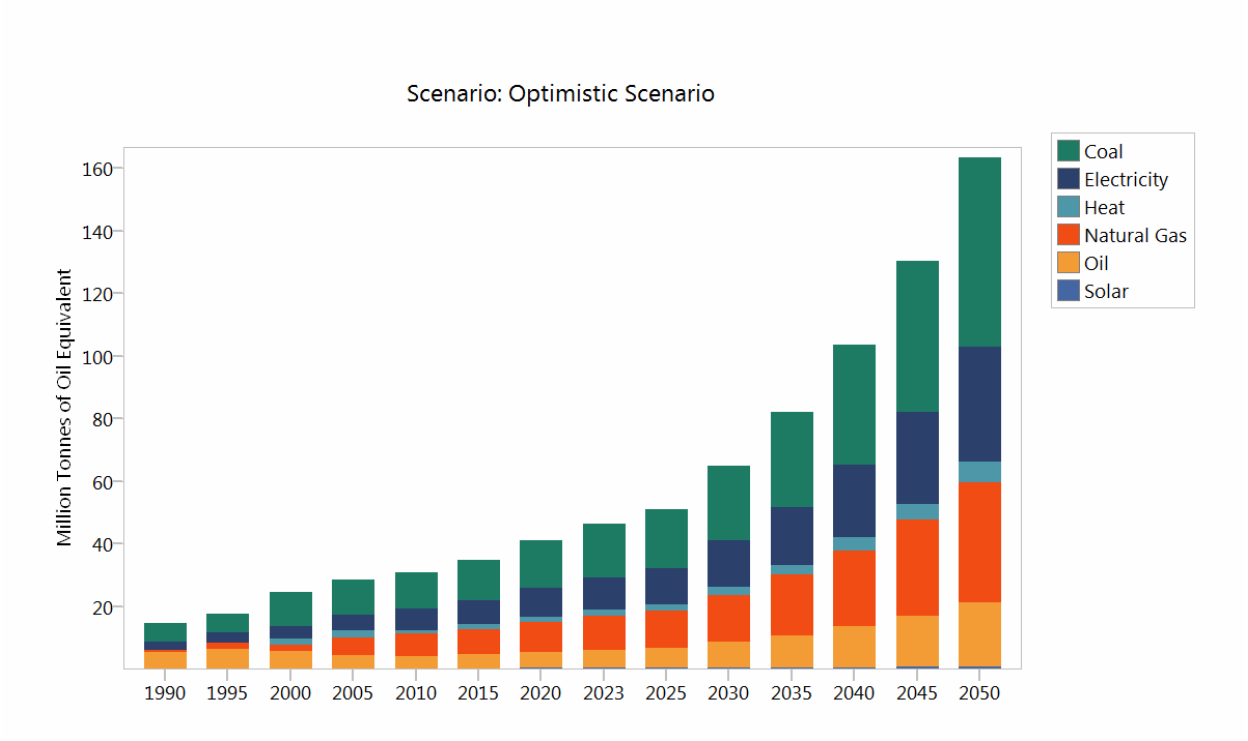

Figure 13: Final Energy Demand in Industry.

Transport

Turkey has targets for mode shift and increasing the bio-fuel share in transportation. For OPT scenario, it was assumed to achieve these targets by 2023. The projections of energy demand in this sector and transport sector per fuel for 2050 are shown in Figures 14 and 15.

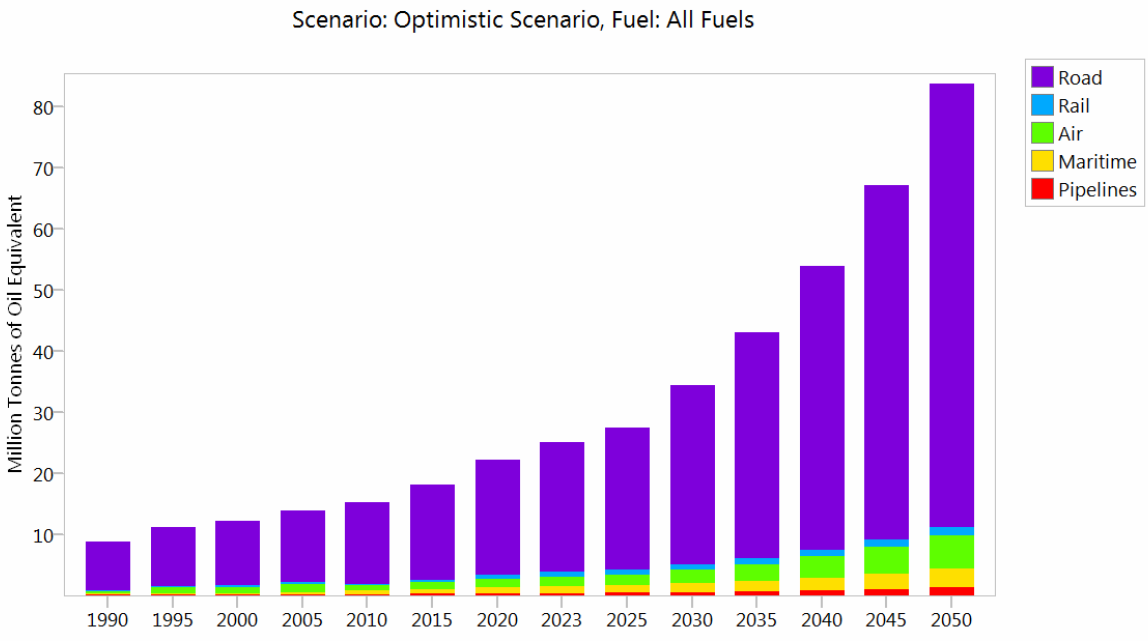

Figure 14: Final Energy Demand in Transport Sector.

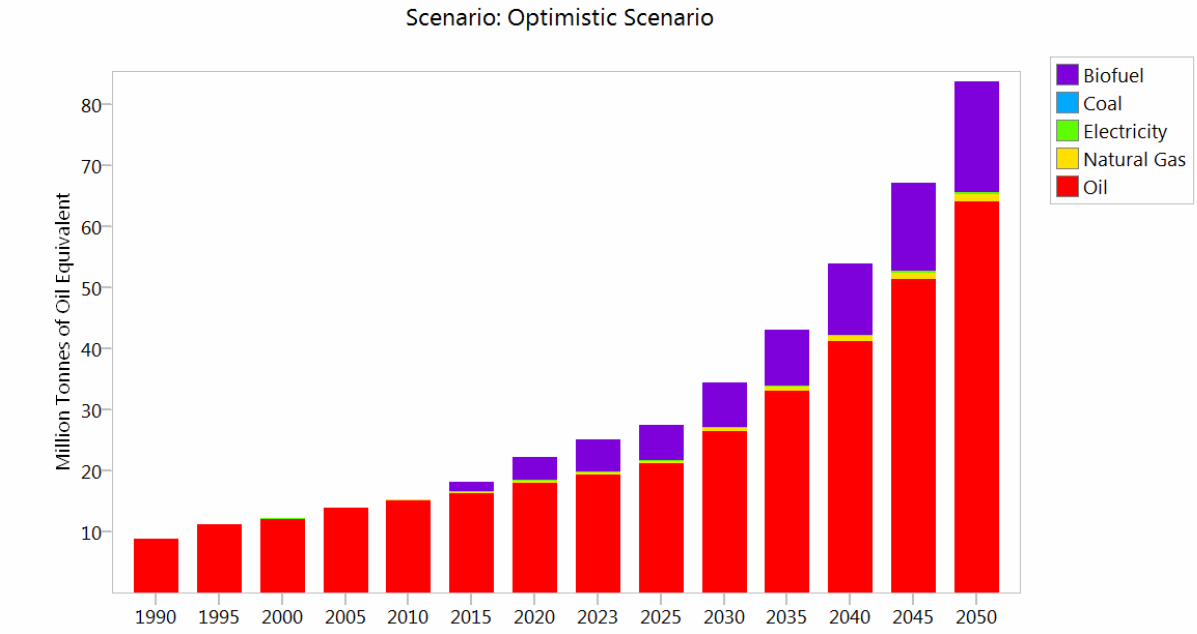

Figure 15: Final Energy Demand in transport sector per fuel.

Transformation

Transmission and Distribution losses

In Opt, it was assumed that the transmission and distribution losses would be 8% by 2023.

Electricity generation

Turkey aims to increase RES share in the electricity generation. In Opt scenario, it was assumed to achieve these targets by 2023.

Coal transformation

Since in coal reserves of Turkey the majority is lignite, the process performed is coal drying in order to get coal with higher heating value. No assumptions for Opt.

Oil Refining

Due to the lack of data about the future of the sector, it is assumed that no change will occur in the Opt scenario.

Global warming potential (GHG emissions)

The below graph shows the GHG emissions which are attributed to each "energy consuming" sector.

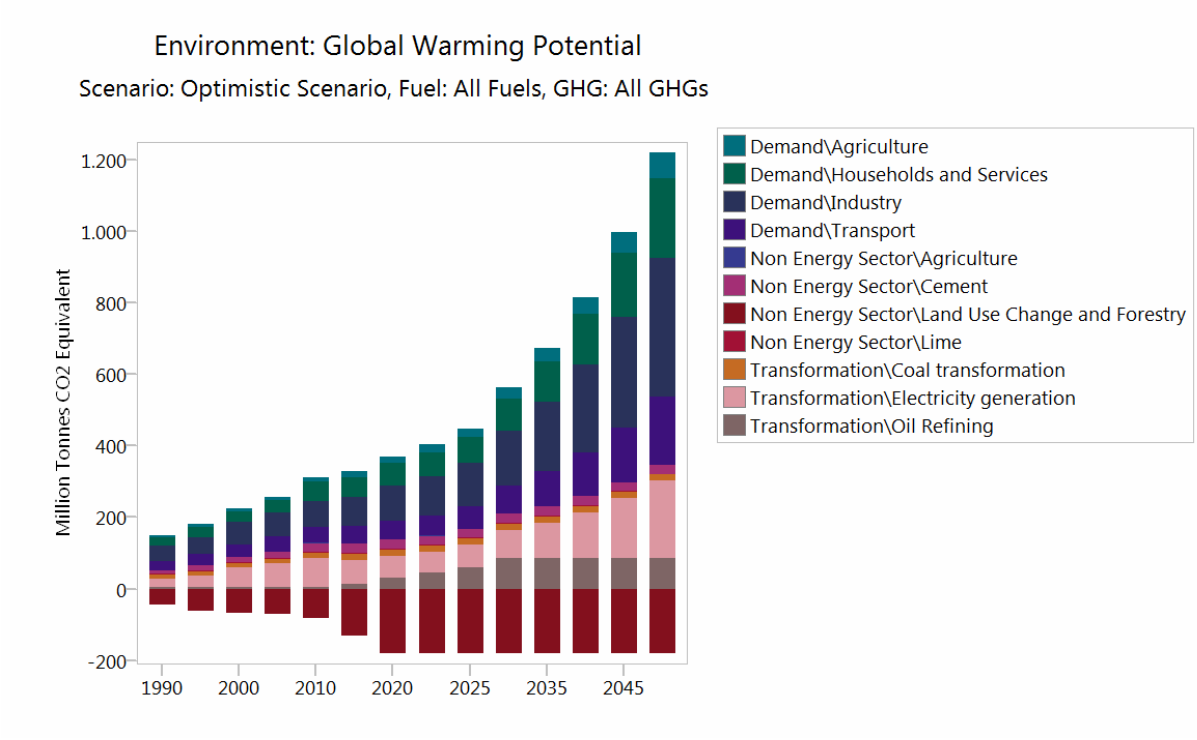

Figure 16: GHG emissions per sector.

PESSIMISTIC (PES) SCENARIO (2000 – 2050)

Description of PES scenario

General comments

The Pessimistic scenario concerns the time evolution of a mitigation/adaptation policy portfolio that the country will implement up to 2050 without exploiting fully the national potential in energy efficiency and renewable energy sources and by facing the worse expected impacts of climate change.

The Pes scenario is structured by: i) the mitigation/adaptation policy instruments that the country has set into force after 1st January 2011; ii) no other additional policy instruments apart from those already decided to be implemented and in line with the EU climate change policy; the EU policy instruments will be adjusted to the needs and priorities of the Turkey and iii) the minimum exploitation of the potential of the country in energy efficiency and renewable energy sources by limiting the possible technological options to the sectors. These are the energy and transport sectors with the highest potential in energy efficiency and hydro and wind which are the most promising for RES.

Turkey has a mission to ensure efficient, effective safe and environment-sensitive use of energy and natural resources in a way that reduces external dependency of the country, and makes the greatest contribution to the country's welfare.

Currently, 49% of electricity generation is covered by natural gas plants, while 20% is covered by coal and 18% is covered by hydropower plants. In order to eliminate problems related with high dependency on imported fuels, Turkey is trying to establish an energy strategy based on securing energy supply, reducing import dependency, increasing energy efficiency, minimizing environmental degradation and establishment of liberalized and competitive electricity and natural gas markets. One part of this strategy is diversification of energy sources including construction of nuclear power plants and increasing the share of renewable energy sources (Sirin M.S. and Ege A., 2012).

Also, the ninth Development Plan (2007-2013) dated 1 July 2006, quotes that "in order to provide a good variety in the supply of electrical power, nuclear energy will be included in the electricity generation sources".

Following these strategies, Law No. 5710 on Construction and Operation of Nuclear Power Plants and Law on Sale of Energy (2007) were enacted. Turkey concluded an international agreement with the Russian Federation paving the way for the construction of a 4800 MW nuclear power plant at Akkuyu nuclear site *(published in the Official Gazette: dated 21 July 2010 and numbered* 27648). Also, it is targeted by 2020 that nuclear power plants will have a minimum of 5% share in electricity production[37].

Due to the national targets concerning the reduction of import dependency, the government plans to increase the coal (used mainly for electricity generation, cement production and iron&steel production) supply from 20.1 Mtoe in 1999 to 118.4 Mtoe in 2020 (Kılıç F.Ç. and Kaya D., 2007). The most abundant domestic energy source in Turkey is lignite with the proven reserves of 7300 million ton (Kotcioğlu İ, 2011)

37 http://www.enerji.gov.tr/index.php?dil=en&sf=webpages&b=nukleerenerji_EN&bn=224&hn=&nm=40717&id=40738

Policy portfolio for this scenario

Existing policy instruments

The policy instruments that form the policy portfolio of the BAU scenario are also included in this scenario, but with the following modifications due to the update of certain Laws.

Law No. 5346 on Utilization of Renewable Energy Sources for the Purpose of Generating Electricity (published in the Official Gazette: dated 18 May 2005 and numbered 225819) and its amended version Law No. 6094 on Renewable Energy (published in the Official Gazette: dated 8 January 2011 and numbered 27809)

It was described in the Opt scenario. It remains the same for this scenario also since it is implemented.

Regulation on increasing efficiency in the use of energy resources and energy (Official Gazette No: 28097, 27 October 2011)

It was described in the Opt scenario. It remains the same for this scenario also since it is implemented.

Additional policy instruments

The additional policy instruments already mentioned in the Opt scenario will be included also in this scenario, but with different implementation ratio.

Policy instruments for mitigation activities

For RES

FIT incentives should be increased and tax-reliefs and subsidy programs should be provided only for the RES types that are more promising for the country. For the other the situation remains as in BAU.

For energy efficiency

Only half of the expected energy savings are to be achieved. This is due to the currently implemented policy portfolio.

For households

- Introduction of a building code;
- Implementation of stricter energy efficiency standards.

For transport

- The change of transport modes;
- The introduction of innovative vehicle technology.

For emission trading

- The determination of an administrative and regulatory framework for the CDM.

Policy instruments for adaptation needs

Financial policy instruments

Subsidies or tax exemptions for farmers oriented to the purchase of irrigation equipment or for changing plantations so as to handle climate change impacts will allow them to adapt partially.

Regulatory instruments

The introduction of a policy instruments that defines the percentage of arable land or of water use are also taken into consideration.

Main characteristics of this policy portfolio

It is policy portfolio oriented to the needs of the country as an emerging economy. The policy instruments for mitigation activities are restricted compared to the ones proposed in the OPT scenario. The policy instruments, that are proposed to handle the adaptation needs, focus mainly on the agricultural sector which is an important component of the national economy.

Key assumptions

The categories of the key parameters are common for all scenarios and are divided as follows:

Demographics

In *Pessimistic scenario,* the average annual rate of changes for the Turkish population is assumed as in BAU scenario.

Economy

Gross Domestic Product

For the *PES scenario* the GDP and GDP growth rate are the same as BAU scenario and GDP growth rate remains constant until year 2050 based on projections of IMF.

GDP per capita

Projections of this key driver are based on those of GDP and population. LEAP calculates them automatically based on the projections of the other two key drivers as they are defined for each scenario.

GDP distribution per sector

The GDP distribution per sector was assumed same as the BAU scenario.

Average annual household Income

The annual household income is assumed as same as BAU scenario. The growth rate of this variable is assumed to be equal to the growth rate of GDP per capita.

Gini coefficient

Measures of income inequality are based on data on people's household disposable income. The data on the Gini coefficient will be used for assessment of policy portfolios in AMS method.

Industry

As in BAU.

Climate Statistics

Precipitation

For the Pes scenario precipitation was reduced by an annual growth rate of -20% according to the optimistic estimations for the Mediterranean region.

Temperature

For the Pes scenario the assumption is a higher increase at 16,16°C by 2050.

Frequency of extreme events

Flash Floods

For the Pes scenario the assumption is that the mean number of flash floods will increase 10% by 2050 according to BAU and Opt.

Heat Waves

Due to no historical data about the frequency of heat waves, no assumptions were adopted.

Frost days

Due to no historical data about the frequency of frost days, no assumptions were adopted.

Water resources

Due to lack of data for realizing the historical trend of the surface waters, groundwater and Total renewable freshwater resources, no assumptions could be adopted.

Policies and Measures

Feed – in – tariff system

Same as in OPT scenario.

Subsidies

In Turkey, the organizations who have an agreement with local Energy Office receive subsidies for their energy saving projects (Energy Efficiency Law). Due to the lack of data about the value of total subsidies, no assumptions could be adopted.

Land management

For the Pes scenario the arable land was reduced by an annual growth rate of 1%; the orchands and vineyards land was reduced by an annual growth rate of 1%; the meadows and pasture land was increased by an annual growth rate of 3%; the irrigated land was increased by an annual growth rate of 2%.

The forest land was assumed to reach 21.8 million hectare by 2023 for the Pes scenario.

Global trends

Crude oil price

Projections for the crude oil prices regarding the Reference scenario of the IEA, World Energy Outlook 2010 will be used.

Natural gas price

Projections for the crude oil prices regarding the Reference scenario of the IEA, World Energy Outlook 2010 will be used.

Coal price

Same as in BAU.

EUA price

Same as in BAU.

ERU price

Same as in BAU.

CER price

Projections about the ERU price are similar to those of the EUA price.

Adaptation

For the *Pes scenario* the annual household water use was considered to increase by an annual growth rate of 1%; the annual industrial water use was considered to increase by an annual growth rate of 0.5%; and the cooling water use was considered to increase by annual growth rate as same as the energy demand.

Energy Demand

Turkey's energy demand framework is comprised of the sectors: households and services, industry, agriculture and transport. Assumptions about these sectors are described in details in the next sessions.

Households and Services

It is estimated that Turkey holds an energy-saving potential of 30% in the buildings. For PES scenario, it was assumed to achieve half of this goal by 2023. Energy demand in household and services projection for 2050 is presented in Figure 17.

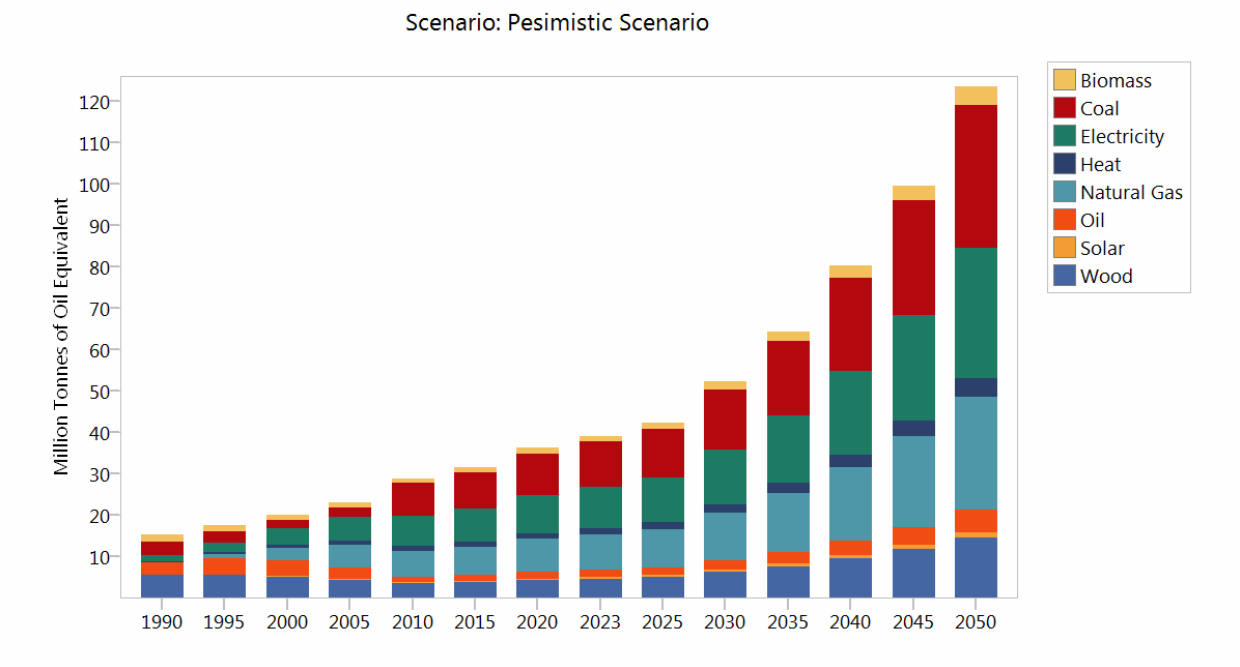

Figure 17: Final Energy Demand in Households and Services.

Agriculture

There is no additional measure for agriculture in the PES Scenario.

Industry

It is estimated that Turkey holds an energy-saving potential of 20% in the industry. For PES scenario, it was assumed to achieve half of this goal by 2023 (Figure 18).

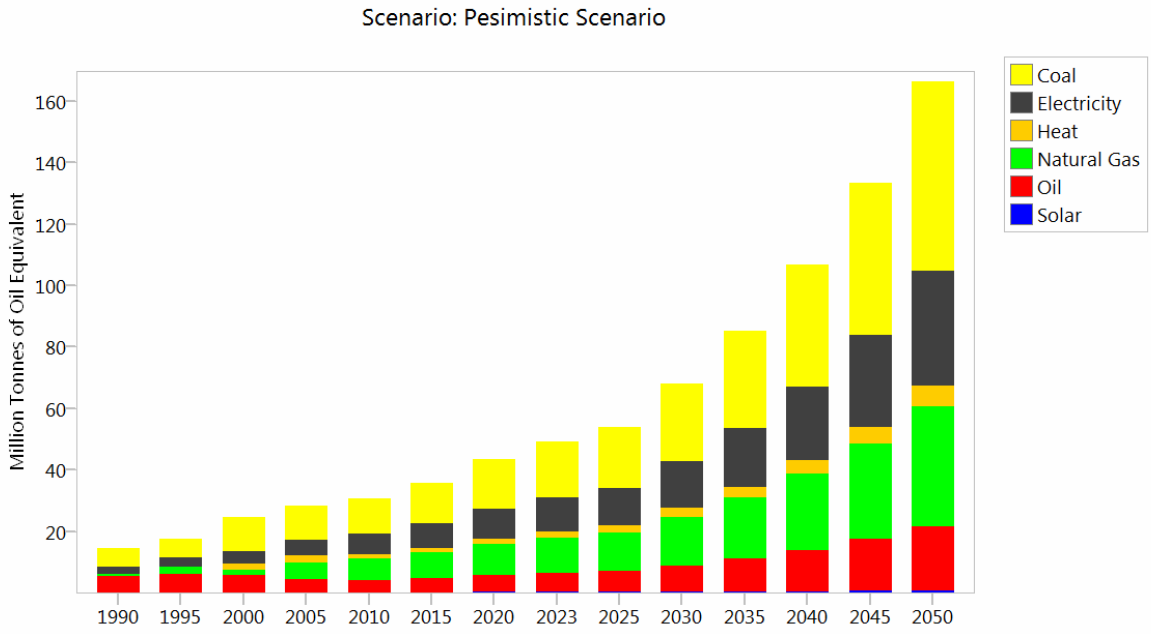

Figure 18: Final Energy Demand in industry.

Transport

Turkey has targets for mode shift and increasing the bio-fuel share in transportation. For OPT scenario, it was assumed to achieve these targets by 2023. The projections of energy demand in transport sector and transport sector per fuel for 2050 are shown in figures 19 and 20.

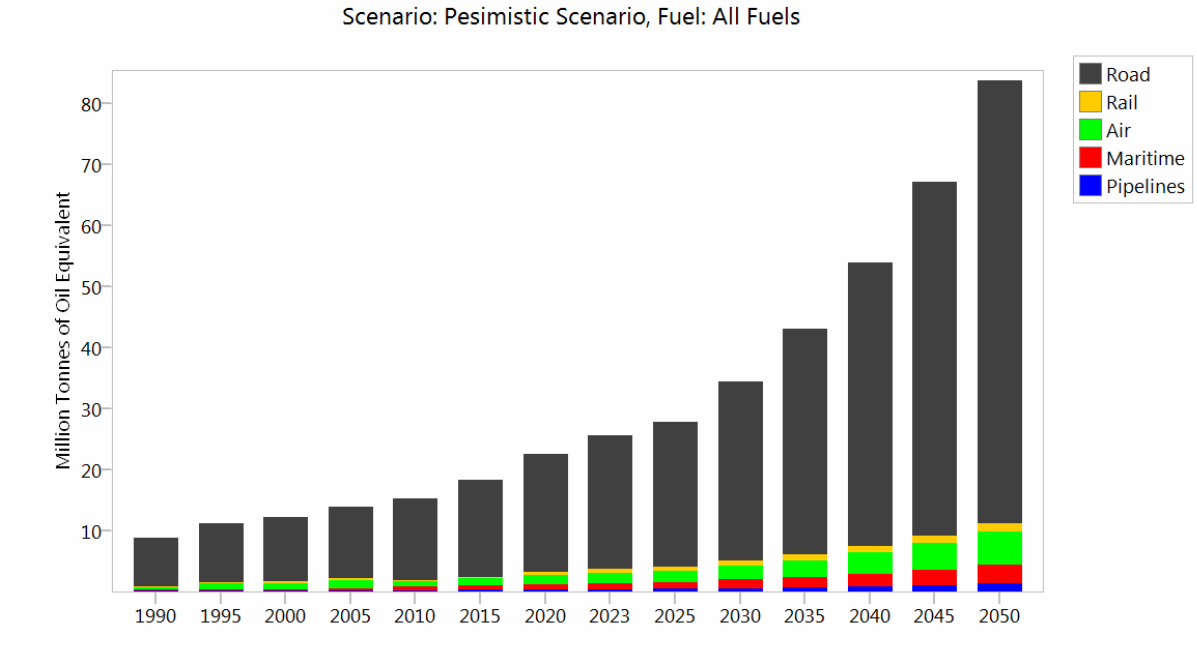

Figure 19: Final Energy Demand in transport sector.

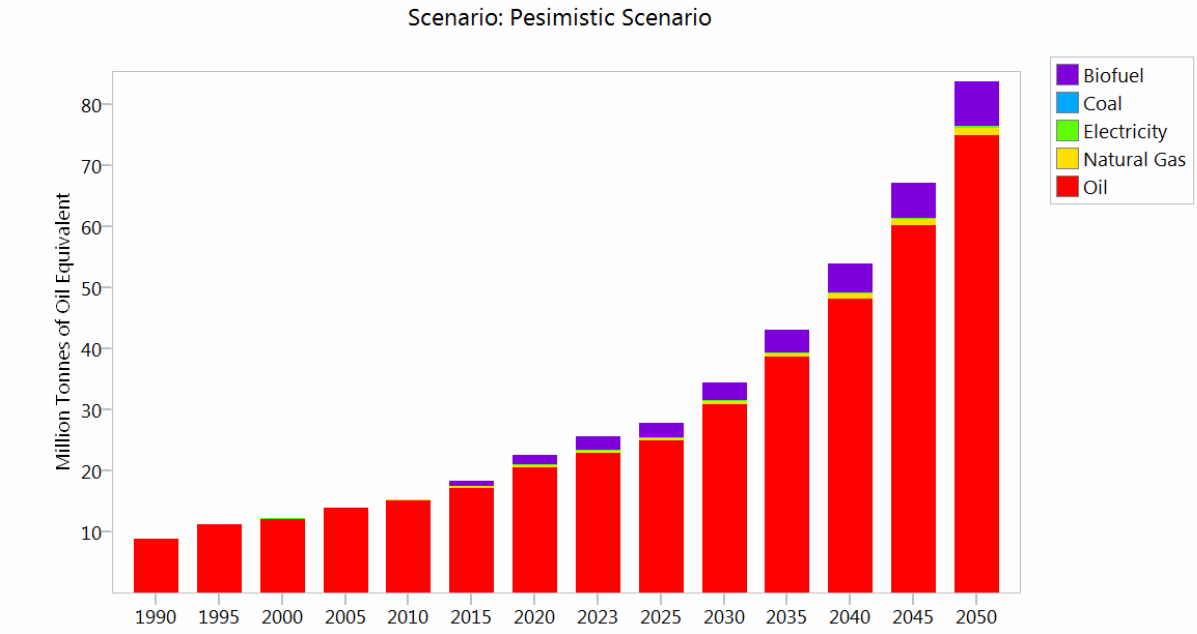

Figure 20: Final Energy Demand in transport sector per fuel.

Transformation

Transmission and Distribution losses

In Pes, it was assumed that the transmission and distribution losses would be 12% by 2023.

Electricity generation

Turkey aims to increase RES share in the electricity generation. In Pes scenario, it was assumed to achieve targets only for hydro and wind by 2023.

Coal transformation

Since in coal reserves of Turkey the majority is lignite, the process performed is coal drying in order to get coal with higher heating value. No assumptions for Pes.

Oil Refining

Due to the lack of data about the future of the sector, it is assumed that no change will occur in the Pes scenario.

Global warming potential (GHG emissions)

The below graph shows the GHG emissions which are attributed to each "energy consuming" sector.

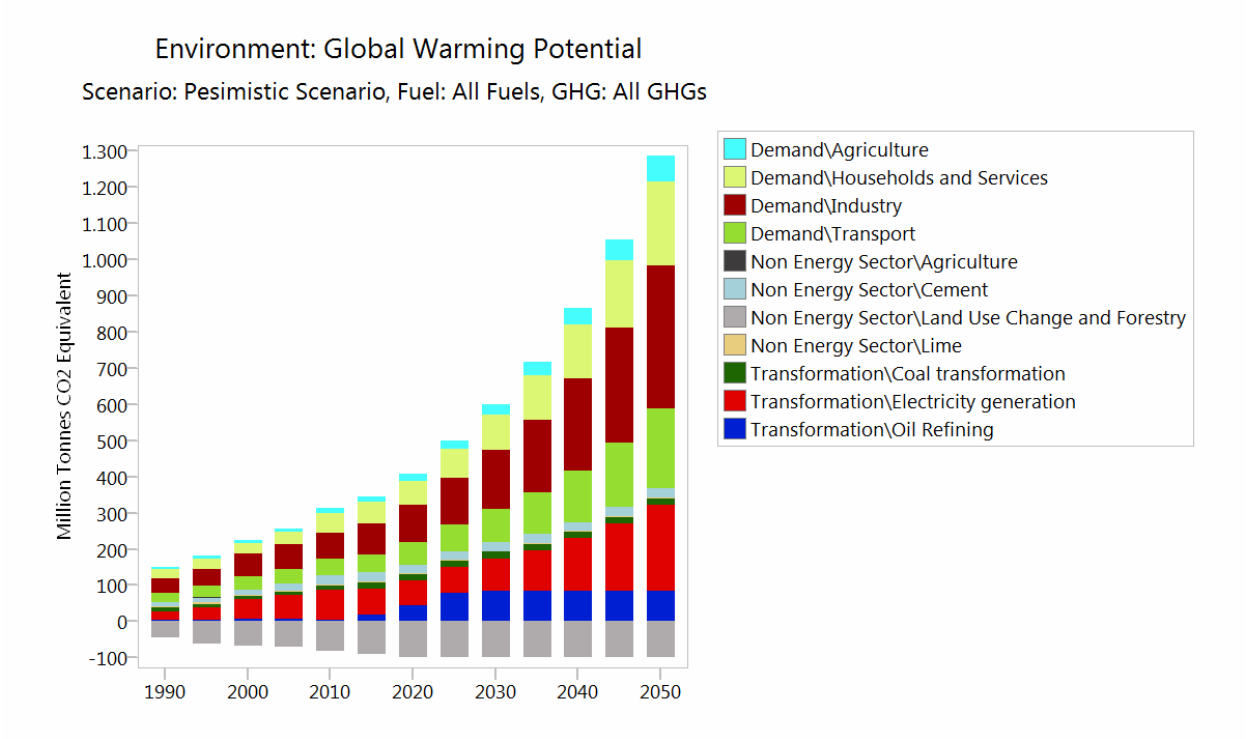

Figure 21: GHG emissions per sector.

RESULTS OF LONG – RANGE ENERGY ALTERNATIVES PLANNING SYSTEM (LEAP)

Energy Demand

The LEAP results of energy demand for three (3) scenarios are shown in figure 22.

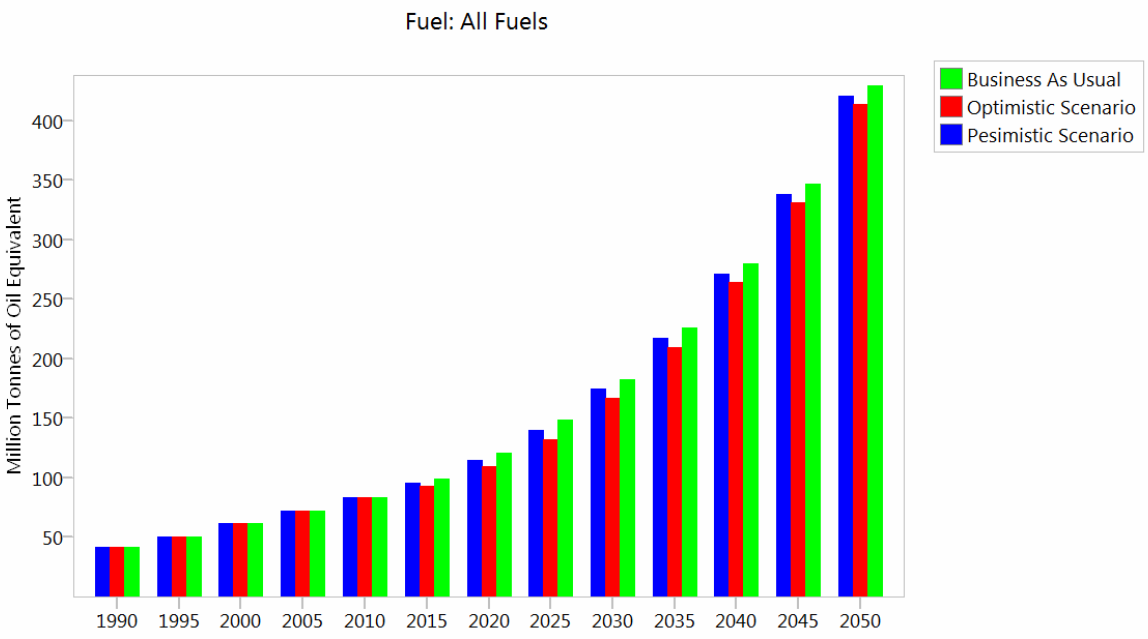

Figure 22: Energy demand curves for 3 scenarios.

The LEAP results of energy demands by sectors are given for all three scenarios in Tables 5, 6 and 7.

Table 5: Energy demands by sectors for BAU (Million TOE).

	1990	2000	2010	2020	2023	2025	2030	2040	2050
Households and Services	15.4	20.1	28.9	39.0	43.5	46.7	56.6	84.6	127.9
Agriculture	2.0	3.1	5.1	7.6	8.7	9.5	11.8	18.2	28.2
Industry	14.5	24.5	30.6	46.0	52.4	57.1	71.0	109.7	169.5
Transport	8.9	12.1	15.3	23.0	26.2	28.6	35.5	54.9	84.8
Non Energy Use	1.0	1.9	3.5	5.2	5.9	6.5	8.0	12.4	19.1
Total	41.7	61.7	83.4	120.8	136.6	148.3	183.0	279.8	429.6

Table 6: Energy demands by sectors for OPT (Million TOE).

	1990	2000	2010	2020	2023	2025	2030	2040	2050
Households and Services	15.4	20.1	28.9	33.3	34.8	38.0	48.0	75.9	119.3
Agriculture	2.0	3.1	5.1	7.6	8.7	9.5	11.8	18.2	28.2
Industry	14.5	24.5	30.6	40.9	46.2	51.0	64.9	103.6	163.4
Transport	8.9	12.1	15.3	22.2	25.1	27.5	34.5	53.8	83.7
Non Energy Use	1.0	1.9	3.5	5.2	5.9	6.5	8.0	12.4	19.1
Total	41.7	61.7	83.4	109.2	120.8	132.5	167.1	263.9	413.7

Table 7: Energy demands by sectors for PES (Million TOE).

	1990	2000	2010	2020	2023	2025	2030	2040	2050
Households and Services	15.4	20.1	28.9	36.1	39.1	42.3	52.3	80.2	123.6
Agriculture	2.0	3.1	5.1	7.6	8.7	9.5	11.8	18.2	28.2
Industry	14.5	24.5	30.6	43.4	49.3	54.1	67.9	106.6	166.4
Transport	8.9	12.1	15.3	22.5	25.5	27.8	34.5	53.8	83.7
Non Energy Use	1.0	1.9	3.5	5.2	5.9	6.5	8.0	12.4	19.1
Total	41.7	61.7	83.4	114.9	128.5	140.1	174.5	271.3	421.1

Transformation

The LEAP results of electricity generation for three (3) scenarios are shown in Figure 23.

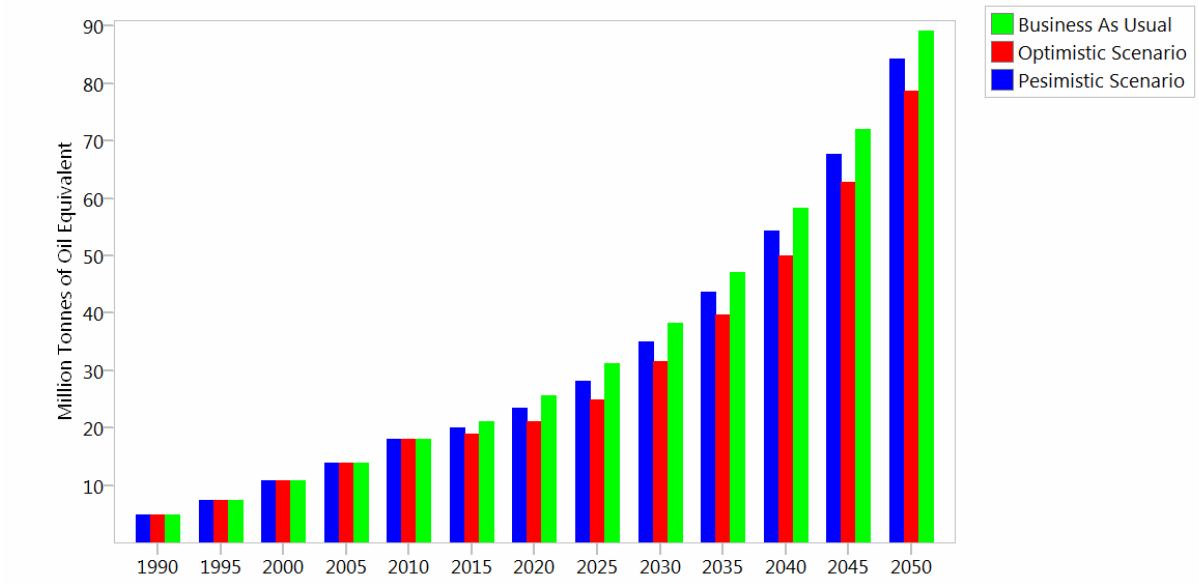

Figure 23: Electricity generation.

The LEAP results of electricity generation for all scenarios are shown in Figures 24, 25 and 26.

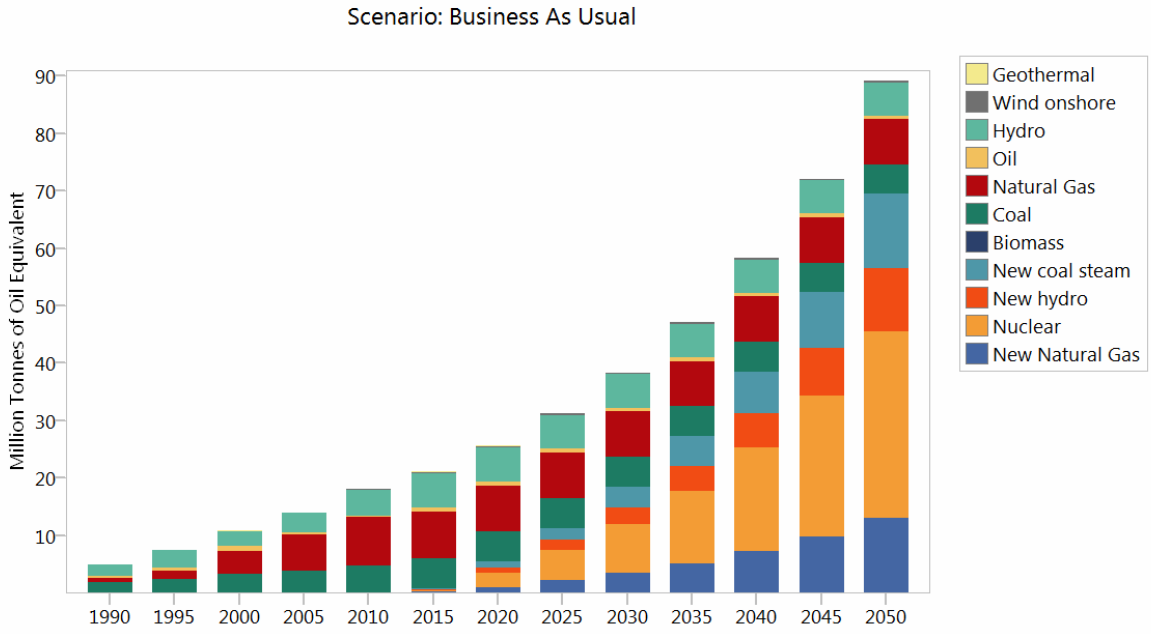

Figure 24: Electricity generation for BAU.

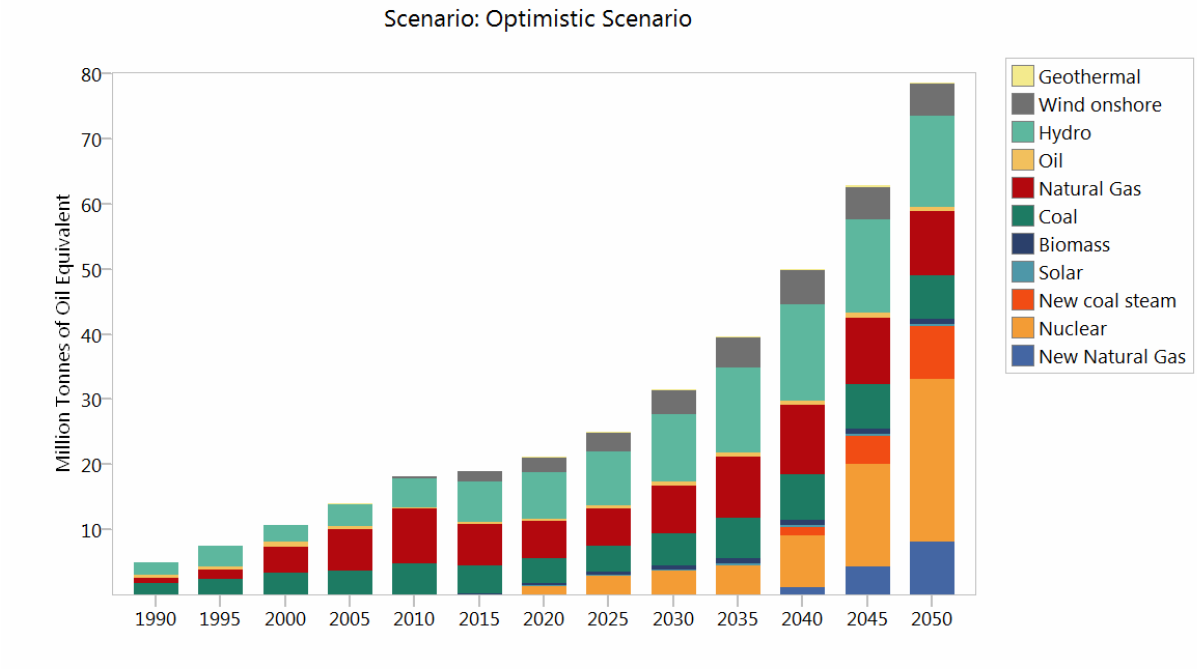

Figure 25: Electricity generation for Opt.

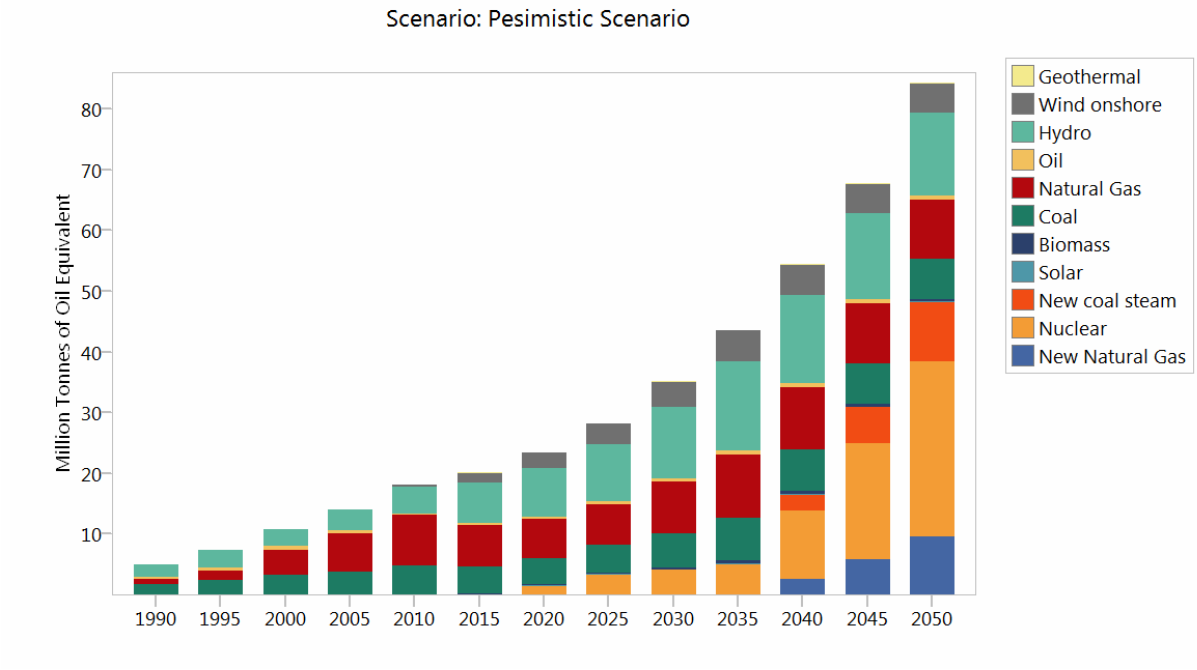

Figure 26: Electricity generation for Pes.

Global Warming Potential

The global warming potentials of 3 scenarios are shown in figure 27.

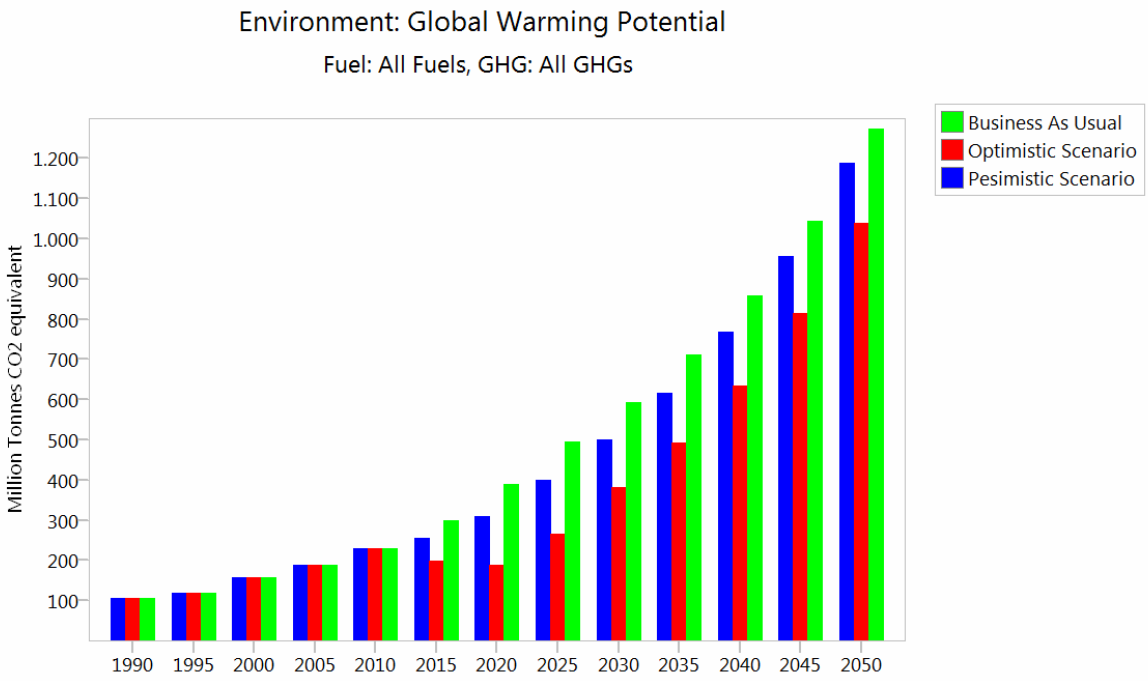

Figure 27: The Global Warming Potential of all three (3) scenarios.

References

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

Capic Mehmet, Yilmaz Osman Ali, Cavusoglu Ibrahim, 2012. Present situation and potential role of renewable energy in Turkey. Renewable Energy 46, pp. 1-13.

ClimSoil, 2008. Final Report – Review of existing information on the interrelations between soil and climate change. Contract number: 070307/2007/486157/SER/B1. Available at: http://ec.europa.eu/environment/soil/pdf/climsoil_key_messages.pdf

Dellal, I., McCarl, B.A., Butt, T., 2011. The Economic Assessment of Climate Change on Turkish Agriculture, Journal of Environmental Protection and Ecology, Vol:12, No:1, 376-385. Available at: http://www.agri.ankara.edu.tr/economy/10022_1330416377.pdf.

Dimkic A. Milan, Milovanovic Miodrag, Dimkic Dejan, 2011. Sustainable and Adaptive Water Management in Serbia, Water Research and management, Vol. 1, No. 4, pages 9-19.

EBRD, 2009. Turkey-Country Profile. Available at: http://ws2-23.myloadspring.com/sites/renew/Shared%20Documents/2009%20Country%20Profiles/Turkey.pdf

EEA, 2009. Report on good practice measures for climate change adaptation in river basin management plans. Prepared by: Cornelius Laaser, Anna Leipprand, Colette de Roo, Rodrigo Vidaurre. EEA/ADS/06/001 – Water. Available at: http://icm.eionet.europa.eu/ETC_Reports/Good_practice_report_final_ETC.pdf

European Commission, 2011. Commission Staff Working Paper, Turkey 2011 Progress report, Accompanying the document Communication from the Commission to the European parliament and the Council – Enlargement Strategy and Main Challenges 2011- 2012. Brussels, 12.10.2011, SEC(2011) 1201 final. Available at: http://ec.europa.eu/enlargement/pdf/key_documents/2011/package/tr_rapport_2011_en.pdf

Evren Türkmenoğlu on behalf of Ministry of Environment and Urbanism, 2012. "Climate Change Policies in Turkey" Presentation. Available at: http://www.cgseurope.net/UserFiles/file/Ankara%20workshop_june%202012/presentations/Evren%20Turkmenoglu.pdf

Garcia-Ruiz M. Jose, Lopez-Moreno J. Ignacio, Vicente-Serrano M. Sergio, Lasanta-Martinez Teodoro, Begueria Santiago, 2011. Mediterranean water resources in a global change scenario. Earth-Science Revies 105, pp. 121-139.

Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), 2007

Isaac Morna, van Vuuren Detlef P., 2009. Modeling global residential sector energy demand for heating and air conditioning in the context of climate change, Energy Policy, 37, pp. 507-521.

Kaygusuz Kamil, 2010. Sustainable energy, environmental and agricultural policies in Turkey. Energy Conversion and Management 51, pp 1075–1084.

Kotciolu I., 2011. Clean and sustainable energy policies in Turkey, Renewable and Sustainable Energy Reviews, 15 (9), pp. 5111-5119.

Lal R., 2011. Sequestering carbon in soils of agro-ecosystems. Food Policy 36: S33-S39.

Lindner Marcus, Maroschek Michael, Netherer Sigrid, Kremer Antoine, Barbati Anna, Garcia-Gonzalo Jordi, Seidl, Rupert, Delzon Sylvain, Corona Piermaria, Kolstrom Marja, Lexer J. Manfred, Marchetti Marco, 2010. Climate change impacts, adaptive capacity, and vulnerability of European forest ecosystems, Forest Ecology and management 259, pp. 698-709.

MENR, 2009. Report on replacement of incandescent light bulbs in public buildings Republic of Turkey, Ministry of Energy and Natural Resources. Available at (in Turkish): http://www.enerji.gov.tr/BysWEB/DownloadBelgeServlet?read=db&fileId=47707

MENR, 2010. Strategic Plan of the Ministry of Energy and Natural Resources (2010-2014) Republic of Turkey, Ministry of Energy and Natural Resources. Available at: http://www.enerji.gov.tr/yayinlar_raporlar_EN/ETKB_2010_2014_Stratejik_Plani_EN.pdf

MENR, 2012. Nükleer Santraller ve Ülkemizde Kurulacak Nükleer Santrallere İlişkin Bilgiler (Information about the nuclear plants and the nuclear power plants planned to be established in our country), Republic of Turkey, Ministry of Energy and Natural Resources. Available at (in Turkish): http://www.enerji.gov.tr/yayinlar_raporlar/Nukleer_Santraller_ve_Ulkemizde_Kurulacak_Nukleer_Santrale_Iliskin_Bilgiler.pdf

MoEF, 2010a., 2010 (a). National Climate Change Strategy (2010-2020). Republic of Turkey, Ministry of Environment and Forestry Available at: http://iklim.cob.gov.tr/iklim/Files/Stratejiler/National%20Strategy.pdf

Onol, B. and Semazzi, F. (2006), "Regional Impact (in Climate Change on Water Resources over Eastern Mediterranean: Euphrates-Tigris Basin", 18th Conference on Climate Variability and Change, 86th AMS Meeting, USA.

Ozturk Munir, Gucel Salih, Kucuk Mahir and Sakcali Serdal, 2010. Forest diversity, climate change and forest fires in the Mediterranean region of Turkey. Journal of Environmental Biology, januray 2010, 31, 1-9. Available at: http://www.jeb.co.in/journal_issues/201001_jan10/paper_01.pdf

Pilli-Sihvola Karoliina, Aatola Piia, Ollikainen Markuu, Tuomenvirta Heikki, 2010. Climate change and electricity consumption-Witnessing increasing or decreasing use and costs? Energy Policy 38, pp. 2409-2419

Point Carbon, 2008. EU ETS Phase II – the potential and scale of windfall profits in the power sector. A report for WWF by Point carbon Advisory Services, March 2008. Available at: http://www.wwf.dk/dk/Service/Bibliotek/Klima/Rapporter+mv./Windfall+profits

Posthumus H., Deeks L.K., Fenn I. and Rickson J., 2011. Soil conservation in two English catchments: Linking soil management with policies. Land degradation & development 22: 97-110. DOI: 10.1002/ldr. 987.

Republic of Turkey, General Directorate of State Hydraulic Works, 2009. Turkey Water Report. Available at: http://www2.dsi.gov.tr/english/pdf_files/TurkeyWaterReport.pdf

Republic of Turkey, Ministry of Environment and Forestry, 2007. 1st National Communication on Climate Change - Under the United Nations Framework Convention to Climate Change. Available at: http://unfccc.int/resource/docs/natc/turnc1.pdf

Republic of Turkey, Ministry of Environment and Forestry, 2010 (b). Registry Operations of Green House Gas Emission Reduction Projects. Available at: http://www.karbonkayit.cob.gov.tr/Karbon/Files/RegistryBrochures-ENG.pdf

Republic of Turkey, Ministry of Environment and Forestry, 2010 (c). *The Communication on Registry* Operations of GHG Emission Projects (published in the Official Gazette dated 7 August 2010 and numbered 27665). Available at: http://www.karbonkayit.cob.gov.tr/Karbon/Files/Communication%20on%20Registry%20Operations%20of%20GHG%20Emission%20Reduction%20Projects.pdf

Republic of Turkey, Ministry of Environment and Forestry, 2010 (d). National Activities of Turkey on Climate Change. Available at: http://www.dsi.gov.tr/docs/iklim-degisikligi/national_activities_of_turkey_on_climate_change.pdf?sfvrsn=2

Republic of Turkey, Ministry of Environment and Forestry, 2011. *National Experience in Carbon Markets and Future Outlook. Available at (in Turkish):* http://www.karbonkayit.cob.gov.tr/Karbon/Files/Karbon%20Piyaslar%C4%B1nda%20Ulusal%20Deneyim%20ve%20Gelece%C4%9Fe%20Bak%C4%B1%C5%9F.pdf

Republic of Turkey, Ministry of Environment and Urbanism, 2011. National Climate Change Action Plan, 2011-2023. Available at: http://iklim.cob.gov.tr/iklim/Files/IDEP/%C4%B0DEPENG.pdf

Republic of Turkey, Ministry of Environment and Urbanism, 2011. Turkey's National Climate Change Adaptation Strategy and Action Plan (Draft). Available at: http://www.undp.org.tr/energEnvirDocs/00058944_Draft%20Climate%20Change%20Adaptation%20Strategy.pdf

Republic of Turkey, Prime Ministry Undersecretariat of State Planning Organization, 2009. *Electricity Energy Market and Supply Security Strategy (to the* Ministry of Energy and Natural Resources). Available at: http://www.enerji.gov.tr/yayinlar_raporlar_EN/Arz_Guvenligi_Strateji_Belgesi_EN.pdf

Republic of Turkey, Turkish Statistical Institute, 2012. National Greenhouse Gas Inventory Report (1990-2010). Available at: http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/6598.php

Rose K. Steven, Ahammad Helal, Eickhout bas, Fisher Brian, Kurosawa Atsushi, Rao Shilpa, Riahi Keywan, van Vuuren P. Detlef, 2012. Land-based mitigation in climate stabilization. Energy Economics 34: 365-380.

Scheffer Roberto, Szklo Alexandre Salem, de Lucena Andre Frossard Pereira, Borda Bruno Soares Moreira Cesar, Nogueira Larissa Pinheiro Pupo, Fleming Fernanda Pereira, Troccoli Alberto, Harrison Mike, Boulahya Mohammed Sadeck, 2012. Energy sector vulnerability to climate change: A review. Energy 38, pp. 1-12.

Sirin S.M., Ege A., 2012. Overcoming problems in Turkey's renewable energy policy: How can EU contribute?, Renewable and Sustainable Energy Reviews, Volume 16, Issue 7, September 2012, Pages 4917–4926

Tahmiscioğlu M.S., Karaca Ö., Özdemir A.D., Özgüler H., 2006. International Conference on Climate Change and the Middle East Past, Present and Future, 20-23 November 2006, ITU, Istanbul. Available at: http://www.dsi.gov.tr/docs/iklim-degisikligi/possible_effect_of_the_global_climate_change_on_water_resources_and_floods_in_turkey.pdf?sfvrsn=2

Topkaya Sermin Oguz, 2012. A discussion on recent developments in Turkey's emerging solar power market. Renewable and Sustainable Energy Reviews 16, pp. 3754– 3765.

Turkish Electricity Transmission Corporation (TEIAS), Research Planning and Coordination Department, 2012. Turkish Electrical Energy 10-Year Generation Capacity Projection (2010-2020). Available at (in Turkish): http://www.teias.gov.tr/projeksiyon/KAPASITEPROJEKSIYONU2011.pdf

United Nations, Department of Economic and Social Affairs, 2011. World Population Prospects – The 2010 Revision, Volume I: Comprehensive Tables. Available at: http://esa.un.org/unpd/wpp/Documentation/pdf/WPP2010_Volume-I_Comprehensive-Tables.pdf and http://esa.un.org/unpd/wpp/Documentation/pdf/WPP2010_Volume-II_Demographic-Profiles.pdf

Yano Tomohisa, Aydin Mehmet and Haraguchi Tomokazu, 2007. Impact of Climate Change on Irrigation Demand and Crop Growth in a Mediterranean Environment of Turkey. *Sensors* **2007**, *7*, 2297-2315