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LOW CARBON DEVELOPMENT PATHWAYS AND PRIORITIES FOR TURKEY

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LOW CARBON DEVELOPMENT PATHWAYS AND PRIORITIES FOR TURKEY

Climate-Friendly Development in Turkey: A Macro Level Evaluation

Contents

TURKEY ACCOUNTS FOR 0.94% OF GLOBAL EMISSIONS. SINCE 1990, IT HAS INCREASED ITS GHG EMISSIONS BY 110.4%.

FOREWORD

The average global temperature rose by 0.85°C from 1880 to 2012. Climate scientists indicate that this increase has been caused by human activities. Should greenhouse gas emissions continue to increase at its current rate, the temperature rise may reach 4°C in 2060, and 6°C in 2100. Parties to the United Nations Framework Convention on Climate Change (UNFCCC), including Turkey, officially acknowledged this scientific fact and set the limit for the temperature increase at 2°C in an effort to constrain the effects of the temperature rise on natural and human systems.

Scientists and decision makers agree that climate change is one of the most serious problems facing humankind.

195 contracting states to the UNFCCC will meet in Paris in December 2015 to find a solution to this problem and to negotiate the new climate agreement that is intended to replace the Kyoto Protocol after 2020.

Prior to the Climate Summit to be held in Paris at the end of this year, each country was invited to determine, in accordance with its historical responsibility in the GHG emissions growth and with its current capacity, its national contributions to meet the 2°C target and to safeguard ecosystems and communities from the devastating impacts of climate change.

Turkey's GHG emissions amount to 4‰ of the cumulative historical global emissions and to 0.94% of the global emissions in 2013. Turkey is not among the biggest polluters. However, it has increased its emissions by 110.4% since 1990. As it attempts to determine its national contribution to climate change mitigation, Turkey faces three critical questions:

1. What responsibility lies with Turkey within the scope of the 2°C target, and what could its emission reduction target be?
2. What policies could be pursued in order to achieve the required emission reduction?
3. What kind of an impact could these policies have on macroeconomic indicators? What are the costs of implementing and not implementing these policies?

This study, prepared with the collaboration of Istanbul Policy Center and the precious contributions of Prof. Dr. Erinç Yeldan and Assoc. Prof. Dr. Ebru Voyvoda, seeks answers to the above-mentioned questions. The results of this analysis suggest that Turkey can keep its GHG emissions in check and better manage risks including those pertaining to energy security and import dependence in energy by initiating a transformation in its emission intensive industries with a focus on renewable energy sources and energy savings. In this regards, timing is of key importance. The sooner the transformation is initiated, the more positive impacts it will have on the economy.

The success of climate change mitigation efforts will depend not only on actors such as the U.S. and China, but also on developing countries like Turkey, whose emissions are rapidly increasing. We hope that this study will light the way for the parties and decision makers that have a say in climate change policies.

Uğur Bayar
Chairman of the Board of Directors
WWF-Turkey

THE INTERNATIONAL ENERGY AGENCY WARNS THAT TWO THIRDS OF FOSSIL FUEL RESERVES SHOULD REMAIN UNDERGROUND IN ORDER TO LIMIT THE GLOBAL TEMPERATURE RISE TO 2°C.

FOREWORD

In addition to being the most important ecological problem threatening our planet and the future of humanity, climate change deeply impacts the global economy. According to the International Energy Agency (IEA), the fact that 80% of global energy supply is provided by fossil fuels and the growing energy demand lead to a continued rise in GHG emissions. The IEA warns that two thirds of the world's fossil fuel reserves should remain underground and a structural transformation towards low carbon technologies should be initiated in order to limit the temperature rise to 2°C.

Undoubtedly, climate change is one of the most serious problems of the globalizing world. Then, how are we going to mitigate climate change? What can we do? For the success of mitigation efforts, we need to halt, at the global level, the tendency of economic growth and social development to follow the same trajectory as the GHG emissions growth. In other words, we need to decarbonise the economy. To that end, we should enhance energy efficiency, eliminate fossil fuel subsidies and increase the share of renewables including wind and solar energy in the power production mix.

Turkey's historical responsibility in climate change inducing GHG emissions is low, but it is a country with rapidly increasing emissions. Due to the accelerating increase in developing country emissions in recent years, emission reductions merely in industrialized Western countries are no longer sufficient for climate change mitigation. For this reason, Turkey should constrain, alongside other developing countries with rapidly growing economies including China and India, its fossil fuel use and GHG emissions, and contribute to international climate policies.

Even though Turkey has, to date, made significant preparations towards climate change mitigation, it has neither been able to keep the growing GHG emissions in check, nor has it played an active role in international climate policies. However, as also stated by President Erdoğan in his speech at the United Nations Climate Change Leaders' Summit in New York in 2014, Turkey has been preparing to take part in and make its national contribution to the new climate regime to be agreed on at the Conference of the Parties, which will be held in Paris at the end of this year.

It is of utmost importance that countries base their emission reduction targets for climate change mitigation on scientific research and measure the economic implications of the necessary policy instruments. In these efforts, it is also vital that contributions from all relevant parties, including state institutions and organizations, academics, specialists, business circles and civil society, be ensured. Innovative, realistic, viable and effective policies can be designed only through filtering the required results from a wide range of analyses with diverse methods.

This report, prepared with the collaboration of Istanbul Policy Center-Sabancı University Stiftung Mercator Initiative and WWF-Turkey, sets off to realize this goal. The findings of the long researches and analyses carried out by two valuable researchers, Prof. Dr. Erinç Yeldan and Assoc. Prof. Dr. Ebru Voyvoda, show us that Turkey's fulfilment of its responsibility to contribute to climate change mitigation is feasible also from an economic point of view, and that a climate-friendly and decarbonising economy may pave the way for green growth in Turkey as well.

I hope this stimulating and useful report prepared with academic rigour will encourage a collective, scientific and solution-oriented debate on the issue of climate change.

Fuat Keyman
Istanbul Policy Center, Director

EXECUTIVE SUMMARY

Scientists and decision makers agree that climate change is the biggest problem ever faced by humankind. Parties to the United Nations Framework Convention on Climate Change (UNFCCC), including 195 contracting states and the European Union, will meet in Paris in December 2015 and negotiate the new climate agreement that is expected to replace the Kyoto Protocol after 2020. Prior to the 21st Conference of the Parties to the UNFCCC (COP21) in Paris, the United Nations called on each state to specify its future contributions to the efforts to keep the global average temperature rise below 2°C and to safeguard ecosystems and communities from the devastating impacts of climate change. Countries are expected to determine their contributions on the basis of their historical responsibilities in the GHG emissions growth and their current capacities.

This analysis brings up three critical questions that Turkey should seek answers to, as it attempts to determine its national contribution to climate change mitigation:

-What could Turkey's responsibility and its emission reduction target be within the scope of the 2°C target?

-What kind of a policy package could be implemented in order to achieve the required emission reduction?

- What could be the impact of these policies on macroeconomic indicators? What are the costs of implementing and not implementing these policies?

In order to avoid the devastating impacts of climate change, global carbon emissions should not exceed 2,900 $GtCO_2$. This is referred to as the carbon budget. 65% of this budget (that is, 1,900 $GtCO_2$) had been used up as of 2011. Should the current upward trend in emissions continue, the remaining 1,000 $GtCO_2$ will have been emitted before 2050. To stay within the 2°C target, global carbon neutrality will need to be achieved sometime between 2055 and 2070, and total global greenhouse gas emissions need to shrink to net zero some time between 2080 and 2100.

This study identified Turkey's share in the remaining carbon budget based on "minimum historical responsibility" and "maximum development needs". In this respect, in order to fulfil its responsibility within the scope of the 2°C target, Turkey should reduce its cumulative carbon emissions by 2,980 $MtCO_2$ until 2030 relative to the reference scenario.

Projections suggest that Turkey's CO_2 emissions, which amounted to 363 $MtCO_2$ in 2013, will reach 851 $MtCO_2$ by 2030 under high growth scenarios, and 659 $MtCO_2$ by the same year under realistic growth scenarios. In this study, high growth scenarios will be assessed under the Official Plans Scenario, and more realistic growth scenarios under the Business-as-Usual (BaU) Scenario.

In order for Turkey to fulfil its responsibility regarding the 2°C target, its annual CO_2 emissions should reach a peak level of 390 $MtCO_2$ by 2020, and gradually decrease thereafter down to 340 $MtCO_2$ (the 2010 level) by 2030.

What policy instruments Turkey will employ to meet the 2°C target and what kind of macroeconomic implications these policy instruments will have are the key questions that call for answers with respect to the formulation of climate policies. Under a scenario called the "Climate Policy Package", this analysis identified three main policy instruments :

-Carbon tax.

-Use of carbon tax revenues for electricity generation from renewables by means of a renewable energy investment fund.

-Autonomous efficiency gains (i.e., depending on technological advances and market conditions, and not on any deliberate energy efficiency policies).

If these policy tools are put into practice, the annual CO_2 emissions might be 506 $MtCO_2$ in 2030. This is 23% less than the level projected regarding the Business-as-Usual Scenario. This means that it is possible to ensure a 20% decrease in the carbon emission intensity (annual CO_2 emissions/GDP) of the economy.

Under the Climate Policy Package, the level of CO_2 emissions in 2030 is estimated to be 40% lower than the projections regarding the Official Plans Scenario. This proves the critical importance of the assumptions made when identifying a reference emission growth pathway. When assessing the contributions of countries that adopt a baseline scenario target, one should consider how realistic and sound the emission values projected in the reference scenario are.

The Climate Policy Package entails a notable transition from natural gas and coal to solar and wind energy in the energy mix. It foresees that this transition will lead to a 25% decline in coal imports and a 35% decline in natural gas imports, relative to the reference scenario.

The gains cited above come with a cost. According to the results of the model, the GDP growth in the period leading up to 2020 will be 3.3%, instead of 4%, as a consequence of the policy package. It is estimated that the gap between the projected growth rates regarding the Climate Policy Package and those regarding the reference scenario will narrow after the year 2025, eventually disappearing in 2030.

The model results point to a decline in employment rates parallel with the decline in the GDP growth rates. It may be possible to regulate the distribution of national income through social policy packages and to mitigate the negative impacts by managing the fluctuations in employment.

The analysis indicates that the marginal cost of abating 1 kg CO_2 hovers around 7 and 23 US$ cents. This is rather a marginal cost considering that an emission reduction of up to 25% relative to the reference scenario can be achieved at the cost of a tax burden corresponding to 1.2% of the total GDP. Given the benefits of such a structural transformation that will reduce dependence on imported coal and gas in the energy mix and expedite the transition from fossil fuels to domestic renewable sources, this cost may be regarded as fairly reasonable.

Under the “Climate Policy Package”, it will be possible to reduce carbon emissions by a total of 1,965 $MTCO_2$ in comparison to the reference scenario. In other words, the policy measures included in this package will enable Turkey to realize, by 2030, two thirds of its fair share of emission reductions regarding the 2°C target.

The policy tools included in the “Climate Policy Package” are adequate for keeping the emissions level in line with the 2°C target through to the year 2020. In order to meet the 2°C target, emissions should reach a “peak point” around 2020, and start to decline thereafter. To fully achieve this goal, it is necessary to adopt additional policy measures and practices. Towards this end, sector-based analyses and studies should be conducted in such areas as industry, transport, waste management, and energy efficiency.

Turkey’s role in and sway on the new climate regime will be defined by the adaptation and mitigation policies it will implement at the national and local levels, as well as by the emission reduction target it will declare. In this context, a holistic approach to mitigation and adaptation policies is called for. Tools such as earmarking a portion of the prospective carbon tax revenues for reducing vulnerability towards climate change at the local level may contribute to achieving such coherence.

Climate finance is not among the policy tools included in the “Climate Policy Package”. If, in the new international climate regime, Turkey benefits from international climate finance for meeting its emission reduction targets, the adverse economic consequences of emission reduction may be mitigated.

Scientists claim that taking swift measures to reduce GHG emissions is vital for avoiding both the devastating impacts and the economic losses to be caused by climate change. The results of the analysis show that early action is of critical importance for Turkey , as well. If Turkey defers the implementation of emission reduction measures of the “Climate Policy Package” up until 2020, it may face “negative” growth rates after the year 2024, in order to be able to fulfil its responsibility regarding the 2°C target. By immediately putting into practice the emission reduction policies, on the other hand, it will be possible to maintain the economic growth, though with some degree of decline in the GDP growth rate. This may be interpreted as suggesting that the “green growth” approach is adequate and feasible for Turkey as well.

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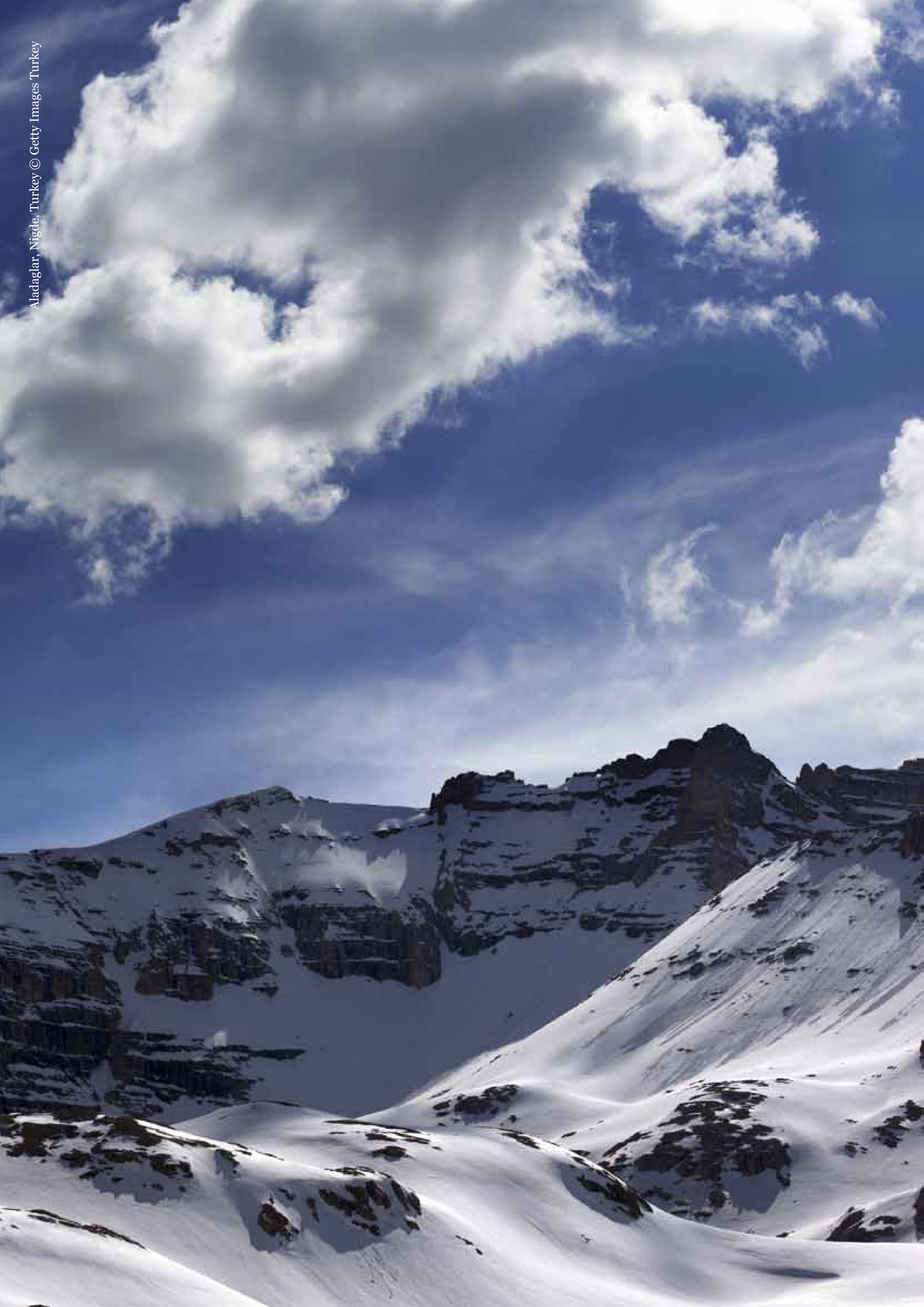
PART 1:

CLIMATE CHANGE AND TURKEY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CLIMATE CHANGE AND TURKEY

Climate Change

0.85°C
AVERAGE GLOBAL TEMPERATURE RISE SINCE 1880

It is indisputable that global temperatures are on the rise due to human activities. From 1880 to 2012, the average global temperature rose by 0.85°C.[1] In this period almost all the ocean and land areas warmed up. 2014 was the warmest year since instrumental temperature measurement was first introduced in 1880[2], and 14 of the 15 warmest years on record have occurred in the 21st century.[3]

Consistent changes are taking place in the climate system as a whole due to global warming; snow mantle and glaciers are shrinking, sea levels are rising and precipitation regimes are changing as land and sea temperatures are increasing.[4] “Human-induced (anthropogenic) climate change”, which emerged in the wake of the industrial revolution and has gradually accelerated in the last 40 years, is caused by growing greenhouse gas concentrations in the atmosphere. Atmospheric concentrations of carbon dioxide, methane and nitrous oxide, which are the main greenhouse gases, have reached a level that is unprecedented 800 thousand years. Carbon dioxide concentrations have increased by more than 40% compared to pre-industrial levels (approximately 280 ppm [ppm: parts-per-million]) exceeding 400 ppm in 2014. The primary reason for this is the burning of fossil fuels (coal, oil, natural gas), while the second reason is the emissions generated by land use change (deforestation, agriculture, etc.).

Emissions Trends

According to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC), 40% of the total human-induced GHG emissions released to the atmosphere since the industrial revolution have occurred in the last 40 years. Despite the need to reduce and eventually eliminate emissions so as to mitigate climate change, a drastic increase is observed in annual global emissions. Global emissions, which displayed an average annual increase of 1.3% between 1970 and 2000, rose by 2.2% between 2000 and 2010.
The main driving force behind this increase is the fossil fuel use and industrial processes. While 65% of the total emissions in 2010 were generated by the fossil fuel use and industrial processes, the IPCC revealed that these two factors were responsible for 78% of the emissions growth between 1970 and 2010.

Source: IPCC, 2014. Fifth Assessment Report, Working Group III Contribution: Mitigation of Climate Change. http://mitigation2014.org/report/summary-for-policy-makers

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[1] Intergovernmental Panel on Climate Change. CLIMATE CHANGE 2013: The Physical Science Basis Summary for Policymakers. https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WGIAR5_SPM_brochure_en.pdf
[2] http://www.ncdc.noaa.gov/sotc/summary-info/global/201412
[3] https://www.wmo.int/media/?q=content/warming-trend-continues-2014
[4] Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report Working Group I. “Climate Change 2013: The Physical Science Basis” https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WGIAR5_SPM_brochure_en.pdf

Impacts of Climate Change

x3

THE NUMBER OF METEOROLOGICAL, HYDROLOGICAL AND CLIMATIC DISASTERS ALMOST TRIPLED ALL AROUND THE WORLD BETWEEN 1980 AND 2014

Among the major observed impacts of climate change are extreme weather and climate events, rising of sea levels, considerable shrinking of glaciers in the North Pole, Greenland and Antarctica, and rising temperatures and acidification in oceans.[5] According to the IPCC's Fifth Assessment Report, climate change has affected in an irreversible way the habitats of many land, sea and freshwater dwelling species. Due to changes in precipitation regimes and melting of snow/ice mantles in many regions of the world, hydrological systems have also changed, and water resources have deteriorated both in quantity and quality. Adverse effects of climate change on agricultural products will be much greater and more pervasive than its positive effects.[6] As a matter of fact, the number of meteorological, hydrological and climatic disasters (sudden precipitations, floods, strong hurricanes, dry spells, heat waves, etc.) tripled between 1980 and 2014.[7]

If no measure is taken and the current trends in emissions levels persist, the temperature rise is likely to exceed the 2°C danger threshold in the coming years. The temperature rise may reach 4.8°C by the end of the 21st century.[8] Scientists suggest that even if the anthropogenic GHG emissions were reduced to zero today, changes in the climate system and their potential impacts would prevail. Nevertheless, a rapid and immediate reduction in global emissions may keep the temperature rise below 2°C. Continuing rise in emissions and temperatures, on the other hand, will increase the risk of occurrence of abrupt and irremediable climate events.

Anticipated Impacts of Climate Change according to the IPCC's Fifth Assessment Report[9]

- Deaths and injuries in small island states, on other small islands and in coastal areas due to hurricanes, floods and sea level rise; damages to settlements.
- Damages to settlements and serious illness threats to city-dwelling populations due to sudden flooding.
- Systemic risks due to extreme weather events leading to serious damages to and/or total destruction of infrastructure systems and the consequent disruption of services such as electricity, water supply, and health and emergency services.
- Increased mortality and morbidity rates during periods of extreme heat among vulnerable sections of urban populations (elderly population, those with respiratory problems, etc.) and those working outdoors in urban and rural areas.
- Breakdown of food supply systems and increased risk of food insecurity particularly among poorer populations due to warming, droughts, floods, and precipitation variability and extremes.
- Loss of livelihoods particularly among subsistence farmers and peasants in semi-arid regions due to insufficient access to drinking and irrigation water and reduced agricultural production.
- Degradation of land and freshwater ecosystems and of biodiversity and ecosystem services they provide for populations living in these areas.

[5] Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report Working Group I. "Climate Change 2013: The Physical Science Basis" https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WGIAR5_SPM_brochure_en.pdf
[6] Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report Working Group II. "Climate Change 2014: Impacts, Adaptation, and Vulnerability" http://ipcc-wg2.gov/AR5/images/uploads/IPCC_WG2AR5_SPM_Approved.pdf
[7] Munich RE, Geo Risks Research, NatCatSERVICE - As at January 2015
[8] Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report Working Group I. "Climate Change 2013: The Physical Science Basis" https://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WGIAR5_SPM_brochure_en.pdf
[9] Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report Working Group II. "Climate Change 2014: Impacts, Adaptation, and Vulnerability" http://ipcc-wg2.gov/AR5/images/uploads/IPCC_WG2AR5_SPM_Approved.pdf

How is Turkey Impacted by Climate Change?

The Mediterranean Basin, including Turkey, is one of the regions most vulnerable to climate change. Major impacts of climate change that have been observed in Turkey up until today are as follows:

- Temperatures have risen all over Turkey in the last 42 years. Higher rates of increase have been observed in summer temperatures compared to other seasons. Warm periods have expanded also in temporal terms.[10]
- An approximately ten-meter annual retreat of mountain glaciers has been observed in the last 50-60 years.[11]
- Peak run-off of snow-fed rivers has shifted to a week earlier than its regular time in the last 40 years.[12]
- The sea levels have risen.[13]

Temperatures are expected to rise in all parts of the country and in all seasons, and the rates of increase in summer temperatures are expected to be higher than in winter temperatures. In addition, it is predicted that Turkey's already limited water resources will be under further stress. Other possible impacts of climate change on Turkey are as follows:

- Lower precipitation rates are expected in the southern regions of Turkey. A slight increase may be observed in its northern and particularly north-eastern regions.
- Rising sea levels may lead to the submergence of river deltas (such as Çarşamba, Bafra, and Çukurova) and of low-lying areas of coastal cities; one-meter rise in global sea levels may affect 3 million individuals in Turkey.[14]
- Regions suffering from water stress may expand in Turkey; 45% of the population may confront water scarcity by the end of the century.[15]
- Higher precipitation rates in the Eastern Black Sea region may increase the risk of landslides.
- Anticipated shrinking of the snow mantle may decrease the risk of avalanches.
- Periods of drought and heat wave may increase in duration and intensity due to rising temperatures and falling precipitation rates.[16]

45 % OF THE POPULATION IN TURKEY MAY CONFRONT WATER SCARCITY BY THE END OF THE CENTURY DUE TO CLIMATE CHANGE

[10] Şen, Ömür Lütfi., Bozkurt, Deniz., Göktürk, Ozan Mert., Dündar, Berna. and Altürk, Bahadır. 2012. "Türkiye'de İklim Değişikliği ve Olası Etkileri" http://ipc.sabanciuniv.edu/en/wp-content/uploads/2012/10/Bildiri_Omer_L_Sen_vd_2013.pdf
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[13] Demir, Coşkun., Yıldız, Hasan., Cingöz, Ayhan., and Simav, Mehmet. 2005. Türkiye Kıyılarında Uzun Dönemli Deniz Seviyesi Değişimleri, p.13, Fifth National Coastal Engineering Symposium, 5-7 May, Bodrum.
[14] Leo Meyer, IPCC Fifth Assessment Report Synthesis Report, Bogazici University, 10 September 2015, IPCC Outreach Event Istanbul, Turkey http://ipcc.ch/apps/outreach/documents/301/1441858899.pdf
[15] Met Office, Climate observations, projections and impacts: Turkey, Devon, 2011
[16] Ömer Lütfi Şen, A Holistic View of Climate Change and Its Impacts in Turkey, Istanbul Policy Center, December, 2013

2°C Target/Remaining in the Safe Zone

Impacts of climate change such as rising sea levels, ocean acidification, melting of glaciers, and increased frequency and intensity of extreme weather and climate events such as droughts, floods, and strong hurricanes, pose serious risks to human communities as well as to plants, animals and ecosystems.

2°C

THE AVERAGE TEMPERATURE RISE SHOULD BE KEPT BELOW THIS THRESHOLD SO AS TO AVOID DEVASTATING EFFECTS OF CLIMATE CHANGE

Scientists assert that the average temperature rise should be limited to 2°C in order to avoid the devastating impacts of climate change. Failing to stay within this limit is expected to cause pervasive and irremediable impacts on all ecosystems and human communities. The 2°C target was accepted by all countries under the 2010 Cancun Agreements, and subsequently all emission reduction negotiations are conducted in line with this target. To meet this target, atmospheric CO_2 levels, which have risen by 40% (from 280 ppm to 400 ppm [ppm: parts-per-million]) in the last 250 years, should remain below 450 ppm.

Average global temperatures have, to date, risen by 0.85°C. If the current rate of increase in GHG emissions persists, the temperature rise may reach 4°C in 2060[17], and 6°C in 2100[18]. IPCC states that in order to keep global warming below the 2°C threshold, structural changes should be made in the global energy system, thereby ensuring considerable GHG emission reductions within the shortest time possible. It is underlined that to stay within the 2°C target, global carbon neutrality will need to be achieved sometime between 2055 and 2070, and total global greenhouse gas emissions need to shrink to net zero some time between 2080 and 2100**.[19] Accordingly, the share of low carbon energy sources in electricity generation should exceed 90% by 2050.

The International Energy Agency (IEA) also emphasizes that in order to stay within the to 2°C target, two thirds of the world's fossil fuel reserves should remain underground.[20] The IEA warns that our dependence on fossil fuel infrastructure will render energy security and climate targets harder and more costly to achieve unless a structural transformation towards clean energy and low carbon technologies is initiated by 2017.[21]

*Net Carbon Emission= Amount of carbon released to the atmosphere – Amount of carbon absorbed by carbon sinks
**Net GHG Emission= Total amount of GHG released to the atmosphere – Total amount of GHG absorbed by carbon sinks
[17] "Turn Down The Heat: Why a 4°C World Must be Avoided", World Bank, 2012. http://documents.worldbank.org/curated/en/2012/11/17097815/turn-down-heat-4%C2%B0c-warmer-world-must-avoided
[18] "Turn Down The Heat: Why a 4°C World Must be Avoided", World Bank, 2012. http://documents.worldbank.org/curated/en/2012/11/17097815/turn-down-heat-4%C2%B0c-warmer-world-must-avoided
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[20] IEA, World Energy Outlook 2012 http://www.worldenergyoutlook.org/publications/weo-2012/
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Global Climate Change Mitigation and Actions Towards It

The main objective of the United Nations Framework Convention on Climate Change (UNFCCC), which was held in Rio in 1992, was defined as "achieving stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system". From that day on, mechanisms affiliated with the UNFCCC, which was signed by 196 parties (195 states and the European Union), have served as the main processes guiding the efforts of governments towards climate change mitigation.

195

NUMBER OF PARTIES SIGNED THE UNFCCC (UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE)

The UNFCCC Conference of the Parties to be held in Paris at the end of 2015 (COP21) is of critical importance for reaching a new agreement that will replace the Kyoto Protocol after 2020. Prior to the summit, all state parties to the UNFCCC were called on to determine their national contributions (INDC – Intended Nationally Determined Contributions) and submit these to the UNFCCC Secretariat. When this report was in progress, 83 parties (111 countries if the EU countries are taken into account separately) that are responsible for the 73.7% of the world's total emissions had already submitted their national contributions to the UNFCCC.

For the success of climate change mitigation efforts, each country should identify its share regarding the carbon budget under 2°C target and its level of development, and take action in this direction. Within this framework, targets and commitments that have been or will be put forward by developing countries (such as China, India, Mexico, Turkey, and South Korea), which constitute the main driving force behind rising emissions in the recent period, bear as much importance as those adopted by developed countries (including the U.S., Australia, Japan and the EU members) which have higher historical responsibilities. With the critical Paris summit approaching, emission reduction targets declared by some of these countries are shown in Table 1.

INDC and Target Types

On the eve of the 2015 Paris Climate Conference (COP21), contracting countries have been submitting to the UNFCCC their post-2020 schemes for climate change mitigation under the title of INDC (Intended Nationally Determined Contributions). INDC's involve various types of targets for reducing GHG emissions:

- Base year target: A commitment to reduce, or control the increase of, emissions by a specified quantity relative to a base year.

- Fixed level target: A commitment to reduce, or control the increase of, emissions to an absolute emissions level in a target year.

- Baseline scenario target: A commitment to reduce emissions by a specified quantity relative to a projected emissions baseline scenario.

- Intensity target: A commitment to reduce emissions intensity (emissions per unit of another variable, typically GDP) by a specified quantity relative to a historical base year.

- Trajectory target: A commitment to reduce, or control the increase of, emissions to specified emissions quantities in multiple target years or periods over a long time period. years over the long run.

Table 1: Emission Reduction Targets Submitted by Certain Countries Prior to 2015 Paris Climate Conference (COP21)

Country	Share in Global Emissions 2012 (%)*	Share in Global Emissions (1850-2011) (%)**
U.S.	16.4%	27%
China	24.5%	11%
European Union	9.82%	25%
Russia	5.18%	8%
Japan	3.1%	4%
Mexico	1.6%	1%
Brazil		
South Korea	1.55%	<1%
Australia	1.45%	<1%

Annual Per Capita GHG Emissions (Tons)	Type of Target	Emission Reduction Target****
19.9	Base year target	- An emission reduction of 26-28% by 2025 relative to the 2005 level. - According to the U.S., this target seems consistent with the pathway leading to an 80% emission reduction by 2050.
8.1	Intensity and trajectory targets	- To reach a peak point in GHG emissions in 2030 and initiate a downward trend thereafter. - To reduce, by 2030, the economy’s carbon intensity (GDP/GHG emissions) by 60-65% relative to the 2005 level. - To increase the share of non-fossil energy sources in primary energy consumption to 20%.
8.8	Base year target	- The EU seems, in the current situation, to have started a low carbon transformation in its economy. From 1990 to this day, its economy has grown by 44% while its emissions have decreased by 19%. There has been a decrease in per capita emissions as well. - The EU’s target for the year 2030 is to reduce its emissions by at least 40% relative to the 1990 level.
16.2	Base year target	- Russia submitted a rather vague national contribution document. It proposes a reduction of 25-30% by 2030 relative to the 1990 level. This proposal, which also takes into account the carbon sink capacity of forest lands in Russia, envisages a 6-11% decrease in industrial emissions compared to 1990. - The process of economic restructuring undertaken by Russia after the dissolution of the Soviet Union in 1990 led to a significant decrease in emissions. For emissions in 2012 were 50% less than the 1990 level, the target set by Russia implies that its emissions will continue to rise. *****
10.5	Base year target	- An emission reduction of 26% by 2030 relative to the 2013 level.
6	Baseline scenario target, and Intensity and trajectory targets	- An emission reduction of 25% by 2030 relative to the reference scenario (BaU). - To reach a peak point in net emissions and initiate a downward trend starting from 2026. - To reduce the economy’s carbon intensity (GDP/GHG emissions) by 40% in the period of 2013-2030.
	Base year target	- An emission reduction of 37% by 2025 relative to the 2005 level.
13.9	Baseline scenario target	-A reduction of 37% by 2030 relative to the Business-as-Usual Scenario (BaU - 850.6 MtCO2e)****** - A section on climate change adaptation is also included in South Korea’s national contribution document.
28.5	Base year target	- An emission reduction of 26-28% by 2030 relative to the 2005 level.

* The figures in this column do not take into account the emissions generated by land use, land use change and forestry and carbon sinks. Source: World Resources Institute CAIT Database (http://cait.wri.org).
** Source: World Resources Institute: http://www.wri.org/blog/2014/11/6-graphs-explain-world%E2%80%99s-top-10-emitters
*** The figures in this column do not take into account the emissions generated by land use, land use change and forestry and carbon sinks. Source: World Resources Institute CAIT Database (http://cait.wri.org).
**** Source: Paris Contributions Data, World Resources Institute. http://cait.wri.org/indc/
***** Source: Climate Action Tracker. http://climateactiontracker.org/countries/russianfederation.html
****** Carbon dioxide equivalent (CO_2e) is a standard unit that allows quantifying greenhouse gases with differing impact levels in a common unit based on the specific impact of each gas on global warming. CO_2e signifies the amount of CO_2 which would have the equivalent global warming impact. For instance, the global warming impact of nitrous oxide is 310 times the impact of carbon dioxide. In other words, one unit of N_2O equals 310 CO_2 -equivalent. Source: Regional Environmental Center, 2009. International Local Government GHG Emissions Analysis Protocol (IEAP) http://www.rec.org.tr/dyn_files/20/4865-seragazi-kitap.pdf

Turkey and International Climate Policies

Turkey started to take part in international climate policy processes at a rather early date by participating in the Noordwijk Ministerial Conference, which was held in the Netherlands in 1989. Despite its low historical responsibility, Turkey was listed, alongside developed countries with the highest levels of historical responsibility for climate change, under Annexes I and II of the United Nations Framework Convention on Climate Change, which was opened for signature in 1992. Being concerned about the ensuing obligations relating to emission reductions and financial support to developing countries, Turkey refrained, for a long time, from signing the convention. For this reason, it participated in the Kyoto Protocol negotiations held in 1997 in an "observer" capacity.

During the UNFCCC's 7th Conference of the Parties (COP7), which was held in Marrakesh in 2001, Turkey was removed from Annex II and parties to the convention were invited to recognize the special circumstances of Turkey which place Turkey in a situation different from that of other parties included in Annex I. Following this development, Turkey became a party to the Framework Convention in 2004, and from this date on, started to participate more actively in climate policies. Turkey issued its first Greenhouse Gas Emissions Inventory in 2006 in an effort to fulfil one of the most significant obligations imposed on the parties, which requires each party to prepare its national GHG emissions inventory on a yearly basis and submit it to the UNFCCC. In 2007, Turkey prepared its first National Communication on Climate Change and established the Global Warming Research Commission at the Turkish Grand National Assembly. Following the entry into force of the Kyoto Protocol in 2005 and the opening of Turkey's EU accession negotiations the same year, public discussions on Turkey's expected approval of the Protocol intensified, consequently leading Turkey to ratify the Protocol in 2009. However, since Turkey participated in the preparations of the Kyoto Protocol as an observer, it did not undertake any emission reduction obligations at the time.

110%

RATE OF INCREASE IN TURKEY'S GHG EMISSIONS BETWEEN 1990 AND 2013

Turkey's first Greenhouse Gas Emissions Inventory, published in 2006, reported that Turkey's GHG emissions rose by 74.4% between 1990 and 2004. This rate has further increased in every new inventory because of the continuous increase in GHG emissions. Finally, the rate of emissions growth reached 110.4% in the 2015 inventory, constituting a slightly lesser rate compared to the previous year due to a change in the calculation method. Owing to these rates, Turkey has ranked first in GHG emissions growth among the Annex I countries every year since 2006. Turkey pronounced for the first time certain figures for emission reduction in the context of a prospective agreement that was supposed to be signed prior to the UNFCCC's 15th Conference of the Parties (COP15), which was held in Copenhagen in 2009. As the conference failed, however, Turkey did not again make any emission reduction commitments, nor did it endorse the Copenhagen Accord.

At the UNFCCC's 16th Conference of the Parties (COP16), which was organized in Cancún in 2010, all parties recognized Turkey's special circumstances under Annex I. Despite this development, Turkey did not join the Kyoto Protocol's second commitment period that was opened for signature in Doha in 2012. When this process was combined with Turkey's fossil fuel-oriented rapid development policies and its strategy to prioritize coal use, Turkey's efforts towards climate change mitigation waned.

When Turkey announced at the UNFCCC's 19th Conference of the Parties (COP19) in Warsaw in 2013 that it will agree to become a party to the new agreement with a flexible target to be determined on its own terms if the critical mass is reached, Turkey's climate policies entered a new phase. President Erdoğan declared, at the United Nations Climate Change Leaders' Summit in New York in 2014, that Turkey was ready to undertake its responsibility in the new process. In the lead-up to the UNFCCC's 21th Conference of the Parties (COP21) to be held in Paris in December 2015, Turkey has been preparing to contribute to international climate change mitigation efforts with a plan (INDC) it has itself drawn up for the first time.

Even though it has not set an emission reduction target throughout the international climate negotiations, Turkey has prepared strategy documents and action plans on climate change mitigation, designed sectoral policies, and realized projects on capacity building, climate change impact assessment and adaptation.

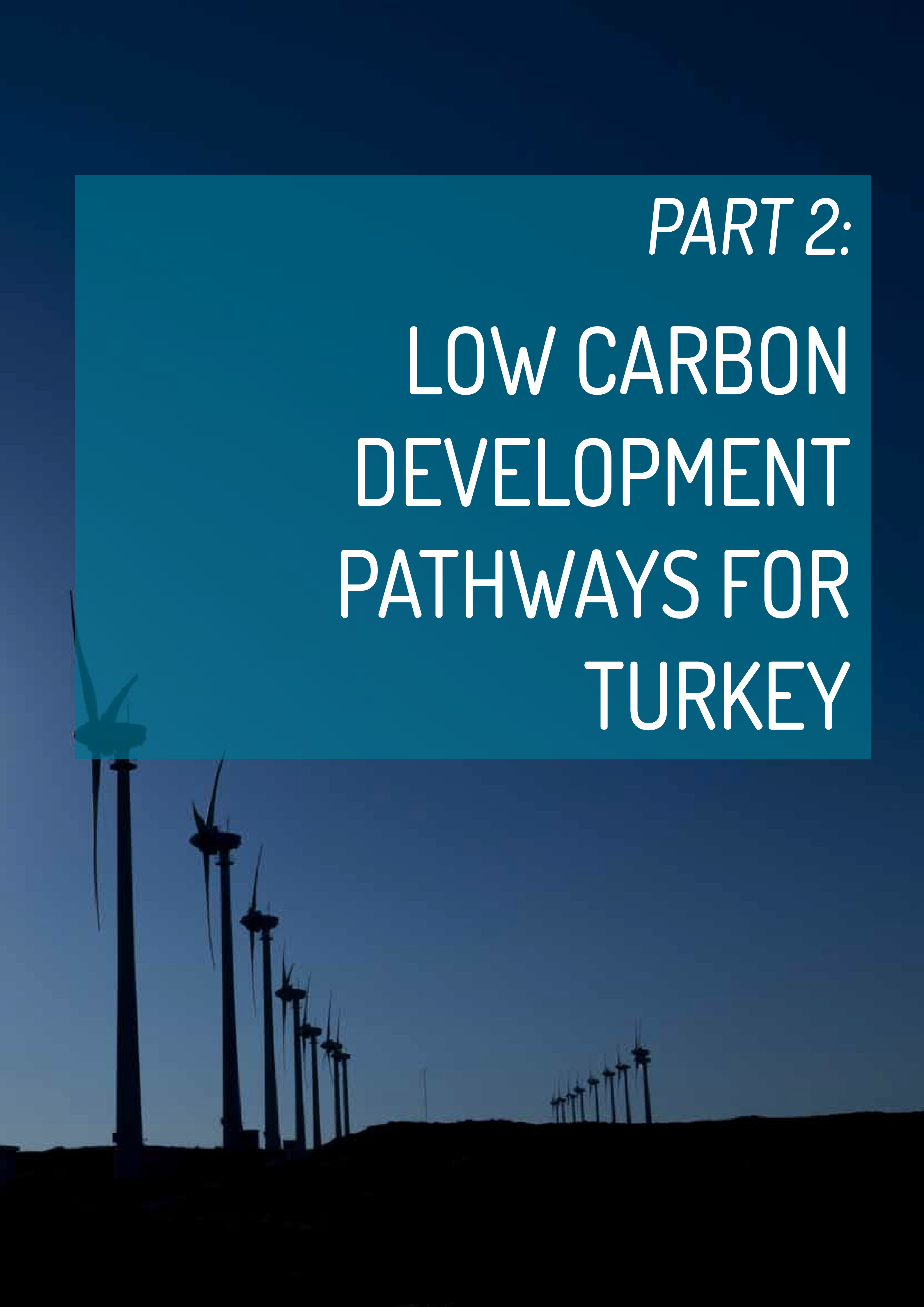
Establishing voluntary carbon markets, subsidizing renewable energy by laws and regulations, and organizing campaigns aiming to reduce, though in a limited manner, energy-generated emissions through demand management can be cited among Turkey's endeavours towards curbing GHG emissions growth. In its first National Communication on Climate Change, Turkey stated that the rise in emissions could be 7% lower by 2020. However, all these policies did not add up to a scheme that would allow an active involvement in and contribution to international climate change mitigation processes. When considered in relation to Turkey's national energy strategy based on increasing the share of coal in the energy mix, this situation suggests that Turkey does not yet pursue a concrete policy for emission reduction. The Conference of the Parties to be held in Paris in December 2015 is a crucial turning point in this respect.*

*For more detailed information on this issue, see: Şahin, Ümit. 2014. "Türkiye'nin İklim Politikalarında Aktör Haritası", Sabancı University Istanbul Policy Center. http://ipc.sabanciuniv.edu/wp-content/uploads/2014/12/AktorHaritasiRapor_25.11.14_web.pdf

Canakkale © Getty Images Turkey

PART 2:

LOW CARBON DEVELOPMENT PATHWAYS FOR TURKEY



LOW CARBON DEVELOPMENT PATHWAYS FOR TURKEY

In its Fifth Assessment Report issued in 2013, the Intergovernmental Panel on Climate Change stated with 95 percent confidence that humans are the main cause of the current global warming. The IPCC underscored that two thirds of the GHG emissions released since the industrial revolution have been generated by burning of fossil fuels and cement production.[22]

In the period between 1880 and 2012, average temperatures rose by 0.85°C. If the current rate of increase in GHG emissions persists, the temperature rise is expected to reach 2°C around the year 2030.[23] If no measure is taken, the temperature rise may reach 4°C in 2060[24], and 6°C at the end of the century[25]. Scientists claim that for avoiding the devastating impacts of climate change, the rise in average temperatures compared to pre-industrial levels should be limited to 2°C.

According to the IPCC, meeting the 2°C target requires a radical transformation in the global energy infrastructure so as to ensure significant reductions in GHG emissions in the shortest time possible. Accordingly, the share of low carbon energy in electricity production should exceed 90% by 2050. Acknowledging this scientific fact, in the G7 summit held in Germany in June 2015, G7 countries emphasized that the global economy should be decarbonised by the end of the 21th century, and to this end, both developed and developing countries should transform, in a comprehensive manner, their energy sectors up until 2050. [26]

19

TURKEY'S RANKING IN GLOBAL GHG EMISSIONS

Turkey's GHG emissions amount to 4‰ of the cumulative historical global emissions[27] and to 0.94% of the global emissions in 2013[28]. In 2012, Turkey ranked 19th in total GHG emissions in the world and 81st in per capita emissions among 182 countries.[29] With per capita emissions of 6.04 tons[30], Turkey is below the world average. The rise in Turkey's emissions since 1990 is remarkable, though. In the period between 1990 and 2013, Turkey's total annual emissions increased by 110.4%, and per capita emissions by 53%.[31]

Mitigating climate change is an issue that calls for global solutions. As also highlighted by climate scientists, meeting the 2°C target requires decarbonisation of the global economy. The sooner this requirement is fulfilled, the higher the chances of preserving life, human civilization and the ecological system on our planet will be.

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[22] Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report Working Group III. "Climate Change 2014: Mitigation of Climate Change" http://mitigation2014.org/report/summary-for-policy-makers
[23] Met Office Hadley Center. Climate risk: An update on the science. 2014 14/0479
[24] "Turn Down The Heat: Why a 4°C World Must be Avoided", World Bank, 2012. http://documents.worldbank.org/curated/en/2012/11/17097815/turn-down-heat-4%C2%B0c-warmer-world-must-avoided
[25] Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report Working Group II. "Climate Change 2014: Impacts, Adaptation, and Vulnerability" http://ipcc-wg2.gov/AR5/images/uploads/IPCC_WG2AR5_SPM_Approved.pdf
[26] 2015 G7 Summit Leaders' Declaration. https://www.g7germany.de/Content/EN/_Anlagen/G7/2015-06-08-g7-abschluss-eng_en.pdf?__blob=publicationFile&v=3
[27] World Resources Institute, 2005. Navigating the Numbers: Greenhouse Gas Data and International Climate Policy http://pdf.wri.org/navigating_numbers_chapter6.pdf
[28] World Resources Institute CAIT Climate Data Explorer, http://cait.wri.org/historical
[29] World Resources Institute CAIT Climate Data Explorer, http://cait.wri.org/historical
[30] TurkStat, Greenhouse Gas Emissions Inventory, 2013. http://www.tuik.gov.tr/PreHaberBultenleri.do?id=18744
[31] TurkStat, Greenhouse Gas Emissions Inventory, 2013. http://www.tuik.gov.tr/PreHaberBultenleri.do?id=18744

Countries that have a mutual responsibility for taking action have been carrying on climate negotiations for more than twenty years with the aim of ensuring the fair allocation of this . The Conference of the Parties (COP21) to be held in Paris in December 2015 bears particular importance. Before the Paris Conference, during which a new agreement to replace the Kyoto Protocol will be negotiated, all countries are expected to submit their INDCs to the UNFCCC Secretariat.

Turkey previously announced that it will endorse the Paris Agreement, which is expected to be signed at the end of 2015. In order to determine its INDC, Turkey should identify its share in global emission reductions on the basis of its historical and current responsibility and its right to development; specify what kind of low carbon development policies it will adopt and how it will implement these policies to ensure its reduction target; scientifically assess the costs and impacts of these reduction policies on the country's economy and how negative impacts might be mitigated.

In this research, we seek answers to three major questions in an effort to support Turkey's endeavours towards the above-mentioned goals:

1. What responsibility lies with Turkey within the scope of the 2°C target, and what could its emission reduction target be?

2. What kind of a low carbon policy package could be adopted in order to achieve the required emission reduction?

3. What kind of an impact could these policies have on macroeconomic indicators? What are the costs of implementing and not implementing these policies?

Izmir, Turkey © Şeref Yilmaz - Getty Images Turkey

Methodology

The analysis presented in this report rests on the Computable General Equilibrium model. The analysis seeks answers to the questions below:

1. What are the characteristics of economic growth and CO_2 emissions for Turkey over the medium/long run?
2. What is the appropriate policy mix for sustaining green growth under this path, given the fiscal and external constraints and specific labor market rigidities?
3. What are the possible mix of innovation technologies and tax-cum-incentive policies to enhance productivity growth and to foster employment?

An important premise in the analysis is that, in order to capture the general equilibrium effects of green policies, these will need to accompany ongoing growth-enhancing economic policies aimed at increasing the level of investment and its efficiency, achieving stronger employment generation and higher labor productivity, and other measures to enhance competitiveness and mitigate risks.

To this end, a Computable General Equilibrium (CGE) model of the Turkish economy has been developed, in order to assess the impact of a selected number of climate policy instruments and public policy intervention mechanisms, including market-based incentives designed to accelerate technology adoption and achieve higher employment and sustainable growth patterns. The study spans the 2015-2030 growth trajectory of the Turkish economy, with a detailed focus on carbon emissions from both firms and households and the relevant market instruments of abatement.

The base year for our model is 2010. The notion of a "base year" is necessary for our analytical model to "calibrate" the micro/sectorial and macroeconomic balances to the existing data.

A major source of data for this analysis is the Input/Output (I/O) statistics. The most recent I/O data for Turkey is available for 2002. This data was updated to 2010 balances using the national income data on macro aggregates.

In the model, 18 sectors have been distinguished, 17 of which are officially recognized in the I/O. The additional "Renewable Energy Sources" sector was deduced separately and was appended as a new sector to the I/O data. Renewable Energy Sources was accommodated using available data from World Energy Association, the World Input-Output Data, and independent studies. For the GHG data, the model drew on the Greenhouse Gas Inventories prepared by the Turkish Statistical Institute (TurkStat) within the scope of the UN Framework Convention on Climate Change.

Additional information on methodology may be found in the "Appendix" of this report.

Why was the Computable General Equilibrium Model Preferred?

Alternative approaches to energy-economy-environment modelling are mainly categorized into four: top-down, bottom-up, hybrid and econometric approaches.

The most commonly used tool of the top-down approach is the computable general equilibrium (CGE) modeling. This model enables the representation of the macroeconomic structure of the country under analysis, thus allowing the observation of the impact of any policy change on the scale of the entire economy.

On the other hand, these models lack statistical background in the standard calibration process. Besides, these models generally omit explicit capital representation of the energy sector as they use economic variables in an aggregated manner; hence they are considered weak in representing the technological restrictions in detail. Moreover, top-down approaches are based on past data and assume rational agents so that they are also weak in representing inter-fuel substitution possibilities. As a result, top-down approaches tend to overestimate the cost of mitigation options.

This study aims to understand the macroeconomic implications of GHG emission reduction targets related climate change policy instruments that could be employed to achieve these targets. Therefore, it was based on the General Equilibrium Model. When assessing its results, the model's tendency to overestimate the cost of relevant mitigation policy instruments should be taken into consideration.

Carbon Budget For the 2°C Target: What Could Turkey's Emission Reduction Target Be?

The term carbon budget signifies the total amount of global GHG emissions that the atmosphere can "tolerate" in a given time period, or in other words, that will allow keeping the average temperature rise below 2°C. According to the Fifth Assessment Report issued by the Intergovernmental Panel on Climate Change, in order to keep global warming below 2°C, the maximum amount of green house gases that can be emitted since the industrial revolution, namely the global carbon budget, is likely[32] to be 2900 $GtCO_2$ (Figure 1). 1900 $GtCO_2$ (65%) of this budget had been used up until 2011.[33] Current emission trends indicate that the remaining 1000 $GtCO_2$ will have been emitted to the atmosphere before 2050.[34] In order to meet the 2°C target, , global carbon neutrality will need to be achieved sometime between 2055 and 2070[35] and total global greenhouse gas emissions need to shrink to net zero some time between 2080 and 2100[36] (Figure 2).

65%

PERCENTAGE OF THE CARBON BUDGET THAT HAS BEEN USED UP SINCE THE INDUSTRIAL REVOLUTION

Figure 1: Global Carbon Budget

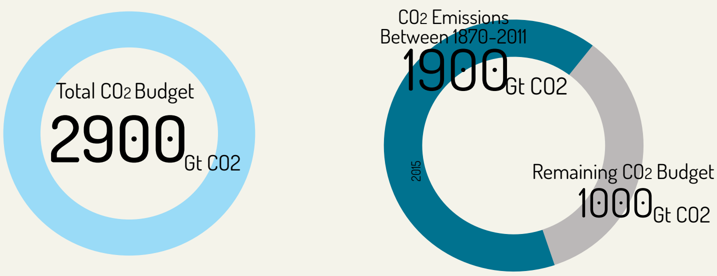
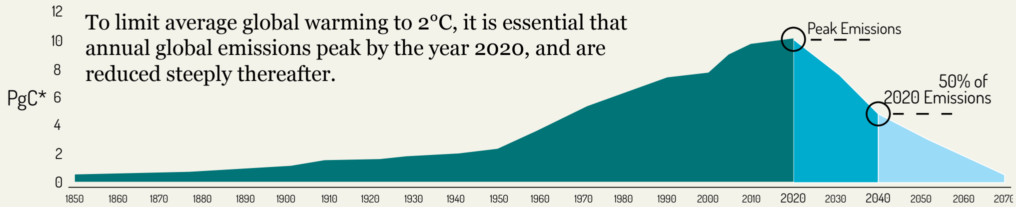


Figure 2: Global Carbon Emission Reduction Curve to Remain Below 2°C Threshold



*1 PgC (petagrams of carbon) = 1 GtC (gigatons of carbon) = 3.67 GtCO2 (gigatons of carbon dioxide)

Source: http://www.wri.org/ipcc-infographics

Peak Emissions

According to climate science, global carbon neutrality will need to be achieved sometime between 2055 and 2070, and total global greenhouse gas emissions need to shrink to net zero some time between 2080 and 2100. On the other hand, however, the upward trend in global emissions continues. When and at what level emissions growth will be halted (peak emissions), and how rapidly emissions will be reduced thereafter are crucial factors that will spell the success of efforts towards the 2°C target.

[32] In the IPCC terminology, the following terms are used to express the likelihood of occurrence of an outcome based on expert views: Virtually certain > %99, Extremely likely > %95, Very likely > %90, Likely> %66, More likely than not > %50, Unlikely < %33 Very unlikely < %10, Extremely unlikely < %5.
[33] Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, "Climate Change 2014: Synthesis Report" http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf
[34] Understanding the IPCC Reports, World Resources Institute. http://www.wri.org/ipcc-infographics
[35] Net carbon emission = Amount of carbon released to the atmosphere – Amount of carbon absorbed by carbon sinks
[36] UNEP Emissions Gap Report, 2014. http://www.unep.org/publications/ebooks/emissionsgapreport2014/portals/50268/pdf/EGR2014_EXECUTIVE_SUMMARY.pdf

TURKEY'S FAIR SHARE IN THE GLOBAL CARBON BUDGET AND EMISSION REDUCTION TARGETS WAS DETERMINED ACCORDING TO ITS "MINIMUM HISTORICAL RESPONSIBILITY" AND "MAXIMUM DEVELOPMENT NEEDS"

This picture, depicted by climate scientists, indicates that the entire global economy, including both developed and developing countries, should take part in this transformation. Accordingly, countries should determine their share on the basis of a range of indicators that include historical emissions and levels of development.

In an effort to establish Turkey's share in the global carbon budget in reference to its historical and current emission trends, its economic structure and level of development, and thus find out what kind of an emission reduction commitment it may face, this study employed the "Climate Equity Reference Calculator" (CERC) designed by the Stockholm Environment Institute and EcoEquity.[37]

In order to determine the global carbon budget, the CERC based calculation rested on the "2°C Pathway", which is also consistent with the reference pathway contained in UNEP's Emissions Gap Report.

Turkey is a G20 country that has a low historical responsibility due to its late economic development and has not undertaken any commitment during the first commitment period of the Kyoto Protocol. On the other hand, however, it has a high level of dependence on fossil fuels in energy production and a high economic growth rate as of today. Having increased its total emissions by 110.4% since 1990, Turkey will determine its contribution to the international efforts for climate change mitigation in accordance with the principle of "common but differentiated responsibilities" and of its position to date as "a developing country with special circumstances" under Annex I. For this reason, Turkey's fair share of the global carbon budget and of emission reduction targets was assessed on the basis of "minimum historical responsibility" and "maximum development needs".

Climate Equity Reference Calculator (CERC)

The CERC is an online climate equity reference tool designed to determine each country's "fair share" of the global carbon budget and the global climate mitigation effort. In order to ensure the fair sharing of the carbon budget and the mitigation responsibility, this tool rests on the UNFCCC's principles of "equity" including adequacy, common but differentiated responsibilities and capabilities, and fair access to sustainable development. The calculator enables the user to specify a given country's "responsibility" in emissions growth and its "national capacity" for emission reduction. With this tool, the relevant country's fair share of the global carbon budget allowed to meet the 2°C can be calculated on the basis of such parameters as current demographic and macroeconomic indicators, historical responsibility in emissions, and present national capacity.

With the CERC, the user selects from among three separate emission reduction pathways (1,5°C, 2°C and G8 pathways, from the most ambitious to the least), and among various assumptions regarding the responsibility of the country under analysis in historical emissions and its capacity for emission reduction, or in other words, its national income. Based on these selections, the tool delivers an emission projection for the relevant country revealing the country's fair share in global emission reduction efforts, according to its historical responsibility and its income level.

For more information: http://climateequityreference.org/calculator-about/

[37] Climate Equity Reference Calculator, http://climateequityreference.org/calculator-about/

Scenarios: What Direction Will Turkey's GHG Emissions Take?

Turkey's GHG emissions rose by 110.4% in the period between 1990 and 2013. During the same period annual per capita emissions displayed an increase of 53%, rising from 3.96 tons to 6.04 tons. With increase rates of over 130%, energy and industry were the main sectors that drove emissions growth in this period. Emissions generated by electricity production grew by 236%, increasing the share of electricity production in total emissions from 15% to 25%.[38]

Projections for the future vary. Variations in economic growth predictions lead to discrepancies in emissions growth projections. One thing is for certain though; for the success of climate change mitigation efforts, curbing emissions growth is a must. In this regard, the analysis sets forth three different emissions growth scenarios:

1 BILLION TONS

TURKEY'S ESTIMATED TOTAL GHG EMISSIONS BY 2030 UNDER OFFICIAL PLANS SCENARIO

1. Official Plans Scenario

Given the economic growth rates targeted by Turkey's official economic program (a real annual GDP growth rate of 5% in the medium term), annual GHG emissions, which amounted to 459 million tons CO_2e* in 2013, are projected to increase to over 1 billion tons CO_2e* in 2030 under a scenario where no new policy measure to reduce emissions is implemented (Figures 3-6). This trend constitutes the backbone of the Official Plans Scenario. Under this scenario, annual CO_2 emissions are predicted to rise to the level of 851 million tons by 2030, with the cumulative CO_2 emissions in the 2010-2030 period totalling 11.58 billion tons.

2. Business-as-Usual (BaU) Scenario

This scenario rests on growth projections that are more realistic and more consistent with the recessionary tendencies in the global and national economy (an average annual GDP growth rate of 3.45% during the period). Under this scenario where, again, no new policy measure to reduce emissions is taken, total GHG emissions are envisaged to rise from the 2013 level of 459 million tons CO_2e up to 787 million tons by 2030 (Figures 3, 4, and 6). This projection is referred to as the Business-as-Usual Scenario (BaU) in this analysis. According to this scenario, annual CO_2 emissions are predicted to increase to 659 million tons by 2030, with the cumulative CO_2 emissions in the 2010-2030 period exceeding 10.67 billion tons.

The analysis presented in this report employs the Business-as-Usual Scenario which is more likely to occur in the light of the current global economic developments, as the reference scenario. It should be underlined that unrealistically high emissions growth projections under the Official Plans Scenario entail the risk of over estimating emission reduction targets.

Details of emission projections under different scenarios are shown in Table 4 on page 37.

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* Carbon dioxide equivalent (CO_2e) is a standard unit that allows quantifying greenhouse gases with differing impact levels in a common unit based on the specific impact of each gas on global warming. CO_2e signifies the amount of CO_2 which would have the equivalent global warming impact. For instance, the global warming impact of nitrous oxide is 310 times the impact of carbon dioxide. In other words, one unit of N_2O equals 310 CO_2 -equivalent. Source: Regional Environmental Center, 2009. International Local Government GHG Emissions Analysis Protocol (IEAP) http://www.rec.org.tr/dyn_files/20/4865-seragazi-kitap.pdf

[38] TurkStat, Greenhouse Gas Emissions Inventory, 2013. http://www.tuik.gov.tr/PreHaberBultenleri.do?id=18744

GHG Emissions and CO2 Emissions

Turkey's GHG emissions inventory includes emissions of direct and indirect greenhouse gases that are generated by energy, industrial processes and product use, agricultural activities and waste. Direct greenhouse gases included in the inventory are carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and F-gases, and the indirect greenhouse gases are nitrogen oxides (NO_x), non-methane volatile organic compounds (NMVOC), carbon monoxide (CO), and sulphur dioxide (SO_2).[39] CO_2 is the most potent greenhouse gas, and the share of CO_2 emissions in Turkey's annual GHG emissions rose from 71% in 1990 to 80% in 2007. CO_2 emissions also accounted for 87% of the total emissions growth between 1990 and 2013. Variations in CO_2 emissions are the main determinants of the shifts in Turkey's total GHG emissions. This is because GHG emissions growth arises substantially from fossil fuel use in the energy sector. For that matter, the analyses presented in the subsequent parts of this report address variations in CO_2 emissions.

Figure 3: Turkey's Total Annual GHG Emission Trajectories Under Official Plans & BaU Scenarios (2010-2030)

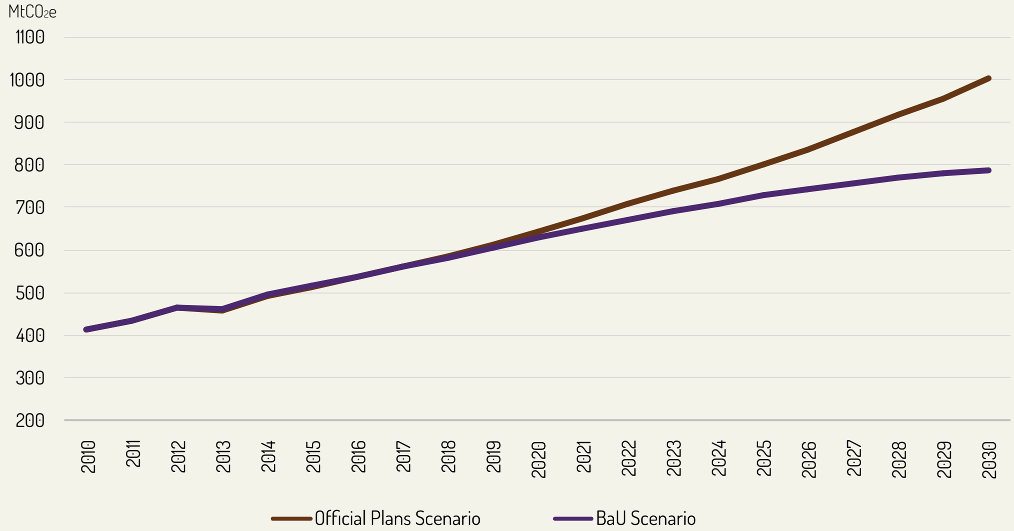
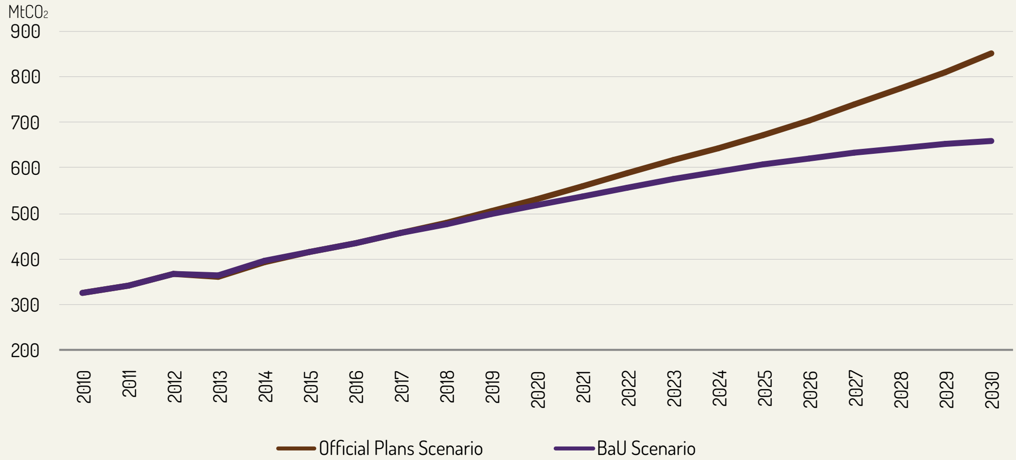


Figure 4: Turkey's Annual CO2 Emission Trajectories Under Official Plans & BaU Scenarios (2010-2030)



[39] TurkStat, Greenhouse Gas Emissions Inventory http://www.tuik.gov.tr/PreHaberBultenleri.do?id=18744

3. 2°C Pathway Scenario

2.98

BILLION TONS

TOTAL AMOUNT OF EMISSION REDUCTION TURKEY SHOULD MAKE BY 2030 TO FULFIL ITS RESPONSIBILITY REGARDING 2°C TARGET

The previous two scenarios are based on the assumption that Turkey would not put into practice any new policy instruments to reduce its emissions. Against these scenarios, we have identified the emission pathway that needs to be pursued in accordance with the 2°C target and the consequent carbon budget for Turkey. This pathway, dubbed as the 2°C Pathway, displays the required reduction commitment using the Climate Equity Reference Calculator (CERC), in line with the "minimum historical responsibility" and "maximum development needs" for Turkey. 2°C Pathway Scenario suggests that, in order to fulfil its responsibility regarding the 2°C target, Turkey should cut its total (cumulative) carbon dioxide emissions up until 2030 by 2.98 billion tons CO2 relative to the BaU Scenario, reducing cumulative emissions to the level of 7.69 billion tons CO2. In order to meet its fair share under 2°C target, by 2030, Turkey's annual CO2 emissions need to decline to the 2010 level of 340 million tons.

Figure 5: CO2 Emission Pathway to Be Pursued by Turkey to Fulfil Its Fair Share Under 2°C Target

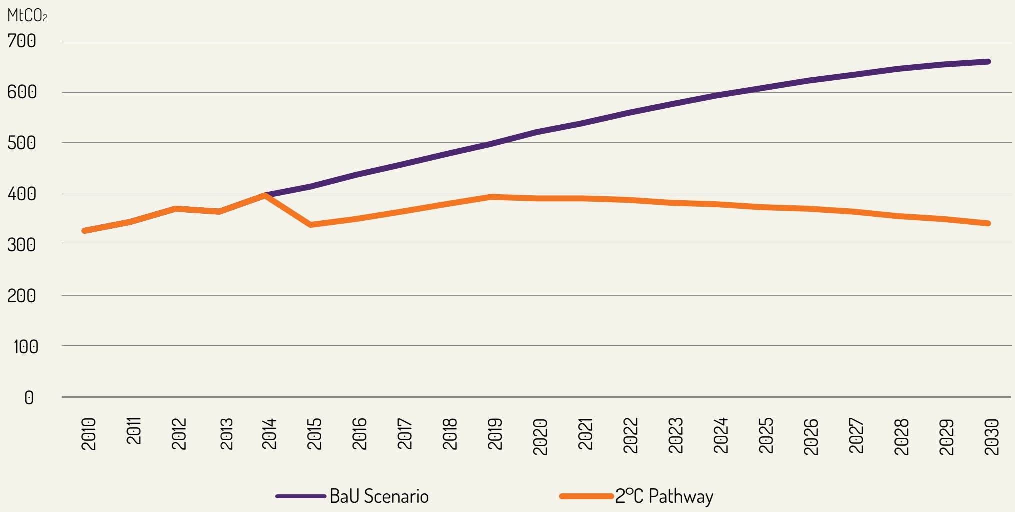
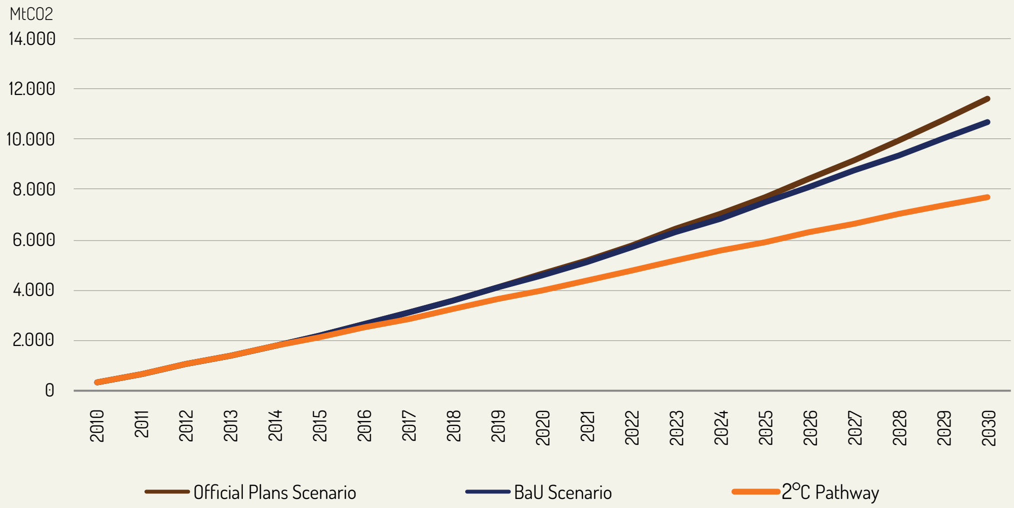


Figure 6: Cumulative CO2 Emission Trajectories According to Different Scenarios (2010-2030)



Iznik , Turkey © Getty Images Turkey

The Reason for the Differences in GHG Emission Projections?

In most developed countries, economic growth has not led to corresponding rates of increase in energy consumption over the last two decades, energy efficiency playing a key role in meeting the demand. In Turkey, on the other hand, we see that the strong positive correlation between economic growth and energy demand persists. While the economy's carbon intensity (annual GHG emissions/GDP) is declining in both OECD members and other developing economies, carbon intensity of Turkey's economy has been stuck at the 1990 levels, with some minor fluctuations over the years.

The official economic program bases its growth projections on the recent economic growth rates and projects a real annual GDP growth rate of 5% in the medium term. However, a more realistic assessment of the global economic conjuncture indicates that this projection is rather optimistic. For instance, the "2015 Economic Outlook" report, issued by the OECD in April, predicts that global production will increase by a moderate rate of around 2% in the next two decades, while Turkey's growth rate will decline from the level of 3.5% down to 2%. In a similar vein, the IMF projects that the global economy will grow by 3% over the next decade while Turkey's growth rates will hover around 3.5-4%.

The two reference scenarios (namely, the Official Plans Scenario and BaU Scenario), which are based on the assumption that no new policies will be adopted for emission reduction, differ in their emission projections. The emissions growth rates projected by the Official Plans Scenario, which foresees an average annual growth rate of 5%, are much higher than those projected by the BaU scenario that rests on more realistic growth predictions (an average annual GDP growth rate of 3.45% during the period). Annual GHG emissions, which reached 459 million tons CO2e in 2013, are projected by the Official Plans Scenario to exceed the threshold of 1 billion tons CO2e by 2030 while this number is projected to be 787 million tons CO2e under the BaU Scenario.

Instruments for Climate Change Policy and Their Macroeconomic Implications

What policy instruments may be adopted by Turkey to reduce emissions, and thus contribute to the 2°C target, and what implications these policy instruments may have for macroeconomic indicators are among the principal questions this study seeks to find answers to.

To answer these questions, this analysis employs the Computable General Equilibrium Model. The first step of the analysis is to specify the policy package to be used to reduce GHG emissions. Under the 2°C Pathway Scenario defined in this study, we assume the implementation of a policy package that comprises of three main instruments . This policy package is referred to as the “Climate Policy Package”. The three instruments this package involves are carbon taxation, renewable energy investment fund, and enhancement of energy efficiency:

1.2%

GDP SHARE OF THE TOTAL CARBON TAX REVENUE TO BE COLLECTED BY 2030 UNDER CLIMATE POLICY PACKAGE

1. Carbon Taxation: The first climate policy instrument used in the analysis is a dynamically active and flexible taxation scheme on CO2 polluters. In the model, the said tax is imposed on ad valorem basis as a ratio of the emissions of CO2 as differentiated by the source of polluters, energy users, (industrial) process generators, and households. The model foresees that the carbon tax to be collected will amount to 1.2% of the GDP by 2030.

2. Renewable Energy Investment Fund: The second climate policy instrument is a fiscal policy intervention to earmark the tax proceeds to an investment fund for the expansion of renewables.

3. Energy Efficiency: The third climate policy instrument entails autonomous increases in energy efficiency (i.e., depending on technological advances and market conditions, and not on any deliberate supporting efficiency policy). It is assumed that this policy instrument will gradually facilitate a higher per unit energy output (an annual increase of 1.5%) from primary and secondary energy sources.

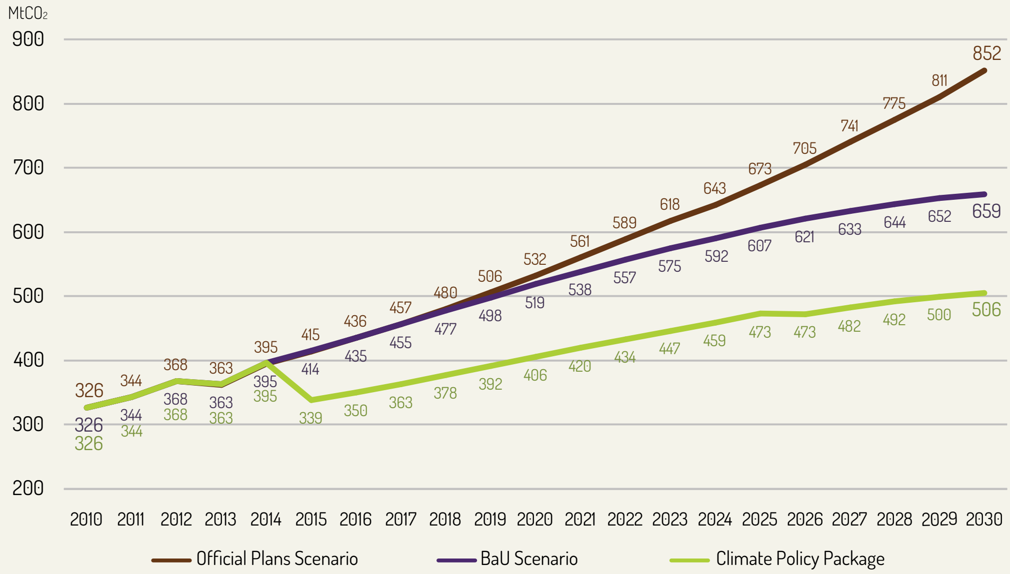
23%

BY ADOPTING THE CLIMATE POLICY PACKAGE IT IS POSSIBLE TO REDUCE EMISSIONS BY 23% RELATIVE TO THE BAU SCENARIO, AND BY 40% RELATIVE TO THE OFFICIAL PLANS SCENARIO UNTIL 2030

The impacts of these policy instruments -dubbed as the Climate Policy Package- on emissions and macroeconomic indicators can be summarized as follows:

1. Should the policy instruments included in this package be implemented, annual CO_2 emissions are projected to be 506 $MtCO_2$ in 2030, which is 23% lower than the BaU projections. When compared to the Official Plans Scenario, the rate of decline is projected to be 40% (Figure 7).

Figure 7: CO_2 Emission Trajectories Under Different Scenarios (2010-2030)



Emission Reduction Rate and Reference Scenarios

Under the Climate Policy Package, Turkey's emissions in 2030 are projected to be 23% lower than the BaU Scenario, and 40% lower than the Official Plans Scenario. This is a vivid proof of the critical importance that assumptions made when defining the reference emissions growth pathway. When assessing the contributions of countries that adopt a reduction from increase target, one should consider how realistic the emission values projected in their reference scenarios are.

2. Emissions in the energy sector, more particularly those generated by electricity generation account for most of the projected decline in GHG emissions. Should the Climate Policy Package be implemented, it could be possible to decrease emissions from electricity generation by 30% compared to the BaU scenario.

3. Implementation of the Climate Policy Package package will also lead to a 20% decrease in the economy's carbon emission intensity (annual CO_2 emissions/ GDP) relative to the reference scenario.

4. The emission level to be attained by 2030 under the Climate Policy Package will be attained under the BaU scenario by 2019-2020. The ten year period in-between is of key importance for Turkey to be able to curb its emissions growth.

30%
ESTIMATED RATE OF REDUCTION IN CO_2 EMISSIONS FROM ELECTRICITY GENERATION UNDER CLIMATE POLICY PACKAGE RELATIVE TO BAU SCENARIO

5. Carbon taxation is the main policy intervention tool in the Climate Policy Package, and earmarking carbon tax revenues for renewable energy investments constitutes the distinguishing feature of the package. As suggested by the model, if carbon tax revenues are directed to renewable energy investments in electricity production, excluding hydropower plants, the share of wind and solar energy in energy mix will expand. The model results show that the share of wind and solar energy in electricity production will thereby increase up to 44%. As a result of this increase, the shares of coal, natural gas and hydropower in the power mix will shrink (Figures 8 and 9).

Figure 8: Electricity Mix Under Climate Policy Package for Selected Years (%, 2010-2030)

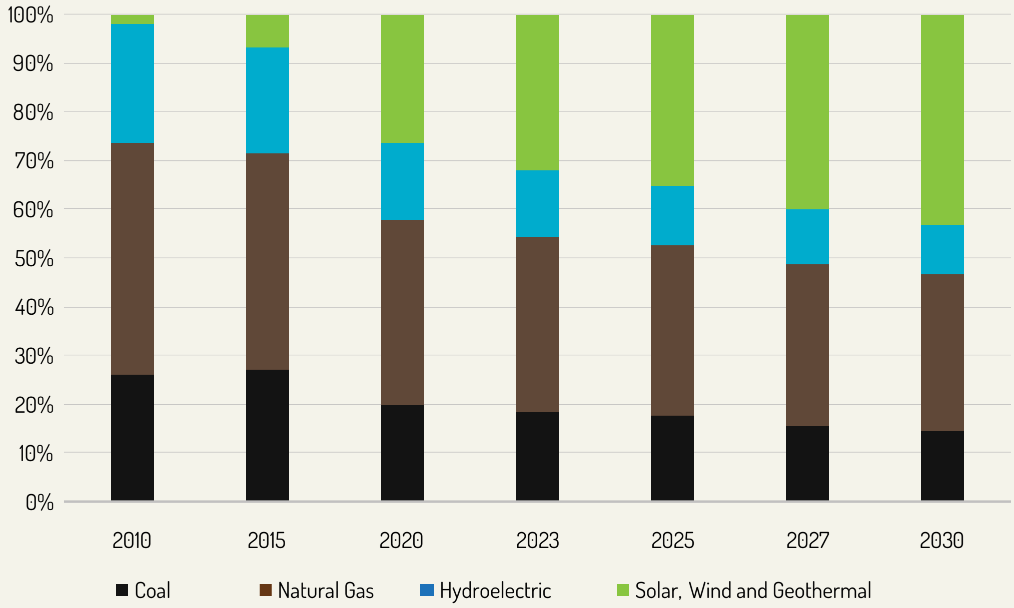
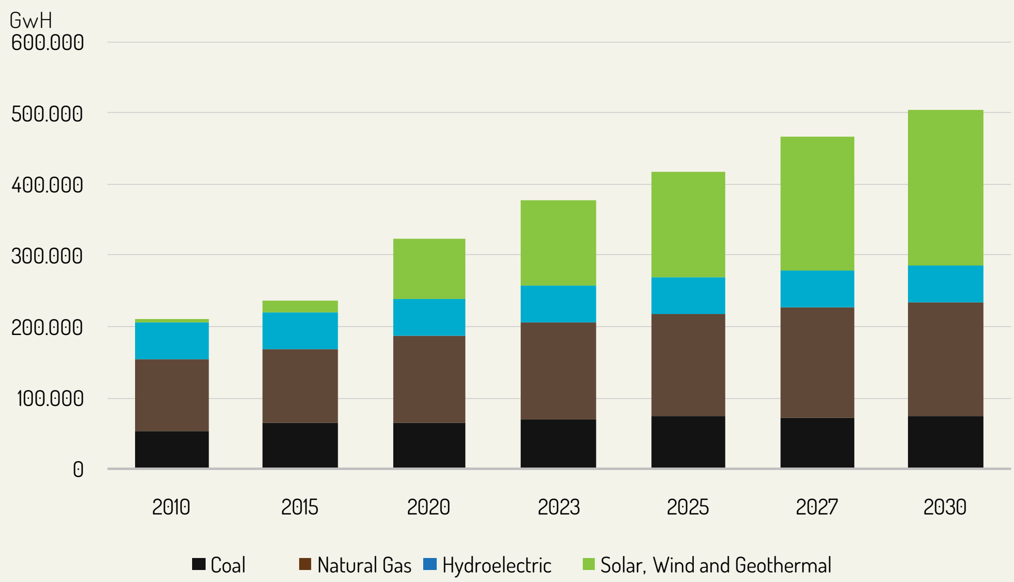


Figure 9: Power Mix Under Climate Policy Package for Selected Years (Absolute Figures 2010-2030)

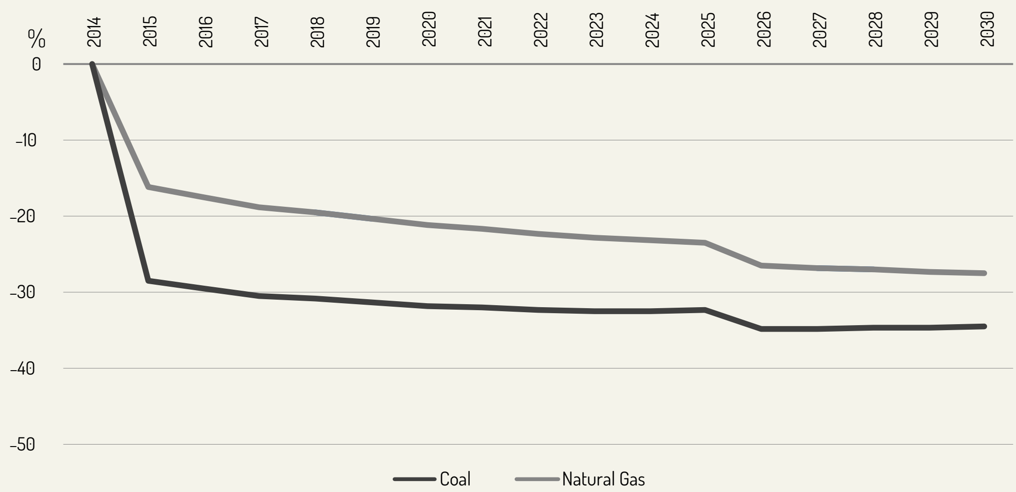


35%

ESTIMATED RATE OF REDUCTION IN NATURAL GAS IMPORTS REGARDING CLIMATE POLICY PACKAGE RELATIVE TO BAU SCENARIO

6. The Climate Policy Package targets a notable transition from natural gas and coal to wind and solar energy in the energy mix. One major benefit of this adjustment manifests itself in fossil fuel imports. Such a transition might lead to a 25% decline in coal imports, and a 35% decline in natural gas imports, relative to the BaU scenario where existing policies prevail (Figure 10).

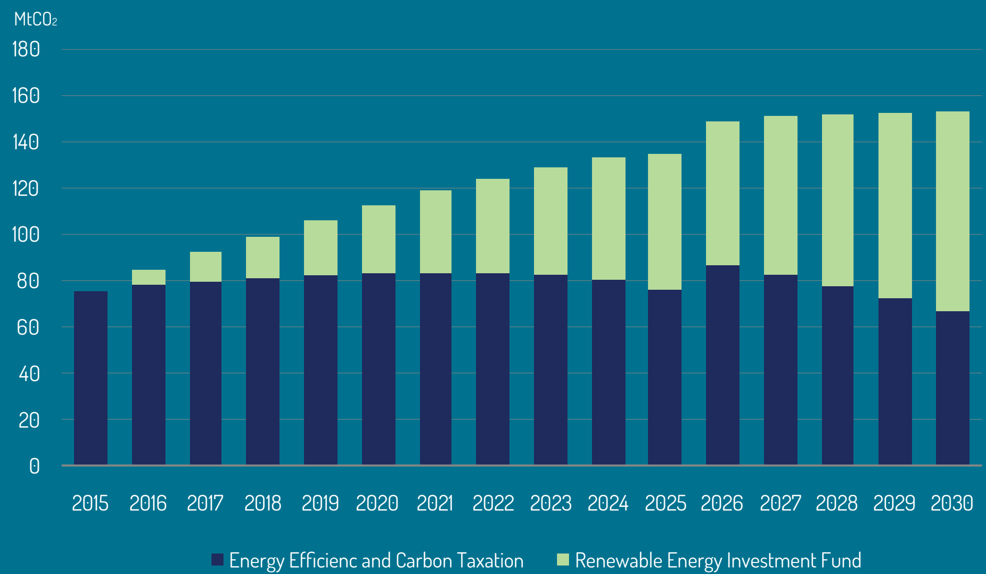
Figure 10: Coal and Natural Gas Import Trajectories Under Climate Policy Package Compared to BaU



Decomposition of Emission Reduction Gains by Policy Instruments

The analysis suggests that it is possible to curb emissions once the Climate Policy Package is in effect. In the period of 2016-2022, carbon taxation and energy efficiency gains will account for 70% of the emission reduction obtained relative to the reference scenario. Following this period, investments to be achieved through the Renewable Energy Investment Fund will start to take effect. By the year 2030, 56% of the emission reduction relative to the reference scenario will result from the increased share of renewables in energy supply (Figure 11).

Figure 11: Decomposition of Emission Reduction Gains by Policy Instrument Under Climate Policy Package



3.3%

ESTIMATED ECONOMIC GROWTH RATE IN 2020 UNDER CLIMATE POLICY PACKAGE

7. The gains cited above come with a cost. According to the model results, the Climate Policy Package might lead to slightly lower growth rates than envisaged by the BaU Scenario. The GDP growth rate in the period leading up to 2020 will be 3.3%, instead of 4%, under the Climate Policy Package. It is estimated that the gap between the projected growth rates under the Climate Policy Package and those under the reference scenario will narrow after the year 2025, eventually disappearing in 2030 (Figure 12).

Figure 12: Difference Between GDP Growth Rates under BaU & Climate Policy Package Scenarios

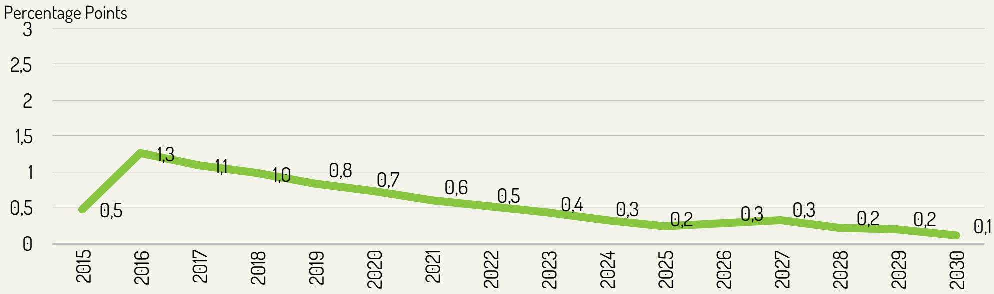


Table 2: Comparison of Scenarios – Macroeconomic Results

	BaU Scenario				Climate Policy Package**			
	2015	**2020**	**2025**	**2030**	**2015**	**2020**	**2025**	**2030**
Total GDP (billion TRY)*	1,372.9	1,692.7	2,004.1	2,255.6	1,366.5	1,607.1	1,863.7	2,074.2
Real Rate of GDP Growth (%)	4.5	4.0	3.2	2.0	4.0	3.3	3.0	1.9
Formal Labour Employment (million workers)	12.2	12.9	13.8	13.6	12.1	12.2	12.8	12.5
Informal Labour Employment (million workers)	12.4	13.1	13.9	14.6	12.4	13.1	13.9	14.6
Total Labour Employment (million workers)	24.6	26.0	27.7	28.2	24.5	25.4	26.7	27.2
Private Disposable Income (billion TRY)*	1,083.4	1,332.1	1,597.0	1,801.4	1,077.7	1,265.7	1,488.0	1,660.9
Government Revenues/GDP (%)	25.4	25.3	25.2	25.2	26.2	26.1	26.0	26.1
Aggregate Investment (billion TRY)*	280.8	340.3	394.0	437.6	283.0	330.7	376.4	415.0
Aggregate Consumption (billion TRY)*	949.5	1,157.7	1,367.0	1,534.5	936.4	1,088.2	1,257.9	1,393.9
Private Foreign Debt/GDP (%)	54.45	64.94	71.55	78.75	54.38	67.87	76.20	84.60
Government Foreign Debt/ GDP (%)	24.01	19.29	16.03	14.15	23.98	20.16	17.07	15.21
Current Deficit/GDP (%)	5.28	4.24	3.52	3.11	5.27	4.43	3.75	3.34
*In fixed 2010 prices								
**Climate Policy Package: Carbon taxation + Earmarking carbon tax revenues to renewable energy investment fund +Increased energy efficiency								

Table 3: Comparison of Scenarios – Environmental Results

	BaU Scenario				Climate Policy Package*			
	2015	2020	2025	2030	2015	2020	2025	2030
CO_2 Emissions (million tons)	415.4	518.9	607.3	659.3	338.6	405.9	472.9	505.8
GHG Emissions (CO_2e million tons)	514.7	628.1	727.2	787.1	434.7	507.3	582.3	620.9
Total CO_2 Emissions from Industrial Processes (Million tons)	67.4	87.0	106.6	122.1	65.0	81.6	100.2	116.1
Energy Related CO_2 Emissions (Million tons)	348.0	431.8	500.6	537.1	273.7	324.3	372.7	389.7
CO_2 Emissions from Agricultural Processes (CO_2e million tons)	46.6	55.9	64.7	72.5	46.3	52.9	59.7	65.8
CO_2 Emissions From Households (million tons)	60.9	75.2	90.6	102.2	48.8	58.7	71.1	81.1
Carbon Intensity (Total CO_2/GDP)	0.54	0.55	0.55	0.53	0.45	0.45	0.46	0.44
CO_2 from Energy/GDP	0.46	0.46	0.45	0.43	0.36	0.36	0.36	0.34
Intermediate Taxes on Fossil Fuels (billion TRY, 2010 prices)	0.00	0.00	0.00	0.00	11.94	14.26	16.98	22.15
Household Taxes on CO_2 (billion TRY, 2010 prices)	0.00	0.00	0.00	0.00	2.56	3.01	3.54	3.95
Total CO_2 Taxes (billion TRY, 2010 prices)	0.00	0.00	0.00	0.00	14.50	17.27	20.51	26.10
Total CO_2 Taxes/GDP (%)	0.00	0.00	0.00	0.00	1.05	1.05	1.06	1.20
Marginal Abatement Cost of CO_2 Taxes (USD/Ton)	0.00	0.00	0.00	0.00	0.14	-0.67	-0.83	-2.31

* Climate Policy Package: Carbon taxation + Earmarking carbon tax revenues to renewable energy investment fund +Increased energy efficiency

8. The model foresees that carbon tax revenues will correspond to 1.2% of the GDP in 2030. The analysis indicates that the marginal cost of abatement of 1 kg CO_2 hovers around 7 and 23 cents (USD). This is rather a marginal cost considering that an emission reduction of up to 25% relative to the reference scenario can be achieved at the cost of a tax burden corresponding to 1.2% of the total GDP. Given the benefits of such a structural transformation that will reduce dependence on imported coal and gas in the energy mix and expedite the transition from fossil fuels to domestic renewable sources, this cost may be regarded as fairly reasonable.

0.07-0.23 $
MARGINAL COST OF ABATEMENT PER KG OF CO_2 EMISSIONS

9. The model results point to slightly lower employment rates compared to the BaU scenario, a result that parallels the relative decrease in the GDP growth rate. According to the model, total employment in 2030 under the Climate Policy Package might be 3.5% lower than the projected employment rate under the BaU Scenario. This result may partly be due to the constraints of the top-down modelling approach. A more positive picture may come out if sector-based, bottom-up models are employed for figuring out the employment implications of the Climate Policy Package which foresees a considerable growth in the renewable energy sector.

10. Climate finance is not among the policy instruments included in the Climate Policy Package. In case Turkey benefits from international climate finance for meeting its emission reduction targets under the new climate regime, the adverse economic consequences of emission reduction may be mitigated.

11. Under the Climate Policy Package, carbon tax revenues, which will reach 315 billion TRY (in 2010 prices) by 2030, will be earmarked for renewable energy investments.

Employment Generation Potential of Renewable Energy

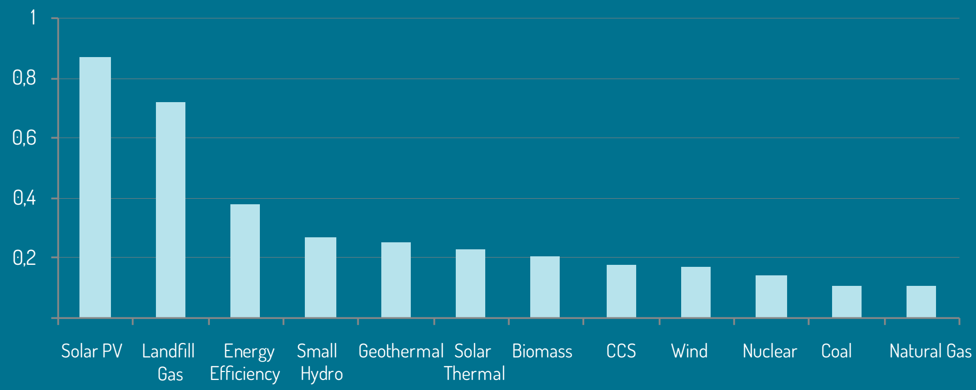
The Computable General Equilibrium Modelling approach rests on past data and assumes the continuity of the economic structure extending from past to present. This approach, which allows observing the impact of any policy change on the scale of the entire economy, may fall short of reflecting technological advances, changing costs and other dynamics in the energy sector.

Research on employment implications of renewable energy reveals that renewable energy technologies, solar energy in particular, have a higher employment generation potential than fossil fuels.

According to the "Green Jobs" report, published by the International Labour Organization (ILO) in 2008, employment (jobs per unit of installed capacity) generated by renewable energy sources, especially solar energy and landfill gas, is much higher than employment generated by coal, natural gas, and other fossil fuels.* The World Bank also states that renewable energy technologies prevail over energy production from fossil fuels and nuclear plants in terms of employment per unit of electricity generated (Figure 13).**

Figure 13: Direct Employment Generated by Alternative Energy Technologies in The United States

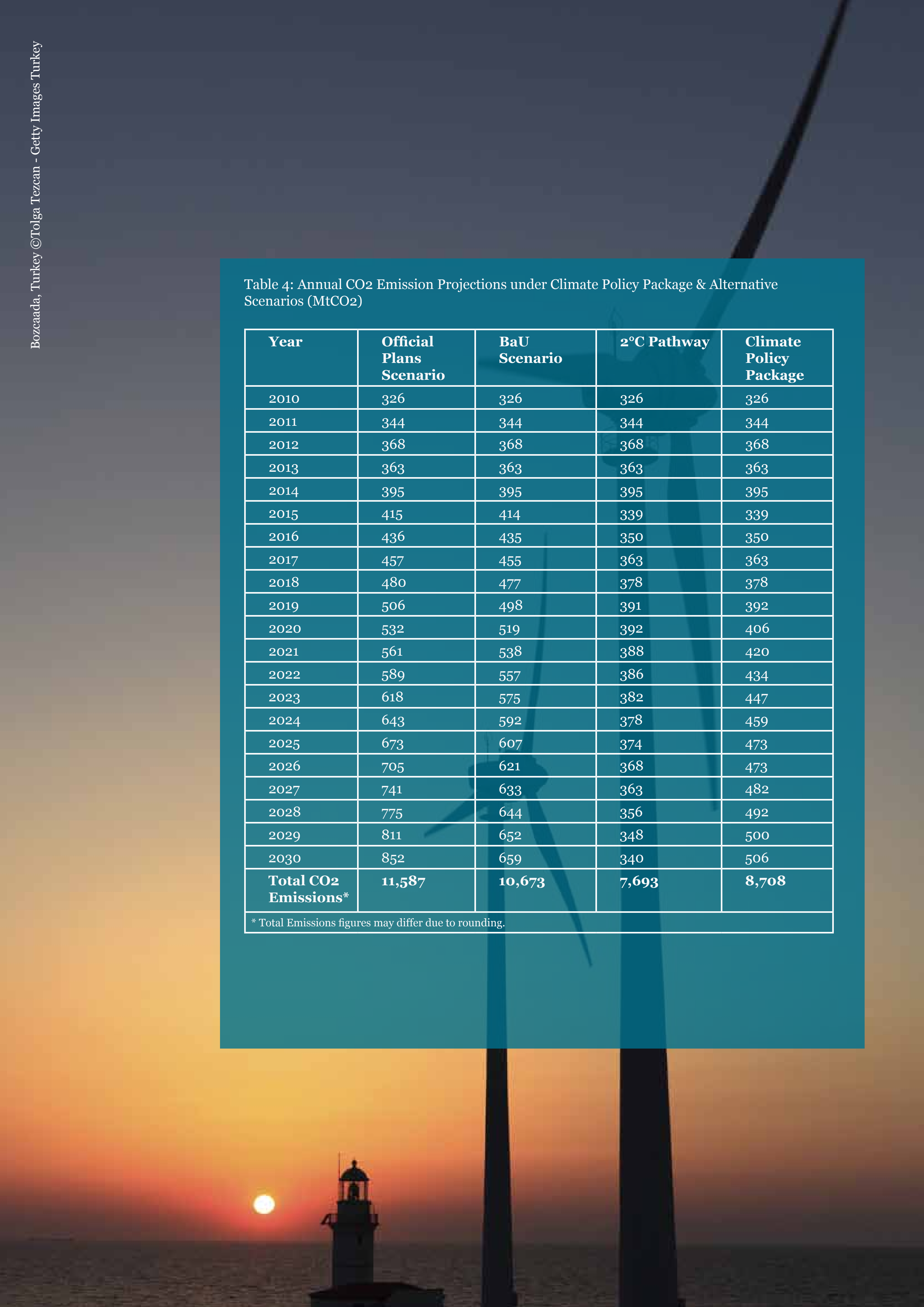
(Average Jobs/GW)



The scenarios that assume a considerable expansion of renewables in energy supply foresee a significant increase in net employment in the energy sector.***

Despite the lack of comprehensive research on Turkey in this area, we may hold that renewable energy sources and solar energy in particular may display a high potential for employment generation in Turkey as well. Based on this assumption, we may argue that an expanded use of renewable sources may impact positively on employment rates in the energy sector, and thus offset, to some degree, the potential contraction in employment projected by the model.

* UNEP/ILO/IOE/ITUC, 2008. Green Jobs: Towards Decent Work in a Sustainable Low Carbon World
** The World Bank, 2011. Issues in estimating the employment generated by energy sector activities, http://siteresources.worldbank.org/INTOGMC/Resources/Measuring_the_employment_impact_of_energy_sector1.pdf
*** The Energy (R)evolution Report, prepared by the European Renewable Energy Council (EREC), the Global Wind Energy Council (GWEC) and Greenpeace International in 2012, predicts that under a scenario where the share of renewables in primary energy is increased to 41% by 2030, net employment in the energy sector will expand by 16%.



Bozcaada, Turkey ©Tolga Tezcan - Getty Images Turkey

Table 4: Annual CO_2 Emission Projections under Climate Policy Package & Alternative Scenarios ($MtCO_2$)

Year	Official Plans Scenario	BaU Scenario	2°C Pathway	Climate Policy Package
2010	326	326	326	326
2011	344	344	344	344
2012	368	368	368	368
2013	363	363	363	363
2014	395	395	395	395
2015	415	414	339	339
2016	436	435	350	350
2017	457	455	363	363
2018	480	477	378	378
2019	506	498	391	392
2020	532	519	392	406
2021	561	538	388	420
2022	589	557	386	434
2023	618	575	382	447
2024	643	592	378	459
2025	673	607	374	473
2026	705	621	368	473
2027	741	633	363	482
2028	775	644	356	492
2029	811	652	348	500
2030	852	659	340	506
Total CO_2 Emissions*	**11,587**	**10,673**	**7,693**	**8,708**

* Total Emissions figures may differ due to rounding.

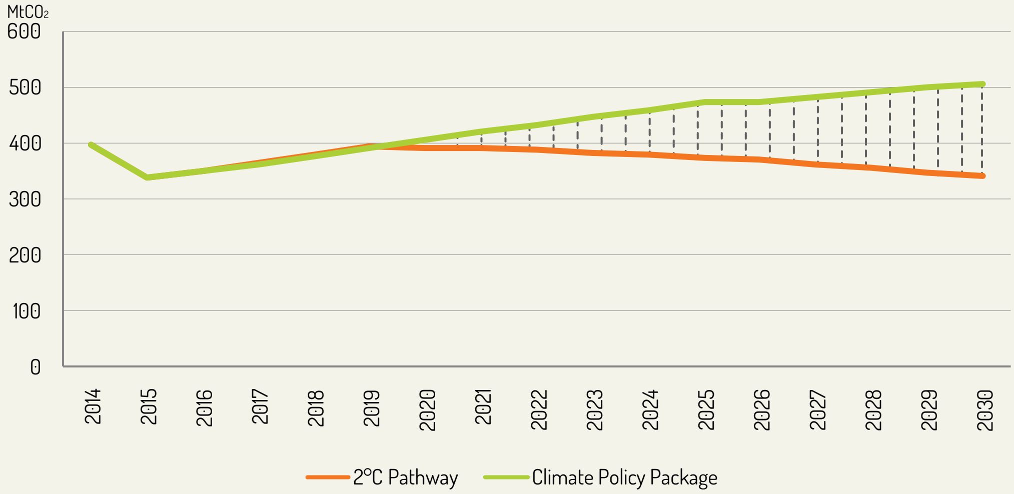
2°C Pathway for Turkey

1,015
$MTCO_2$
LEVEL OF FURTHER EMISSION REDUCTIONS (2015-2030) REQUIRED TO COMPLEMENT CLIMATE POLICY PACKAGE TO MEET 2°C PATHWAY

The analysis indicates that through the Climate Policy Package -which rests on carbon taxation, use of carbon tax revenues for electricity production from renewables through a renewable energy investment fund and autonomous energy efficiency gains-, it is possible to cut carbon emissions by 1,965 MtCO2 relative to the BaU scenario. In other words, two thirds of Turkey's fair share of emission reductions to meet the 2°C target, which amounts to 2,980 million tons, can be achieved by 2030 by implementing these policy measures. In order to achieve the 2°C Pathway target, other policy tools need to be employed in order to achieve a further reduction of 1,015 MtCO2 (shaded area) by 2030 (Figure 14).

While the policy instruments included in the Climate Policy Package are sufficient for keeping the emission levels in line with the 2°C target through to the year 2020, emissions should peak around 2020, and decrease thereafter if the 2°C target is to be met (Figure 14).

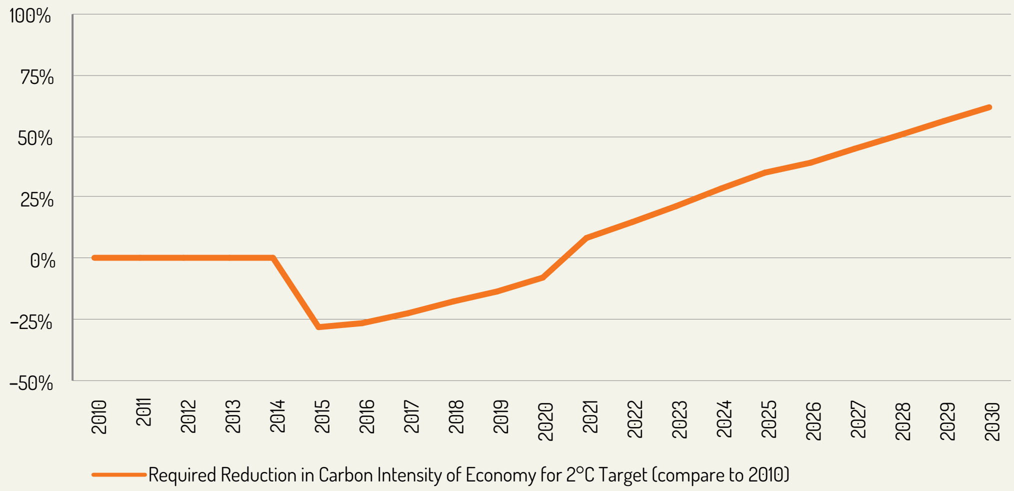
Figure 14: Emission Reduction Trajectories Under 2°C Pathway & Climate Policy Package



60%
RATE OF REDUCTION IN TURKISH ECONOMY'S CO_2 EMISSION INTENSITY BY 2030 REQUIRED TO MEET THE 2°C TARGET

An assessment of the Turkey's economy's carbon intensity shows that in order to achieve the 2°C target, the economy's CO2 emission intensity should be decreased by 60% by 2030 (Figure 15).

Figure 15: Carbon Intensity Reduction Required for 2°C Target



To fully achieve the 2°C target, additional policies and implementations are required to be put into practice to complement the policies included in the Climate Policy Package. To this end, sector-based analyses and studies that employ a bottom-up approach should be conducted in such areas as industry, transport, waste management, and energy efficiency. Sectors and respective policy measures that could be prioritized in this context are as follows:

18.6%

SHARE OF TRANSPORT RELATED CO_2 EMISSIONS IN TURKEY'S TOTAL CO_2 EMISSIONS

Transport: According to 2013 figures, CO2 emissions generated by the transport sector constitute 18.6% of Turkey's total CO2 emissions. After electricity generation, transport is the largest contributor to CO2 emissions.[40] Land vehicles account for 90% of transport-generated emissions in Turkey.[41] A recent study on Turkey's emission reduction potential proves that an increased fuel efficiency in transport (through the adoption of the 2025 target of 35.9 km/l and the 2030 target of 47.5 km/l for cars registered for the first time, which is an issue under discussion in the EU now) could lead to a decline in GHG emissions by 15 to 19 MtCO2e by 2020, and 50 to 88 MtCO2e (million ton CO2 equivalent) by 2030.[42] A further emission reduction may be achieved by transforming the transport infrastructure, and by promoting railroad and maritime transportation rather than land transportation.

Buildings: 18% of Turkey's total CO2 emissions are generated by energy use in buildings. As indicated in the Climate Change Action Plan, there exists a 35% energy saving potential in buildings. Realizing this potential may lead to decreased emissions. An analysis conducted by the European Bank for Reconstruction and Development (EBRD) in 2010 suggests that even under scenarios that do not foresee progressive change in relevant policies, implementation of energy efficiency measures (introduction of energy efficiency standards for new buildings, insulation of existing buildings, and expansion of solar water heating systems) in buildings that positive NPV[43] may bring about a decline in emissions relative to the reference pathways. The analysis also shows that if these measures are complemented by other policy instruments, their effect will be further enhanced. In the buildings sector, investments with positive NPV may help achieve an emission reduction of 24-43 MtCO2e in the period of 2010-2030.[44]

Cement: According to 2012 figures, CO2 emissions generated by the cement sector amounted to 30 million tons. This constitutes 54% of CO2 emissions from industrial processes.[45] The Ecofys analysis, which is referred to above, reveals that an improved clinker–cement ratio could bring about an emission gain of 5 MtCO2e in the cement sector by 2030, relative to the reference scenario.[46] According to the EBRD analysis, investments with positive NPV may reduce emissions in the cement sector by 7-17 MtCO2e in the period of 2010-2030.47 The analysis cites the enhancement of energy efficiency and the use of natural gas, instead of coal, in existing and new plants as the main instruments for emission reduction, stating that a 35% replacement of clinker with other substitutes may bring about a 23% decrease in emissions.

It should be underlined that emission reduction measures in the sectors of transport, energy, buildings and industry will also contribute to the security of energy supply and air quality as well as enable the harmonization with the EU norms and standards.

[40] TurkStat, Greenhouse Gas Emissions Inventory, 2013. http://www.tuik.gov.tr/PreHaberBultenleri.do?id=18744
[41] Energy Efficiency in Vehicles, Business World and Sustainable Development Assocation Turkey, 2015. http://www.skdturkiye.org/tasitlardaenerjiverimliligi.pdf
[42] PBL, Netherlands Environmental Assessment Agency, 2015. Enhanced Policy Scenarios for Major Emitting Countries http://www.ecofys.com/files/files/pbl-2015-enhanced-policy-scenarios-for-major-emitting-countries_1631.pdf
[43] Net Present Value > 0
[44] The Demand for Greenhouse Gas Emissions Reductions: An Investors' Marginal Abatement Cost Curve for Turkey. EBRD, 2011. http://www.ebrd.com/what-we-do/sectors-and-topics/sustainable-resources/carbon-market-support.html (for English version) http://www.ebrd.com/downloads/research/economics/publications/specials/Turkey_MACC_report_TURK.pdf (for Turkish version)
[45] National Inventory Submissions Turkey, 2012 http://unfccc.int/national_reports/annex_i_ghg_inventories/national_inventories_submissions/items/8108.php
[46] PBL, Netherlands Environmental Assessment Agency, 2015. Enhanced Policy Scenarios for Major Emitting Countries http://www.ecofys.com/files/files/pbl-2015-enhanced-policy-scenarios-for-major-emitting-countries_1631.pdf
[47] The Demand for Greenhouse Gas Emissions Reductions: An Investors' Marginal Abatement Cost Curve for Turkey. EBRD, 2011. http://www.ebrd.com/what-we-do/sectors-and-topics/sustainable-resources/carbon-market-support.html (for English version) http://www.ebrd.com/downloads/research/economics/publications/specials/Turkey_MACC_report_TURK.pdf (for Turkish version)

31%

SHARE OF ELECTRICITY SECTOR RELATED CO_2 EMISSIONS IN TOTAL CO_2 EMISSIONS

Priority Sectors for Climate Change Mitigation

The share of carbon dioxide (CO2) in Turkey's total GHG emissions expanded from 70% to 80% over the period of 1990-2013. Among CO2 sources, the highest growth occurred in the use of fossil fuels for electricity generation. CO2 emissions from electricity generation have risen by 236% since 1990, and the sector's share in total CO2 emissions has increased from 22% to 31%.

Besides the electricity sector, the following sectors are the other main contributors to CO2 emissions:

- Transport: The period of 1990-2013 witnessed a 159% increase in transport-generated CO2 emissions, and thus the share of transport in CO2 emissions rose from 17% to 18.6%.
- Energy use in industry: CO2 emissions generated by energy use in the industry sector rose by 84% over the period of 1990-2013.
- Emissions from industrial processes: Process emissions generated by mineral products industry increased by 179%, and those generated by metal products industry by 51%.

Table 5: Annual CO2 Emission Projections under Climate Policy Package & Alternative Scenarios

Sectoral shares in CO2 emissions (%-Percent)	**1990**	**1995**	**2000**	**2005**	**2010**	**2011**	**2012**	**2013**
Fuel combustion in electricity generation (%)	21.99	25.12	28.43	28.49	31.37	31.97	32.66	31.25
Fuel combustion in industry (%)	21.91	20.82	27.77	28.43	18.58	16.68	17.64	17.07
Fuel combustion in transport (%)	16.99	17.89	14.72	14.20	13.64	13.74	16.68	18.61
Fuel combustion in buildings (%)	19.37	18.23	14.60	13.90	19.83	20.49	16.47	15.23
Mineral products manufacturing (%)	9.62	10.24	8.19	8.80	10.36	10.76	10.50	11.37
Metal products manufacturing (%)	8.78	6.55	5.42	5.26	5.48	5.40	5.15	5.63
Other* (%)	1.36	1.14	0.87	0.93	0.74	0.96	0.91	0.84

* "Other" includes CO2 emissions generated by waste, agriculture, non-energy use of fuels and solvents, chemical industry, and leakage CO2 emissions in energy use.

Source: TurkStat, Greenhouse Gas Emissions Inventory, 2013

Zonguldak, Turkey © Ozgur Donmaz - Getty Images Turkey

31 BILLION $

TOTAL VALUE OF FOSSIL FUEL SUBSIDIES IN TURKEY IN 2013

External Costs of Climate Change and High Carbon Policies

Fossil fuel-based power production generates, besides climate change-inducing CO_2 emissions, additional costs and negative externalities on environment and public health. Coal-fired electricity generation causes emissions of particulate matter, sulphur dioxide, nitrogen oxide, heavy metals and persistent organic pollutants which contaminate the air, and directly threaten public health. It also causes soil and water pollution which, in turn, leads to ecosystem degradation. On the other hand, coal mining gives rise to dozens of work accidents and cases of occupational disease, employment injuries and deaths every year. According to a report published by the Health and Environment Alliance (HEAL) in 2014, annual health costs generated exclusively by coal-fired thermal plants in Turkey lie between 2.9 and 3.6 billion USD. Coal-fired thermal plants cause 2,879 cases of premature deaths, 637,643 workdays lost, and 3,823 new cases of chronic bronchitis every year.[48]

Costs of fossil fuel subsidies are pretty striking. According to the IMF figures*, Turkey's fossil fuel subsidies totalled 31 billion USD in 2013, which corresponded to 3.8% of the total GDP. With a total cost of 21.5 billion USD, coal is the most costly source among all fossil fuels. The IMF predicts that the total fossil fuel subsidies in Turkey will reach 38 billion USD by the end of 2015, constituting 4.5% of the GDP.[49]

Note: The IMF calculations take into account air pollution and high CO_2 emissions stemming from fossil fuel combustion, but exclude the costs pertaining to the impact of the extraction and transport of mercury, heavy metals and other minerals on water and agricultural products.

[48] HEAL (Health and Environment Alliance), 2015. Ödenmeyen Sağlık Faturası: Türkiye'de Kömürlü Termik Santraller Bizi Nasıl Hasta Ediyor? http://env-health.org/IMG/pdf/03072015_heal_odenmeyensaglikfaturasi_tr_2015_final.pdf

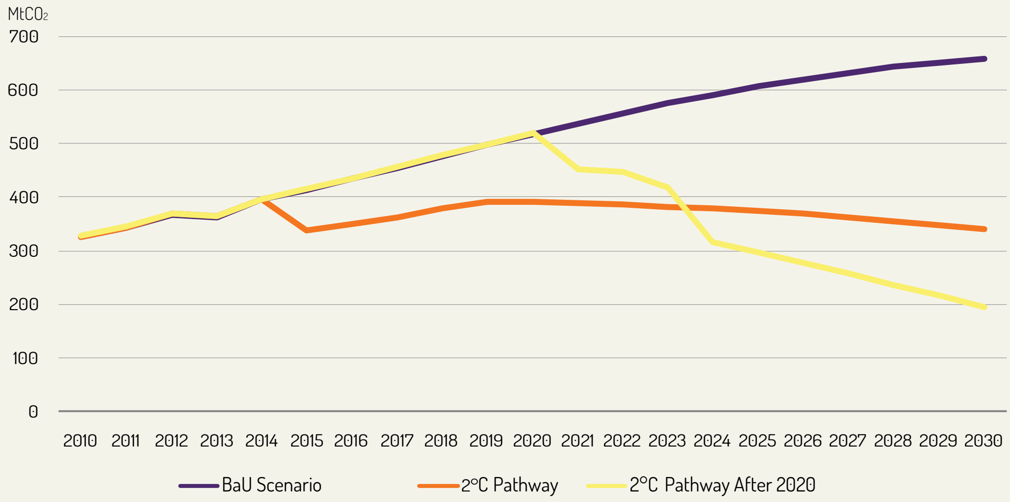
[49] IMF, Counting the Costs of Energy Subsidies, http://www.imf.org/external/pubs/ft/survey/so/2015/NEW070215A.htm

Timing of Climate Policy: The Early Bird Gets the Worm

Climate scientists and economists agree that taking immediate action to reduce GHG emissions is vital for avoiding both the devastating impacts and economic damage to be caused by climate change.

How relevant this perspective will be to Turkey's economy is one of the questions tackled by this analysis. The analysis explores the consequences of late action in climate change mitigation on the basis of a scenario under which the "Climate Policy Package" will be put into practice in 2020, instead of 2015 (Figure 16).

Figure 16: Required Emission Pathways Under 2°C Target in 2020-2030 Period (in case of no emission reduction until 2020)



(-) GROWTH RATES

IF TURKEY DEFERS THE IMPLEMENTATION OF EMISSION REDUCTION MEASURES UNTIL 2020, IT MAY HAVE TO ENDURE "NEGATIVE" GROWTH RATES IN ORDER TO BE ABLE TO FULFIL ITS RESPONSIBILITY

According to the results of the analysis, if Turkey defers the implementation of emission reduction measures included in the "Climate Policy Package" until 2020, it will have to endure a considerable GDP loss to be able to fulfil its responsibility under the 2°C target. In case of late action, Turkey may have to face "negative" growth rates after the year 2024 in order to meet its fair share under the 2°C target.

By immediately putting into practice the emission reduction policies, on the other hand, it will be possible to maintain the economic growth, though with a relative decrease in the GDP growth rate. This may be interpreted as suggesting that the "green growth" approach is adequate and feasible for Turkey.

Negative Emission Technologies and the 2°C Target

Some emission reduction models included in the Fifth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC) suggest that net negative emission technologies such as bio-energy with carbon capture and storage could play a significant role for the 2°C target. That said, the IPCC underscores the technical complexities and environmental risks associated with the large-scale application of these technologies.[50] The IPCC report draws attention to the high costs of these technologies and warns that these solutions with no immediate prospect of large-scale application application "might invite complacency regarding mitigation efforts.[51]

Turkey may avoid the high costs, risks and uncertainties of net negative emission technologies that loom large in the future if it takes immediate action towards fulfilling its responsibility in climate change mitigation.

[50] IPCC, 2014. Fifth Assessment Report Working Group III. "Climate Change 2014: Mitigation of Climate Change" http://mitigation2014.org/report/summary-for-policy-makers
[51] IPCC, 2014. Fifth Assessment Report Working Group II. "Climate Change 2014: Impacts, Adaptation, and Vulnerability" https://ipcc-wg2.gov/AR5/images/uploads/WGIIAR5-Chap20_FINAL.pdf

Kackar Mountains, Turkey © Getty Images Turkey

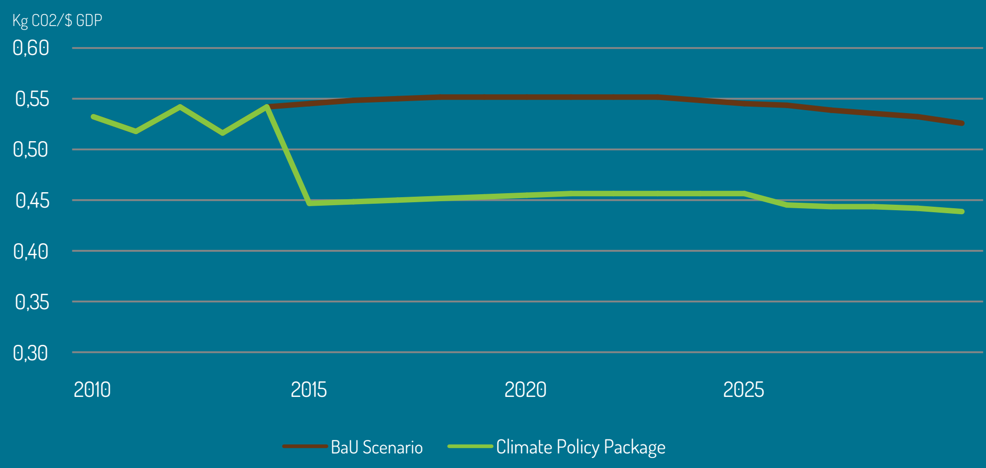
Carbon Intensity of Turkey's Economy

Turkey's economy has a relatively small, yet rapidly growing carbon footprint. Per capita CO_2 emissions in Turkey are below OECD and world averages. It should be noted, however, that per capita emissions have seen an increase of over 50% since 1990.

An analysis of the economy's carbon intensity* in Turkey reveals that in contrast to the general trend in the world, the connection between economic growth and CO_2 emissions in Turkey displays no progress. Between 1990 and 2011, China decreased its economy's carbon intensity by 54% and the carbon intensity of OECD economies fell by 31% on average. In the same period, the global economy's carbon intensity shrank by 23%. Turkey's economy, on the other hand, witnessed a mere 3.1% decline. To put it another way, Turkey generated the same amount of CO_2 emissions as in 1990 to produce one U.S. Dollar's worth of output despite such factors as the expansion of service sector's share in the economy, increased efficiency, and advances in the renewable energy sector.

According to the analysis presented in this report, implementing climate policies will bring about a 20% decrease in the economy's carbon intensity relative to the reference scenario. For Turkey, this could signify the beginning of the dissociation of economic growth from CO_2 emissions, a process that has been observed in developed countries particularly over the last two decades.

Figure 17: CO2 Emission Intensity Trajectories Under Different Scenarios



*Economy's carbon intensity is calculated by dividing the quantity of annual CO_2 emissions by the total value of all goods and services produced in an economy in one year (GDP). It denotes CO_2 emissions per

Denizli, Turkey © Getty Images Turkey

PART 3:

RECOMMENDATIONS FOR TURKEY AHEAD OF COP21

RECOMMENDATIONS FOR TURKEY AHEAD OF COP21

Turkey should set an ambitious emission reduction target prior to the COP21.

- Parties to the United Nations Framework Convention on Climate Change (UNFCCC), including 195 contracting states and the European Union, will meet in Paris in December 2015 to negotiate the new climate agreement that is intended to replace the Kyoto Protocol after 2020. Prior to the COP 21, each state was called on to specify its national contribution (INDC) to the efforts to meet the 2°C target and to safeguard ecosystems and communities from the devastating impacts of climate change. Countries are expected to determine their contributions on the basis of their historical responsibilities in the GHG emissions growth and their current capacities.

- Having become a party to the UNFCCC in 2004 and to the Kyoto Protocol in 2009, Turkey has not, to date, set any emission reduction targets. Turkey announced at the COP19 in Warsaw in 2013 that it will agree to become a party to the new agreement with a flexible target to be determined on its own terms if the critical mass is reached. On the eve of the COP21, Turkey is in the process of devising, for the first time, its own scheme (INDC) to contribute to international climate change mitigation efforts.

- Turkey needs to find answers to three critical questions as it attempts to determine its national contribution to climate change mitigation:
  1. What could Turkey's responsibility and its emission reduction target be within the scope of the 2°C target?
  2. What kind of a policy package could be implemented in order to achieve the required emission reduction?
  3. What could be the impact of these policies on macroeconomic indicators? What are the costs of implementing and not implementing these policies?

2030

IN PARIS, TURKEY COULD COMMIT TO REDUCE ITS EMISSIONS DOWN TO THE 2010 LEVEL BY 2030 REGARDING THE 2°C TARGET

- The official projections suggest that by 2030 Turkey's CO_2 emissions, which amounted to 363 $MtCO_2$ in 2013, will reach 851 million tons by 2030 under high growth scenarios, and 659 million tons under realistic growth scenarios. In this study high growth scenarios are assessed under the Official Plans Scenario, and more realistic growth scenarios under the Business-as-Usual (BaU) Scenario.

- To meet the 2°C target, Turkey's annual emissions should reach a peak level of 390 $MtCO_2$ by 2020, and gradually decrease thereafter down to the 2010 level by 2030. Therefore, the commitment of Turkey in Paris could be to reduce emissions to the 2010 level by 2030.

It is possible to curb emissions through climate policy instruments.

- As suggested by this analysis, if Turkey puts into practice the "Climate Policy Package" which involves three policy instruments ([i] carbon taxation; [ii] use of carbon tax revenues for electricity generation from renewables by means of a

20%
ANTICIPATED DECLINE IN THE ECONOMY'S CO_2 EMISSION INTENSITY REGARDING CLIMATE POLICY PACKAGE

renewable energy investment fund; [iii] autonomous gains in energy efficiency), its annual CO2 emissions are estimated to be 506 MtCO2 in 2030, which is 23% lower than the projections under the BaU scenario. By this means, it is possible to achieve a 20% decrease in the carbon emission intensity (annual CO2 emission/ GDP) of the economy.

- Regarding the Climate Policy Package, the level of CO2 emissions in 2030 is estimated to be 40% lower than the projections under the Official Plans Scenario. This proves the critical importance of the assumptions made while identifying a reference emission growth pathway. When assessing the contributions of countries that adopt a baseline scenario target, one should consider how realistic and sound the emission values projected in the reference scenario are.

Green growth is viable for Turkey.

- According to the model, the GDP growth in the period leading up to 2020 will be 3.3%, instead of 4% as a consequence of the policy package. It is estimated that the gap between the projected growth rates under the Climate Policy Package and those under the reference scenario will narrow after the year 2025, eventually disappearing in 2030.

- The model results point to a decline in employment rates parallel with the decline in the GDP growth rates. It may be possible to regulate the distribution of national income through social policy packages and to mitigate the negative impacts by managing the fluctuations in employment.

- The analysis indicates that the marginal cost of abatement of 1 kg CO2 hovers around 7 and 23 cents (USD). This is rather a marginal cost considering that an emission reduction of up to 25% relative to the reference scenario can be achieved at the cost of a tax burden corresponding to 1.2% of the total GDP. Given the benefits of such a structural transformation that will reduce dependence on imported coal and gas in the energy mix and expedite the transition from fossil fuels to domestic renewable sources, this cost may be regarded as fairly reasonable.

- Climate finance is not among the policy tools included in the Climate Policy Package. If, in the new international climate regime, Turkey benefits from international climate finance for meeting its emission reduction targets, the adverse economic consequences of emission reduction may be mitigated.

Expansion of renewable energy, increased energy efficiency and carbon taxation may help curb the emissions growth. To achieve a decline in emissions, a transformation should be initiated in sectors with high emission intensity.

- Under the "Climate Policy Package", it will be possible to reduce emissions by a total of 1,965 MTCO2 relative to the reference scenario. In other words, the policy measures included in this package might enable Turkey to realize two thirds of its fair share of emission reductions by 2030 within the framework of the 2°C target.

- The policy tools contained in the "Climate Policy Package" are adequate for keeping the emission level in line with the 2°C target through to the year 2020. In order to meet the 2°C target, emissions should reach a "peak point" around 2020 and start to decline thereafter. To fully achieve this goal, it is necessary to adopt additional policy measures and practices. Towards this end sector-based analyses and studies that employ a bottom-up approach should be conducted in such areas as industry, transport, waste management, and energy efficiency.

Timing is key: The early bird gets the worm; late action will come with a heavier toll.

- Early action is critical for Turkey. If Turkey defers the implementation of emission reduction measures included in the "Climate Policy Package" up until 2020, it may face "negative" growth rates after the year 2024 in order to be able to fulfil its responsibility regarding the 2°C target. By immediately putting into practice the emission reduction policies, on the other hand, it will be possible to maintain the economic growth, though with a relative decrease in the GDP growth rate. This may be interpreted as suggesting that the "green growth" approach is adequate and feasible for Turkey.

National climate policies will pave the way for Turkey to assume a pioneering role in international climate negotiations.

- Climate policies are becoming increasingly important as they are directly linked to such sectors as energy, industry, and transport. Risk analysis of climate change as an agenda item is not the reserve of environmental organizations. The International Energy Agency asserts that in order to keep the level of atmospheric CO_2 below 450 ppm, two thirds of the known fossil fuel reserves should remain underground. At the beginning of this year the G20 invited the Financial Stability Board, based in Basel, to prepare an evaluation report on the risks to be potentially imposed on financial markets due to climate change mitigation policies. Holding the G20 Presidency this year, Turkey should recognize this priority and integrate its policy measures regarding climate change mitigation and risk management into all sectoral strategies.

- Turkey's role in and sway on the new climate regime will be defined by the policies it will implement at the national and local level to adapt to and mitigate climate change as well as by the emission reduction target it will declare. In this context, a holistic approach to reduction and adaptation policies is called for. Such tools as earmarking a portion of the prospective carbon tax revenues for reducing vulnerability towards climate change at the local level may contribute to create such coherence.

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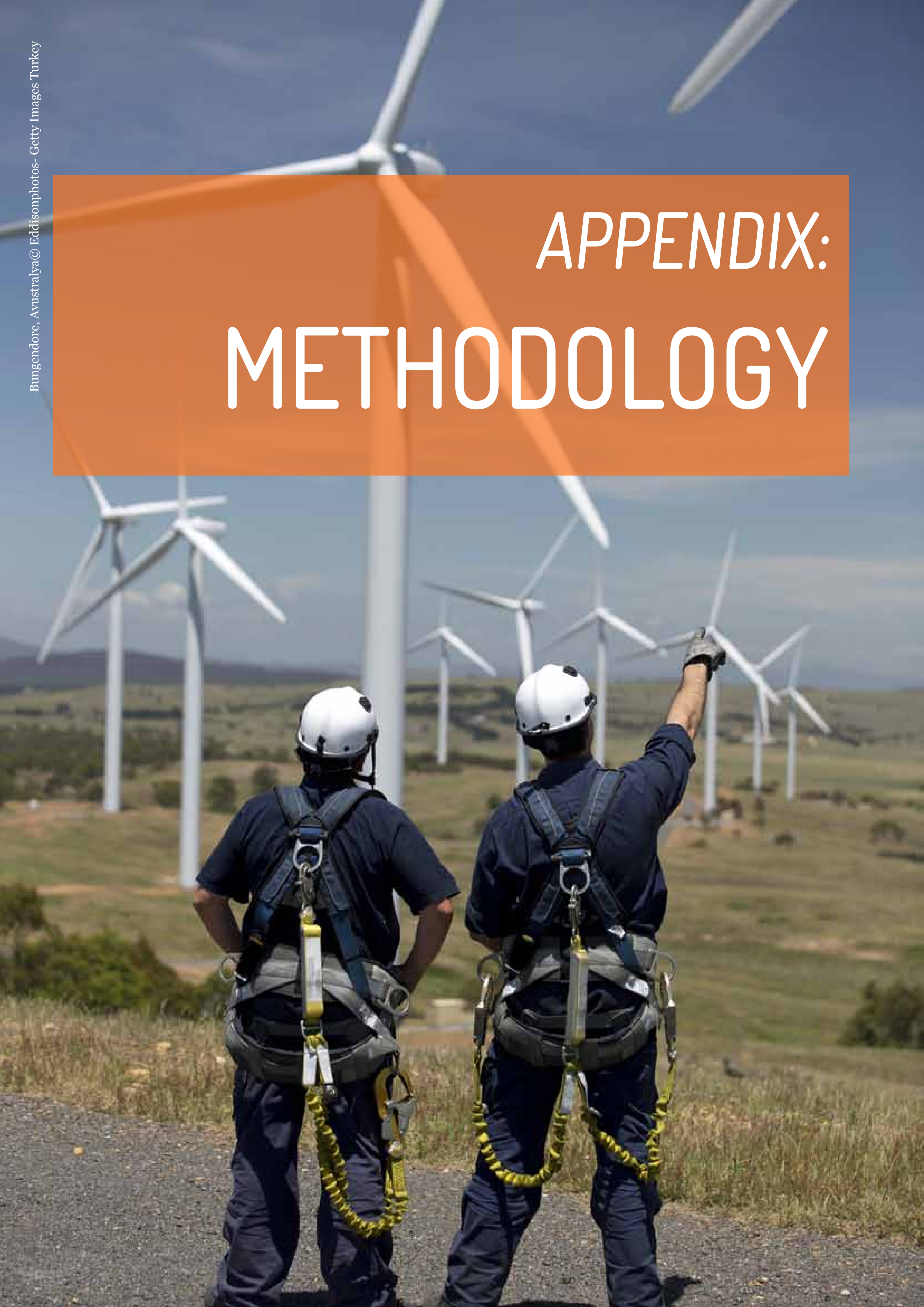
APPENDIX: METHODOLOGY



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METHODOLOGY

1. GENERAL EQUILIBRIUM MODELING OF TURKEY'S ECONOMY

The analysis presented in this report rests on the Computable General Equilibrium (CGE) model. The analysis seeks answers to the questions below:

i. What are the characteristics of economic growth and CO2 emissions for Turkey over the medium/long run?
ii. What is the appropriate policy mix for sustaining green growth regarding this path, given the fiscal and external constraints and specific labor market rigidities?
iii. What are the possible mix of innovation technologies and tax-cum-incentive policies to enhance productivity growth and to foster employment?

Model Structure and Basic Features
The model has been built in order to analyse the macroeconomic impacts of alternative policies for GHG emission reduction. A dynamic analytical approach have been empoyed in order to be able to observe the long term impacts of policies on macroeconomic variables such as technological progress, capital accumulation, public finance and foreign trade balances, in addition to their primary impacts on the overall economy. While revealing the impacts of policy alternatives, CGE model observes intersectoral connections and provides a more comprehensive and meaningful context for analysis by steering sectoral analysis accurately. Therefore, it allows the researcher to reach conclusions on emission limitations, as well as the impacts of emission reduction policy alternatives on production, income allocation, consumption, savings, investments, public balances and foreign trade components of the national economy.

The model specifies the production structure by decomposing economic input output and resource allocation processes. Labor, capital, energy and other intermediate goods are used as inputs in each sector. Land and irrigation are included in the inputs of the agricultural sector. Total supply of labor is taken as constant, while endowments are increased by the respective population growth rates on a yearly basis. Sectoral allocation of labor is a function of marginal product of labor.

Model observes the external balance of the economy, resolves the export, import, capital flows and current account balances in a way that would bring the foreign exchange markets to equilibrium under a floating exchange rate regime.

The supply-side of the economy is modeled as eighteen aggregated sectors. In our model we distinguish 18 sectors, 17 of which are officially recognized in the I/O. The additional "Renewable Energy Sources" (RNW) sector is deduced separately and is appended as a new sector to the I/O data. RNW sector has been accommodated using available data from World Energy Association, the World Input-Output Data and independent studies, based energy balances released by the Ministry of Energy and projections for Levelized Cost of Energy for different energy sources.

Sectorial production is modeled via a multiple-stage production technology where at the top stage, gross output is produced through a Cobb-Douglas technology defining capital (K), labor (L), and intermediate inputs and primary energy composite (ENG) as factors of production. At a lower stage, the primary energy composite (ENG) is a CES aggregate of four major sources of energy supply: coal, petroleum and gas, and electricity (the traditional technologies). For the electricity sector we further distinguish a renewable energy sector (mainly solar and wind). The CES and Cobb-Douglas specifications incorporate the potential for technological substitution of inputs by the producer in response to relative factor prices, including impacts of tax/subsidy instruments.

We specify a dualistic structure in the labor markets where rural and urban labor are differentiated. Rural labor market wages are fully flexible and the low productivity problem is revealed in low wages. Urban labor market is subject to nominal wage fixity and an endogenous unemployment mechanism is generated.

Within intertemporal dynamics, rural labor migrates into urban centers via a simple Harris-Todaro framework with migrants responding to expected urban wage rate and rural wage differences. With this mechanism we try to capture some of the key historical adjustment characteristics of the Turkish growth patterns via effectively unlimited supplies of rural labor. This mechanism will also be explanatory in portraying a basis for the analysis of rural poverty issues.

We will distinguish mainly gaseous emissions (in terms of CO2 equivalents) for indicators of environmental pollution and climate change. Three basic sources of CO2 emissions are distinguished in the model: (i) due to industrial processes, (ii) due to (primary and secondary) energy usage, and (iii) due to energy use of households. Total gaseous emissions in the economy is the sum over from all these sources.
The model is in the Walrasian tradition with optimizing agents against market signals and a simultaneous resolution of market equilibrium of commodity prices, the wage rates and the real rate of foreign exchange. Optimization of market behaviour under tax-cum-subsidy policies are simulated, in order to reach the equilibrium. The base year for our model is 2010. It follows the historical observations between 2011 and 2014 on the level of macroeconomic indicators and makes projections for the period between 2015 and 2030.

2. ANALYTICAL STRUCTURE OF THE MODEL

Algebraic Structure of CGE Model
In this section, we improve the Computable General Equilibrium Model for Turkey in order to analyze GHG emission reduction instruments and their impacts on the economy. There is a variety of CGE modelling applications for Turkey. However, application of CGE modelling for assessing environmental policy is relatively new and rare. Telli, Voyvoda and Yeldan (2008)[1], Vural (2006)[2]; Roe and Yeldan (1996)[3], Boratav, Türel and Yeldan (1996)[4], Şahin (2004)[5], Yeldan Bouzaher and Şahin (2015)[6], Kumbaroğlu (2003)[7] ara among the important contributions in this field.[8]

The first step of the analysis is building a "base path" for the period between 2015 and 2030. The base path helps us identify the socio-economic impacts of alternative policy scenarios. "Dynamics" are integrated into the model via "sequentially" updating the static model into a medium-run of twenty years over 2015 through 2030. Economic growth is the end result of rural and urban labor population growth, investment behavior on the part of both private and public sectors, and the total factor productivity (TFP) growth performance of the Turkish economy. The objectives of the suggested macroeconomic model are the identification of main macroeconomic indicators and energy related emissions between 2015 and 2030; projection of medium an long term changes; and calculation of costs of emission reduction for 2015-2030 period.

The supply-side of the economy is modeled as eighteen aggregated sectors. In line with our focus on strategic industrial sectors and environmental policy evaluation, the disaggregation scheme focuses on the energy sectors and other sectors with significant GHG pollutions. Therefore, it brings together a myriad of activities that have significant contribution to overall production, yet loosely related to climate change. We further distinguish labor, capital and a composite of primary energy inputs (electricity, petroleum and gas and coal), together with other intermediate inputs, as the main factors of production.

Production Structure, Factors Of Production
Figure 1 displays the general production structure of the economy. Sectorial production is modeled via a multiple-stage production technology where at the top stage, gross output is produced through a Cobb-Douglas technology defining capital (K), labor (L), and intermediate inputs and primary energy composite (ENG) as factors of production. In algebraic terms, for the non-agricultural sectors the production technology is given as follows:

$$XS_i = AX_i \left[K_i^{\lambda_{K,i}} L_i^{\lambda_{L,i}} \left(\prod_j ID^{\lambda_{ID,j,i}} \right) ENG_i^{\lambda_{E,i}} \right] \qquad (1)$$

j = (non-energy intermediate inputs).

In equation 1, AX is the technology level parameter $\lambda_{K,i}$, $\lambda_{L,i}$, $\lambda_{E,i}$ denote the shares of capital input, the labor input, aggregate land input (only for agriculture) and the energy input in the value of gross output in sector i. Under the assumption of constant returns to scale (CRS) technology, for every sector i:

$$\lambda_{K,i} + \lambda_{L,i} + \sum_j \lambda_{D,j,i} + \lambda_{E,i} = 1 \qquad (2)$$

[1] Telli, Çagatay & Voyvoda, Ebru & Yeldan, Erinç, 2008. "Economics of environmental policy in Turkey: A general equilibrium investigation of the economic evaluation of sectoral emission reduction policies for climate change," Journal of Policy Modeling, Elsevier, cilt. 30(2),sayfa 321-340
[2] Vural, Bengisu (2006) "General Equilibrium Modeling of Turkish Environmental Policy and the Kyoto Protocol" Bilkent Universitesi yayımlanmamış master tezi
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[5] Sahin, Sebnem (2004) "An Economic Policy Discussion of the GHG Emission Problem in Turkey from a Sustainable Development Perspective within a Regional General Equilibrium Model: TURCO", Université Paris I Panthéon – Sorbonne
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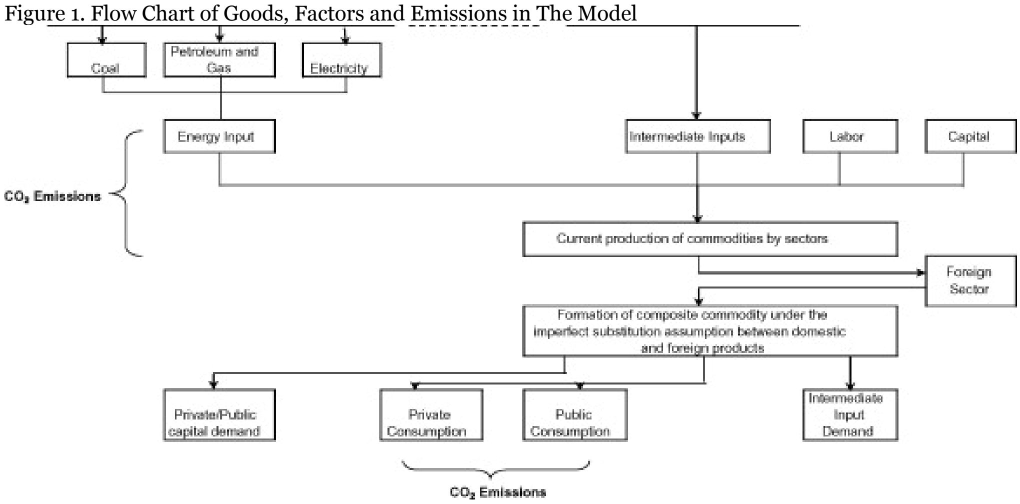
[7] Kumbaroğlu, Selçuk G. (2003) "Environmental Taxation and Economic Effects: A Computable General Equilibrium Analysis for Turkey", Journal of Policy Modeling, 25: 795-810
[8] Apart from CGE applications, there is a small number of studies, which attempts to meet the need to explain energy-environment-economics nexus from different perspectives. Katakaya and Özgaç (2001) analyses a series of economic tools that could help achieve sustainable development in the context of climate change. Ediger and Huvaz (2006) presents projections for sectoral energy use in Turkey by employing decomposition analysis. Lise (2006) tries to identify factors that account for decomposition of CO2 emissions in Turkey between 1980 and 2003.

Figure 1. Flow Chart of Goods, Factors and Emissions in The Model



As described above, together with other factors of production (capital, labor, intermediate inputs), energy composite contributes to GDP in each nine sectors of the economy. Foreign goods are considered as imperfect substitutes for domestic goods. Therefore, composite goods component, which could represent foreign and domestic goods, are introduced to the final goods markets. Final goods are demanded by the public or private sectors for consumption, or are re-introduced to the production processes as intermediate inputs. (Figure 1)

At the lower stage of the production technology, for all sectors except for electricity, the primary energy composite is produced along a constant elasticity of substitution (CES) production function using the primary energy inputs, coal, petroleum and gas and electricity:

$$ENG_i = AE_i\left[\kappa_{CO,i} ID_{CO,i}^{-\rho x_i} + \kappa_{PG,i} ID_{PG,i}^{-\rho x_i} + \kappa_{EL,i} ID_{EL,i}^{-\rho x_i}\right]^{-1/\rho x_i} \quad (3)$$

Under the above production technology, differentiation of the minimum cost per unit of primary energy inputs gives the sectoral demand for coal, petroleum and gas, renewables and electricity:

$$\frac{ID_{CO,i}}{ENG_i} = \left[\frac{\kappa_{CO,i} PEG_i}{AE_i^{-px_i}(1+CO_2tN_{CO})PC_{CO}}\right]^{1/(1+\rho x_i)} \quad (4)$$

$$\frac{ID_{PG,i}}{ENG_i} = \left[\frac{\kappa_{PG,i} PEG_i}{AE_i^{-px_i}(1+CO_2tN_{PG})PC_{PG}}\right]^{1/(1+\rho x_i)} \quad (5)$$

$$\frac{ID_{EL,i}}{ENG_i} = \left[\frac{\kappa_{EL,i} PEG_i}{AE_i^{-px_i}(1+CO_2tN_{EL})PC_{EL}}\right]^{1/(1+\rho x_i)} \quad (6)$$

where PEG is the cost of energy input composite, s is the subsidy rate on renewables, and CO2taxNj is the pollutant's fees (carbon tax rates, respectively) on input j.

Sectoral demands for labor, capital, and energy composite and intermediate inputs arise from the profit-maximization behavior of the representative firm in each sector:

$$K_i^D = \lambda_{K,i}\left[\frac{(1-t_{\mathrm{Pr}od,i} - CO_2tP)PX_i XS_i}{r}\right] \quad (7)$$

$$L_i^D = \lambda_{L,i}\left[\frac{(1-t_{\mathrm{Pr}od,i} - CO_2tP)PX_i XS_i}{(1+pyrltax)\overline{w}}\right] \quad (8)$$

$$ID_j^D = \lambda_{ID,j,i}\left[\frac{(1-t_{\mathrm{Pr}od,i} - CO_2tP)PX_i XS_i}{(1+CO_2tN_j)PC_j}\right] \quad (9)$$

Macroeconomic model builds the open unemployment position in labor markets by keeping the nominal wages being fixed in each period. If we assume that labor supply is given by (L üzeri s), we could display open unemployment as follows:

$$w = \overline{w} \Rightarrow \overline{L}^S - \sum_i L_i^D = UNEMP \quad (10)$$

Likewise, given the aggregate physical capital stock supply in each period, the capital market equilibrium implies an equilibrium profit rate for the economy:

$$\sum_{\mathrm{i}} \mathrm{K_i} = \mathrm{K^S}$$

Under the above mentioned equilibrium, it is the difference in sectorial profit rates that leads to the sectoral allocation of aggregate investments in within-period dynamics of the model. We believe that such an assumption is realistic and necessary in the flexible and liquid nature of capital in today's modern economies.

GHG Emissions and Taxation

As displayed in Figure 1, three basic sources of CO2 emissions are distinguished in the model: (i) due to industrial processes, (ii) due to (primary and secondary) energy usage, and (iii) due to energy use of households. Total gaseous emissions in the economy is the sum over from all these sources. Following Lise (2006)[9], the emissions from industrial processes is regarded to depend on the level of industrial activity, therefore is hypothesized proportional to gross output. On the other hand, total emissions due to energy usage are generated from two sources: sectoral emissions due to combustion of primary energy fuels (coal and petroleum and gas) and sectoral emissions due to combustion of secondary energy fuels (refined petroleum). Under both sources, the mechanism of emission is dependent on the level of pollutant-emitting inputs (energy input at primary and at secondary levels) in each sector. Another source of emissions within the model is the CO2 emissions that is emitted due to energy use by households.

Carbon/energy tax is thought to be introduced at per tons of carbon dioxide emitted, on production, on intermediate input usage and on consumption (CO2tP, CO2tNi ve CO2tCi) respectively. The revenues are directly added to the revenue pool of the government budget.

TOTCO2 = TOTCO2IND + TOTCO2ENG + TOTCO2HH (11)

In accordance with above structure, tax sources could be outlined as follows: Emissions from industrial processes is regarded to depend on the level of industrial activity, therefore is hypothesized proportional to gross output:

$$CO_2EM_i^{IND} = \overline{\delta}_{\mathrm{i}} XS_i \quad (12)$$

On the other hand, total emissions due to energy usage, TOTCO2ENG are generated from two sources: sectoral emissions due to combustion of primary energy fuels (coal and petroleum and gas) and sectoral emissions due to combustion of secondary energy fuels (refined petroleum):

$$TOTCO2ENG = \sum_{\mathrm{i}}\left[\sum_j \left(CO_2EM_{j,i}^{INM} + CO_2EM_{j,i}^{ENG}\right)\right] \quad (13)$$

Under both sources, the mechanism of emission is dependent on the level of pollutant-emitting inputs in each sector:

$$CO_2EM_{j,i}^{ENG} = \varpi_{\mathrm{j,i}}\ ID_{j,i} \qquad j = CO,\ PG \quad (14)$$

$$CO_2EM_{j,i}^{INM} = \overline{\varepsilon}_{\mathrm{j,i}}\ ID_{j,I} \qquad j = RP \quad (15)$$

[9] Lise, Wietze (2006) "Decomposition of CO2 Emissions over 1980–2003 in Turkey", Energy Policy, 34: 1841-1852.

Total emission of CO2 in the use of energy by households is given by:

$$TOTCO_2HH = \sum_i \overline{\psi}_i CD_i \qquad (16)$$

Here, $\overline{\psi}_i$ is the coefficient of emissions of CO2 in private consumption (CDi) of the basic fuels coal (CO) and refined petroleum (RP) by households.

Carbon/energy tax is thought to be introduced at per tons of carbon dioxide emitted, on production, on intermediate input usage and on consumption (CO2tP, CO2tNi ve CO2tCi) respectively.

Hence, energy/carbon tax revenue in the government budget, explained by equation no. (11) is transformed

into the following $TOTCO2TA = \sum_i \mathrm{CO_2tP} PX_i XS_i + \sum_i \sum_j \mathrm{CO_2tN_i} PC_i ID_{i,j} + \sum_i \mathrm{CO_2tC_i} PC_i CD_i$ (17)

Income Generation and Demand

Private sector is aggregated into one household. Household income comprises returns to labor input, net of social security taxes, land rental income, and remittances of profits from the enterprise sector, including the payments to renewables used for electricity production.

$$YHWnet = (1 - sstax)\overline{w} \sum_i L_i^D \qquad (18)$$

The net profit transfer of the enterprise income to private household is mainly composed of returns to capital as a factor of production:

$$EtrHH = (1 - t_{Corp}) \sum_i r\,K_i - EERPtrROW - NFI^G + GtrEE$$
$$r^D DomDebt^G - r^F eForDebt^E + eForBOR^E \qquad (19)$$

Here, a constant proportion trrow, of the total profit income is distributed to the rest of the world to represent the net factor income of foreigners in Turkey:

$$EERPtrROW = trrow \sum_i (1 - t_{Corp}) rK_i \qquad (20)$$

In Equation 28, GtrEE is the net transfers of the government to private enterprises, rDDomDebtG is the interest income of the enterprises (banking sector) out of government domestic debt and rFForDebtE is the interest payments of the private enterprises for their already accumulated foreign debt. As e represents the exchange rate variable, ForBORE is the new foreign borrowing of the private sector in foreign exchange terms.

Finally, the primary sources of income, together with the secondary sources of income constitute the total private income to the household:

$$YHH = YHWnet + EtrHH + GtrHH + SSItrHH + eROWtrHH \qquad (21)$$

In the equation above, GtrHH is government transfers to private households and SSItrHH is the social security institutions transfers to the households. ROWtrHH represents remittances. Private disposable income, is then private income of the households, net of income taxes:

$$YHnet = (1 - t_{Inc})YHH \qquad (22)$$

Private household saves a constant fraction, sp of its income. The residual aggregate private consumption then is distributed into sectoral components through exogenous (and calibrated) shares:

$$CD_i = cles_i \cdot \frac{PRIVCON}{PC_i} \qquad (23)$$

where PCi is the composite price of product i which consists of the unit prices of domestic and foreign commodities, united under the imperfect substitution assumption through an Armingtonian specification.

Likewise, aggregate public consumption is distributed into sectoral production commodities in fixed proportions:

$$GD_i = gles_i . \frac{GOVCON}{PC_i} \quad (24)$$

We assume, the aggregate public consumption is specified to be a constant fraction of aggregate public income:

$$GOVCON = gcrGREV \quad (25)$$

where GREV represents public revenues. GREV composes of direct taxes on wage and profit incomes and profit income from state economic enterprises. The income flow of the public sector is further augmented by indirect taxes on domestic output and foreign trade (net of subsidies), sales taxes and environmental taxes:

$$GREV = \sum_i t_{\Pr od,i} PX_i XS_i + \sum_i t_{Sal,i} PC_i CC_i + \sum_i tm_i eP_i^w M_i + \sum_i te_i eP_i^w E_i + t_{Inc} YHH + t_{Corp} \sum_i rK_i + \sum_i NFI^G + TOTCO2TAX \quad (26)$$

The model follows the fiscal budget constraints closely. Current fiscal policy stance of the government is explicitly recognized as specific targets of primary (non-interest) budget balance. We regard the government transfer items to the households, to the enterprises and to the social security system as fixed ratios to government revenues net of interest payments. Then, under a pre-determined primary surplus/GDP ratio, public investment demand is settled as a residual variable out of the public fiscal accounts.[10]

The public sector borrowing requirement, PSBR then, is defined by

$$PSBR = GREV - GCON - GINV - r_P^G e\, ForDebt^G - r^D DomDebt^G - GtrHH - GtrEE - GtrSSI \quad (27)$$

and is either financed by domestic borrowing, $\Delta DomDebt^G$ or by foreign borrowing $\Delta eForDebt^G$.

General Equilibrium and Dynamics

The overall model is brought into equilibrium through endogenous adjustments of product prices to clear the commodity markets and balance of payments accounts. With nominal wages being fixed in each period, equilibrium in the labor market is sustained through adjustments of employment.

Given the market equilibrium conditions, the following ought to be satisfied for each commodity:

$$CC_i = CD_i + GD_i + IDP_i + IDG_i + INT_i \quad (28)$$

that is, the aggregate absorption (domestic supply negative net exports) of each commodity is demanded either for private or public consumption purposes, private or public investment purposes or as an intermediate good.

The model's closure rule for the savings-investment balance necessitates:

$$PSAV + GSAV + e\, CAdef = PINV + GINV \quad (29)$$

The CAdef in the equation above determines the current account balance in foreign exchange terms and equals to the export revenues and remittances on the revenue side and the import bill, profit transfers abroad and interest payments on the accumulated private and public debt stocks on the expenditures side:

$$CAdef = \sum P_i^W E_i + ROWtrHH$$
$$- \left[\sum P_i^W M_i + \left(trrow \sum (1 - t_{Corp}) rK_i \right) / e + r^F ForDebt^E + r^F ForDebt^G \right] \quad (30)$$

The private and public components of the external capital inflows are regarded exogenous in foreign exchange units. The additional endogenous variable that closes the Walrasian system is the private investments, PINV. Finally, the exchange rate e, serves as the numeriare of the system.

The model updates the annual values of the exogenously specified variables and the policy variables in an attempt to characterize the 2015-2030 growth trajectory of the Turkish economy. In-between periods, first we update the capital stocks with new investment expenditures net of depreciation. Labor endowments are increased by the respective population growth rates. Similarly, technical factor productivity rates are specified in a Hick-neutral manner, and are introduced exogenously.

[10]Fiscal rule is considered as a conditioning that will be implemented in public finance after 2015 and will be the determinant of Turkey's public finance in the post-2015 period. In order to update the model, we combine the fiscal rule with primary surplus target and implement it in the model.

Finally, in this section, we monitor the course of debt dynamics. Previously, public sector borrowing requirement has been identified as PSBR. This is either financed by domestic borrowing or by foreign borrowing.

In Turkish Liras, foreign debt is given by;

$$e\,ForBor^{G} = (gfborrat)PSBR \qquad (31)$$

On the other hand, domestic is given by;

$$DomBor = (1 - gfborrat)\,PSBR \qquad (32)$$

Hence, intertemporal dynamics of outstanding public debt follows the below pathway;

$$DomDebt_{t+1} = DomDebt_{t} + DomBor_{t} \qquad (33)$$

$$ForDebt^{G}_{t+1} = ForDebt^{G}_{t} + ForBor^{G}_{t} \qquad (34)$$

Benzer biçimde özel dış borç stoku da:

Likewise, outstanding public debt is given by;

$$ForDebt^{P}_{t+1} = ForDebt^{P}_{t} + ForBor^{E}_{t} \qquad (35)$$

3. DATA SET

A major source of data in this macroeconomic model ise is the Input/Output (I/O) statistics, published by Turkstat. The most recent I/O data for Turkey is available for 2002. Based on th aforementioned I/O statistics, the flow of transactions within the macroeconomy are monitored via the social accounting matrix (SAM) that was built on 2005 data.

When we take a glance at the sectoral structure decomposed by the macroeconomic model, sectors with highest energy intensity are outlined as follows:

- Crude petroleum and natural gas (PG)
- Coal mining (CO)
- Refined petroleum and products (RP)
- Electricity industry (EL)

I/O tables depict the input-output relationships in the national economy and provides crticial information on the energy and CO2 emissions intensity of different sectors. Electricity generation stands out as the most prominent user of primary energy sources (coal, petroleum and natural gas). Cement industry (CE) and iron and steel industry (IS) ranks after electricity generation in terms of emissions. Energy inputs are used as intermediate inputs in other sectors of the economy. This could be followed through the electricity industry row of I/O table. Apart from the other economy (OE) sector, cement industry and iron and steel industry stand out as the most intensive consumers of electricity. Likewise, transport sector (TR) is the main user of petroleum input.

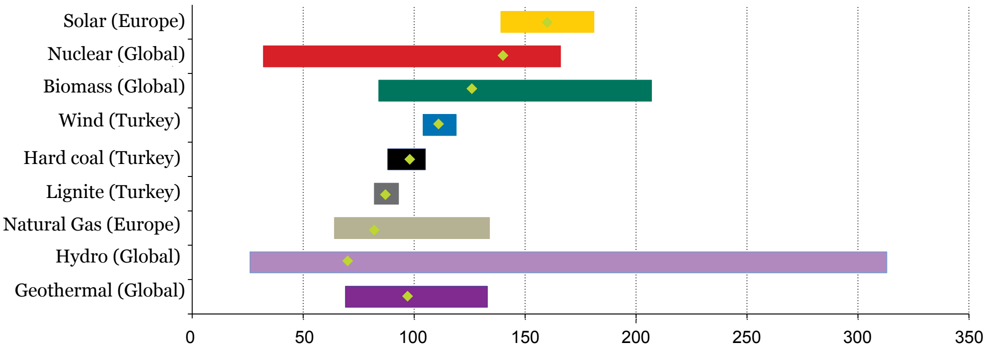
In our model we distinguish 18 sectors, 17 of which are officially recognized in the I/O. The additional "Renewable Energy Sources" (RNW) sector is deduced separately and is appended as a new sector to the I/O data. We accommodated the RNW sector using available data from World Energy Association, the World Input-Output Data, and independent studies. Our starting point is the energy balances released by the Ministry of Energy and Natural Resources (MENR) and the Levelized Cost of energy (LCOE) (Graphic 1) we obtained an estimate of the market valuation (in Million TL) for the RNW sector. The MENR data suggest that a total of 55,837 (GwH) of RNW is utilized in the production of electricity in Turkey and this is about 26% of energy utilized for producing electricity. These are 55,046 GwH for coal and 100,323 GwH for the Petroleum and Gas sectors. They take about 27% and 46% of total energy spent for electricity production.

Using the LCOE estimates from the BNEF data, we converted these energy balances into “market values”. This exercise is depicted in Table 1. Then using the ratio of RNW to Coal market valuation, we obtained a value item to be utilized in the SAM, 2010. This exercise yields a value added of 1,546.7 million TL (in fixed 2010 prices) for the renewables sector.

Table 1: LCOEs and Top-Down Cost Conversion Coefficients in Electricity Production

	(1) Input Output Data, (Millions TL)	(2) Power Generation (GWh)	(3) LCOEs (Bloomberg data, ($/MWh)	(4) Total value implied by TEIAS & Bloomberg LCOE (Million TL)	(5) Conversion Coefficients(s) Implied for I/O Data (Mill TL/MWh) (1)/(2)/1,000
Coal	1,778.0	55,046.4	90.82	7,548.8	0.00003230
Petroleum and Gas	9,540.0	100,323.7	82.00	12,422.1	0.00009509
Renewables (Including Hydro)	1,546.72	55.837.6	77.88	6,566.8	0.00002770
Input-Output Value of Renewables is estimated via (7548.8/6566.8) x 1,778 = 1,546.72 Mil. TL					
			111.00		**0.00003948**
(1) Input Output Data is based on TurkSTAT 2002 Input Output table.					
(2) Power Generation data is based on TEİAŞ.					
(3) LCOEs data is based on the report of Bloomberg New Energy Finance http://about.bnef.com/content/uploads/sites/4/2014/11/BNEF_WWF_ECF_20141118_Turkeys-power-sector_Turkish.pdf					

Graph 1: Levelized Cost Of Energy (LCOE)



In the meantime, this exercise enables us to obtain a series of conversion ratios (e) to convert energy units into market values; i.e., RNWTL (1/e) = RNWtJUL. Our exercise reveals a coefficient of 0.028 (thousand TL, 2010 prices / MWh) for the RNW sector. The same estimate is 0.032 for coal and 0.095 for the petroleum and gas.

The RNW sector is thought to be utilized only in the production of electricity, and is “produced” as a factor of production via investments in renewables. The sector has not been assigned additional labor employment.

GHG Emissions
Turkstat data as reported to the UNFCC reveal an aggregate of 411.7 million tons of gaseous (CO_2 eq) emissions in Turkey for 2010. We use the data of the UNFCC inventory accounts to allocate this total sum into sectorial and functional uses. Total CO_2 emissions from energy combustion is 226.98 mtons, with emissions due to electricity production activities (112.41 mtons) accounting for roughly half of this magnitude. A total of 48.65 mtons is emitted from industrial processes. We distinguished cement and iron and steel as the two sources of such emissions. Agricultural processes and households emit 39.8 mtons and 50.47 mtons, respectively. The emissions data are summarized in Table 2.

Table 2: Emission Invantory of 2010[11]

TOTAL CO2 Emissions From Energy Combustion (Million tons)		**226.84**
AG	Agriculture	13.69
CO	Coal	2.57
PG	Crude Oil and Natural Gas	13.86
PE	Refined Petroleum	5.58
CH	Petroleum Products and Chemicals	3.09
CE	Cement	16.36
IS	Iron and Steel	8.27
PA	Paper and Print	0.06
FD	Food Product, Bever. and Tobacco	0.01
TE	Textile and Clothing	0.06
MW	Machinery and White Goods	1.16
ET	Electronics	2.08
AU	Auto Industry	0.07
EL	Electricty Production	112.41
CN	Construction	0.02
TR	Transportation	44.45
OE	Other Economy	3.10
TOTAL CO2 Emissions by Households		**50.47**
TOTAL CO2 Emissions from Industrial Process		**48.65**
	Cement	31.48
	Iron and Steel	17.18
TOTAL GHG Emissions (CO2e)		**85.64**
	CH4 From Energy	7.47
	CH4 From Insutrial Production	11.79
	CH4 From Agriculture	39.80
	CH4 From Waste	1.38
	N2O From Transportation	19.48
	F Gases	5.72
TOTAL CO2 (eq).		**411.70**

We finally report the labor employment data across sectors and different labor types. The model distinguishes two types of labor: urban versus rural labor. The urban wage rate is given fixed and the urban labor market adjusts via unemployment. The flexibility of the real wage in the informal rural labor market is a characterization of the extend of fragmentation across the dualistic labor market structure for the Turkish economy.

[11] Turkstat, GHG Emissions Inventory, http://www.tuik.gov.tr/PreHaberBultenleri.do?id=18744

Table 3: Parameters of theLabor Market (2010)

	Sector Aggregation	Code I/O 2002 Table	NACE 1.1	Employment (1000 person)	Wages paid (Millions TL)	Avarage Wage Rate (Thousand TL per Annum)
AG	Agriculture	1	01, Agriculture, hunting and related service activities	5683.00	14265.79	2.51
		2	02, Forestry, logging and related services activities			
		3	05, Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing			
CO	Coal	4	10, Mining of coal and lignite; extraction of peat	50.99	2544.18	49.89
PG	Oil and Gas	5	11, Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding surveying	5.54	373.71	67.42
PE	Petroleum Prod Chemicals	17	23, Manufacture of coke, refined petroleum products and nuclear fuels	9.94	695.48	69.96
CH	Chemicals	18	24, Manufacture of chemicals and chemical products	330.14	8345.61	25.28
		19	25, Manufacture of rubber and plastic products			
CE	Cement	20	26, Manufacture of other non-metallic mineral products	287.74	3903.56	13.57
IS	Iron and Steel	21	27, Manufacture of basic metals	154.03	3644.14	23.66
PA	Paper and Print	15	21, Manufacture of papers	144.53	3001.15	20.77
		16	22, Publishing			
FD	Food Processing	9	15, Manufacture of food	586.04	10377.93	17.71
		10	16, Tobacco			
TE	Textiles, Clothing	11	17, Textile	1105.12	16454.52	14.89
		12	18, Clothing			
MW	Machinery, White Goods	22	28, Manufacture of fabricated metal products, except machinery and equipment	672.38	7362.88	10.95
		23	29, Manufacture of machinery and equipment n.e.c.			
		24	30, Manufacture of office machinery and computers			
ET	Electronics	25	31, Manufacture of electrical machinery and apparatus n.e.c.	210.96	3088.00	14.64
		26	32, Manufacture of radio, television and communication equipment and apparatus			
AU	Automative	28	34, Manufacture of motor vehicles, trailers and semi-trailers	201.11	3813.06	18.96
EL	Electricity	32	40, Electricity, gas, steam and hot water supply	165.00	3863.81	23.42
CN	Construction	34	45, Construction	1431.00	12070.42	8.43
TR	Transportation	39	60, Land Transport	1009.00	15431.81	15.29
		40	61, Water Transport			
		41	62, Air Transport			
OE	Other Economy		12, 13, 14, 19, 20, 33, 35, 36, 37, 41, 50, 51, 52, 55, 63, 70, 71, 74, 90, 91, 92, 93, 75, 95, 64, 65, 66, 67, 72, 73, 80, 85	10,547.55	149,153.52	14.14
	TOTAL			**22.594,07**	**258.389,57**	**11,44**

4. REFERENCE SCENARIOS

In general, evaluation of alternative policies that are studied are portrayed w.r.t. a base-run reference scenario. This reference scenario is important in terms of depicting a well-defined and consistent path of the economy and the associated environmental variables.

In this report, we portray two different base-run paths:

(i) Official Plans Scenario: In accordance with the official economic program, this scenario is based on real annual GDP growth rate projections of 5% in the medium term. However, a more realistic assessment of the global economic conjuncture indicates that this projection is rather optimistic.

(ii) Business-as-Usual (BaU) Scenario: Recent forecasts by OECD and IMF predict moderate levels of growth in global economy for the next two decades, which will be reflected in pace of Turkey's growth. Given these estimates, we rely on the database of the Climate Equity Reference Calculator, compiled and utilized by the **Climate Equity Reference Project (CERP) of Stockholm Environment Institute and EcoEquity** to set a more realistic growth trajectory for the Turkish economy over the analyzed period, 2015-2030. The database further includes basic economic (income, Gini coefficients, population etc.) and environmental variables from 195 countries, 193 of which are members of the UNFCCC. Accordingly, main variables that support the BaU scenario are as follows:

- Income: In The Climate Equity Reference Calculator Database, the historical GDP data comes primarily from the World Development Indicators Online[12], which contains data for national income from 1960 to 2012 for 195 countries of the database. Data is reported in $2010 US, at market exchange rates and is converted to Purchasing Power Parity (PPP, 2005) terms in the database. Income projection of the CERP database for 2010-18 are based on IMF's World Economic Outlook[13]. Longer estimates are based on the McKinsey Climate Desk 2.1 dataset.[14]

- CO_2 Emissions: For Annex 1 countries, estimates through 2010 of CO_2 emissions from fossil fuel use and cement manufacturing are taken from the UNFCCC[15], based on required national reports. For non-Annex 1 Countries, CO_2 data is taken from the Carbon Dioxide Information and Analysis Center (CDIAC), and include emissions from fossil fuels and cement production, but not bunker fuels.[16] Data from countries not in CDIAC's data are taken from the US Energy Information Administration or the International Energy Agency (IEA). Baseline CO_2 emissions are projected after 2012 based on convergence from historical rates of intensity improvement to long-term (2030) rates of intensity improvement projections from McKinsey Climate Desk 2.1, combined with GDP projections.[17]

- Non-CO_2 GHGs: Estimates for non-CO_2 GHGs for Annex 1 countries are taken from the IPCC's national reporting. Estimates for non-Annex 1 countries come from US Environmental Protection Agency[18], which contains historical data for every five years from 1990-2005 and projections for 2010-2030.

Both the Official Policies and BaU scenarios are constructed under the following assumptions:

1. No specific introduction of environmental policy action/taxation/quota,
2. Exogenously determined foreign capital inflows,
3. Exogenous real interest rates,
4. Endogenous real exchange rate under the constraint of the current account balance,
5. Wage rates fixed for formal and informal labor categories,
6. Fiscal policy in accordance with the announced policy rule of targeted primary surplus. Domestic interest rates (net costs of domestic debt servicing) are reduced over to 5% by 2015 onwards from their base values of 8% in 2010. The ratio of primary (non-interest) surplus is initially set at 0.04 as a ratio to the GDP over 2011-2015, then is gradually reduced to 0.0 by 2020 and is kept at that level over the rest of the base path.
7. Population growth, urban labor force growth and migration rates between regions is set exogenously,
8. Hicks-neutral productivity growth is assumed at exogenous TFP growth rates.

[12] http://databank.worldbank.org/data/home.aspx
[13] http://www.imf.org/external/pubs/ft/weo/2013/01/weodata/index.aspx
[14] http://solutions.mckinsey.com/climatedesk
[15] http://unfccc.int/ghg_data/ghg_data_unfccc/items/4146.php
[16] http://cdiac.ornl.gov/by_new/bysubjec.html#trace
[17] http://climateequityreference.org/calculator-information/gdp-and-emissions-baselines/ for details of the calculations.
[18] http://www.epa.gov/climatechange/EPAactivities/economics/nonco2projections.html

LOW CARBON DEVELOPMENT PATHWAYS AND PRIORITIES FOR TURKEY

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