Financing & Global Knowledge: Bringing the Best to Turkey and Sharing the Best of Turkey with the World

Turkey Green Growth Policy Paper:
Towards a Greener Economy

The World Bank
Europe and Central Asia Region

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April 2013

This report is the product of the World Bank Turkey Green Growth Technical Assistance Program. It was prepared by the Sustainable Development Department of the Europe and Central Asia Region of the World Bank.

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Abbreviations and Acronyms

BAT	Best Available Technology
CGE	Computable General Equilibrium
CO2	Carbon dioxide
CAP	Common Agricultural Policy
CBA	Cost Benefit Analysis
DPL	Development Policy Loan
ECA	Europe and Central Asia
EIA	Environmental Impact Assessment
ERDF	European Regional Development Fund
EU	European Union
EIA	Environmental Impact Assessment
ELV	End-Of-Life Vehicle
ETS	Emissions Trading System
FAO	Food and Agriculture Organization
GGPP	Green Growth Policy Paper
GDP	Gross Domestic Product
HEPP	Hydroelectric Power Plants
ICT	Information and Communication Technologies
IPPC	Integrated Pollution Prevention and Control
Kwh	Kilowatt hour
MBIs	Market-based Instruments
MoD	Ministry of Development
NDP	National Development Plan
OECD	Organization of Economic Cooperation and Development
PH	Porter Hypothesis
PM10	Particulate matter 10 microns in diameter
PPM	Parts per million
PPP	Purchasing Power Parity
REACH	Regulation on Registration, Evaluation, Authorization and Restriction of Chemicals
R&D	Research and Development
UNDP	United Nations Development Programme
VOC	Volatile Organic Compounds
WEEE	Waste from electrical and electronic equipment

Acknowledgements

This Policy Paper is a main product of the World Bank Technical Assistance "Turkey Green Growth Policy Note." It was prepared by Aziz Bouzaher, with inputs from Maurizio Guadagni, Sebnem Sahin, Craig Meisner, Martin Raiser, and Lezsek Pawel Kasek of the World Bank. Significant input was also provided by Erinc Yeldan, Gunes Kolsuz and Ogun Cicek who served as national consultants for the project. The report was finalized by a World Bank team led by Jian Xie and comprising Sebnem Sahin, Craig Meisner, Maurizio Guadagni, and Esra Arikan and incorporating comments received from the Ministry of Development of Turkey (MoD) and the World Bank team. Demetra Aposporos provided editorial assistance.

The World Bank Technical Assistance Program was managed by Aziz Bouzaher and Jian Xie in 2012 and 2013, respectively, with guidance from Martin Raiser and Kulsum Ahmed at the World Bank. The Program also benefited from the outstanding peer reviews provided by Michael Toman and Kirk Hamilton from the World Bank and Sherman Robinson from IFPRI and from the support and contributions of World Bank staffers Ina-Marlene Ruthenberg, Marina Wes, Mara Warwick, Stephen Karam, Mediha Agar, Carlos Pinerua, Esra Arikan, and Erika Jorgensen. Ulker Karamullaoglu and Linh Van Nguyen provided administrative assistance to the TA program.

The World Bank team is grateful to Sema Bayazit of MoD and her colleagues Arzu Önsal, İzzet Arı, Rıza Fikret Yıkmaz, Selen Arlı Yılmaz, Selin Dilekli, and other MoD staff for their outstanding support and collaboration as well as their excellent comments on the early draft of the Policy Paper. The team also acknowledges the outstanding coordination and contributions provided by the following colleagues: Alper Acar of the UNDP Ankara, Atila Uras; Binhan Ganioglu for the section on fisheries; Brian Bedard, Ragip Bayraktar, and Mesut Aktamar for the section on pastures; Cagdas Avsar and Onur Bayrakdar of the Bosphorous University for data collection and processing; Gursel Kusek, Cuneyt Okan, and Nedret Okan for the section on land consolidation; IJsbrand de Jong of the World Bank, and Yasar Dastan and Giovanni Muñoz of FAO for the section on irrigation; Jose Tavares for the section on biodiversity, Kevin Parris of OECD for the agro-ecological indicators; and Martial Bernoux of the Institut de Recherche pour le Développement, Muzaffer Avci of the Agronomy Department of the Central Research Institute for Field Crops in Ankara; and Erden Aykas of Ege University in Izmir for the section on soils and Conservation Agriculture/no-till.

Executive Summary

Context and Background

The UN June 2012 "Rio+20" Conference has sparked renewed interest in the compatibility of economic growth and environmental sustainability. The concept of "Green Growth" embodies an optimistic view that environmental stability and economic growth need not be tradeoffs and that the greening of economic growth itself provides new economic opportunities. In preparation for the Rio+20 Conference, Turkey engaged in an extensive national consultative process with a particular focus on: (a) showcasing its efforts to achieve rapid economic growth while integrating environmental sustainability requirements into key sector policies and programs, and (b) identifying potential additional policy and institutional measures to further green its economy without eroding its growth potential in the short-term.

Turkey's economic development to date is characterized by a relatively low, but rapidly increasing environmental footprint. The country has lower emissions and energy use per capita than many other emerging or industrialized economies. The alignment of environmental and energy policies with the Acquis of the European Union have encouraged increasing levels of resource efficiency and improved environmental management. Turkey is at a juncture where appropriate policies could allow the country to leapfrog to higher levels of efficiency and thus decouple growth from increasing environmental pressures at much lower levels of resource utilization. At the same time, authorities recognize the environmental challenges associated with rapid urbanization, growing industrialization and pressure on water resources from competing agricultural and urban demands, exacerbated by Turkey's vulnerability to climate change.

This Green Growth Policy Paper (GGPP) reviews the scope for green growth in Turkey. The Paper was prepared by the World Bank, at the request of the Ministry of Development (MoD), as a contribution to the analytical activities and stakeholder consultations aimed at informing Turkey's vision for greening its economy, by identifying opportunities to better integrate environmental sustainability considerations and related social and economic issues into the mainstream economic growth and competitiveness agenda. It should be noted at the outset that Turkey's development vision puts human development at center stage. This GGPP does not attempt to evaluate the distributional implications of policies to green Turkey's development path – such analysis will however be critical to building political support for inclusive, green growth.

Green Growth and Turkey's Development Vision

Green growth is a relatively new concept stemming from a reevaluation of the economic opportunities for wealth and job creation that may result from adopting more environmentally sustainable technologies. According to the World Bank (2012b), "*at the heart of green growth is the underlying assumption that we are not using environmental assets efficiently. Therein lies the potential for green growth—growth that is efficient, clean and resilient. Green-growth policies aim to foster sustainable development by reconciling the need for environmental sustainability with that for economic growth and social improvement.*" While the traditional sustainable development debate revolved around improving the long-term condition of environmental resources and protecting and enhancing ecosystem services, proponents of green growth emphasize both the need to protect natural capital for economic and poverty reduction purposes, and the view that well-designed environmental policies can achieve environmental sustainability at low cost, while helping to stimulate growth.

The concept of green growth continues to be researched and debated but is generally accepted to contain four main elements: (i) environmental protection, (ii) mitigation action against climate change, (iii) adaption to the effects of climate change, and (iv) institutional and technical innovation and the creation of green jobs. In terms of the catalogue of policies to support these four overarching objectives, it is possible to distinguish between regulatory actions, including environmental taxes and pricing policies, measures to boost skills and generally increase the adaptability of the economy, specific measures to boost innovation and development planning tools to ensure that public assets and services are adapted to the potential impacts of climate change and to avoid costly lock-in to antiquated technologies. This GGPN does not cover the whole spectrum of policies. At the request of the Government of Turkey, it concentrates primarily on regulatory and pricing measures in line with EU requirements and generally evaluates the importance of complementary policies to promote green jobs and innovation.

The Turkish government's 2023 vision sets forth ambitious development goals, including making Turkey one of the world's ten largest economies and completing full membership negotiations with the EU by 2023. Turkey has established broad-based policy priorities to achieve this vision, and cover macroeconomic stability and fiscal management, labor market reforms and investment in workforce skills as well as measures to improve the investment climate, fundamental education reforms and continuing health and social welfare reforms. In terms of sustainable development, government policies emphasize investments in renewables and energy efficiency--out of energy security considerations and to contribute to climate change mitigation--and tighten environmental standards and water sector reforms to reduce the environmental footprint of further rapid economic growth. The stated objective of compliance with the EU Environmental *Acquis* offers significant opportunities for greening the Turkish economy through improved management of waste and effluents in the industrial sector, emission reductions in large combustion plants, and by seeking to significantly increase wastewater and solid waste management coverage throughout the country.

This GGPP contributes in particular to an evaluation of the opportunities and costs of EU compliance in core environmental areas. The working definition of green growth in Turkey underlying the analysis in this report is: ***The implementation of environmental policies in strategic sectors, aimed at achieving Turkish and EU standards (as reflected in the main EU Environmental Directives), with special emphasis given to resource efficiency, clean production, consumption, and reduced emissions intensity, combined with policies that foster employment and innovation in environment-related sectors.*** A key premise is that these policies will accompany ongoing growth-enhancing economic policies aimed at increasing the level of investment and its efficiency, achieving stronger employment generation and higher labor productivity, managing capital inflows, and other measures to enhance competitiveness and mitigate risks. Clearly, policy action along a broad front will be required.to achieve Turkey's ambitious development objectives.

How Green is Turkey's Economy Today?

Turkey's economy is characterized by a relatively low, albeit rapidly increasing, environmental footprint. Compared to industrialized countries or other emerging market economies, Turkey stands out as having relatively low carbon emissions per unit of GDP. At the same time, emissions increased much faster than in other OECD countries in recent decades. Aggregate CO2 emissions stood at 369 million tons in 2009 and are estimated by the Bank study to triple by 2030. As such, Turkey has not yet decoupled its economic growth from rising energy use, a process that has been underway in advanced OECD countries for the past decade or so. Generally, however, Turkey's rapid economic growth has not come at the expense of a rapid depletion of its natural capital stock. While sector-specific challenges deserve to be highlighted, on the whole Turkey compares favorably with other industrialized and emerging market economies (see Box ES). This suggests that if policies could be enacted that promote greater resource efficiency and pollution abatement without jeopardizing economic growth, Turkey could progress towards a high income without a dramatic increase its environmental footprint. This is the opportunity--and the promise--of green growth for Turkey.

Turkey has already made progress on some elements of green growth. Out of the five elements underlying green growth (environmental protection; mitigation; adaptation; innovation; and green jobs), Turkey ratified the Kyoto Protocol in 2009. In addition, in May 2010 the Government approved a National Climate Change Strategy, and in July 2011 published a National Climate Change Action. Moreover, as part of negotiating the Environment Chapter for the EU accession process, Turkey has made considerable effort in harmonizing its environmental laws with those of the EU and has begun implementing them in several areas, including waste and water management, and environmental impact assessments (EIA).

To achieve the full benefit of existing and future environmental policies, complementary measures will be needed to alleviate structural rigidities in the labor market and to improve the overall climate for investment and innovation. The increased costs associated with meeting tighter environmental regulations and standards and/or paying higher prices for energy and water use may cause negative short-term effects on employment and income. These negative effects will be exacerbated if economic adjustment is hampered by rigid labor markets and barriers to enterprise entry and exit. Turkey does not compare well with the leaders in green growth, such as Germany or the Scandinavian countries, where labor markets are considerably more flexible and where the business environment is considerably more investor friendly. In the context of an overall flexible economy, clear government signals through regulatory and pricing action, combined with fiscal and other measures to encourage investment and innovation in environmentally sustainable technologies, may help offset negative impacts on income and employment. This GGPN presents some stylized general equilibrium simulations that highlight the importance of these complementary measures.

Basic Results and Recommendations

There is considerable potential for greater resource efficiency and pollution abatement in Turkey's seven strategic sectors. These sectors include: the automotive industry, iron and steel manufacturing, construction, machine building, white goods, electronics and agriculture. A review of existing sector studies as well as focus group discussions with representatives of these seven sectors suggest varying levels of the adoption of global best practice technologies and standards with respect to environmental sustainability. The automotive sector, for instance, is largely on par with European producers in terms of environmental management, and would appear to be relatively less vulnerable to regulatory policies to ensure full EU compliance. The automotive sector is shown to have significant growth potential in a green growth scenario. The same is true for white goods and electronics, which, like the automotive sector, have benefited from significant FDI inflows. Turkey's iron and steel industry has undergone major modernization and is now significantly cleaner than that industry in other emerging markets. Further greening opportunities exist in substituting imported scrap for domestically recycled metal waste. The cement industry, despite significant improvements in recent years, remains at some distance from EU pollution and emission standards, and the costs of compliance could be prohibitive without large-scale investments. Potential for energy efficiency gains lie in the building sector and, in terms of water usage, in the agricultural sector, where a combination of regulatory requirements and pricing policies may induce technological advancements.

A detailed analysis of the marginal costs of further emission or pollution abatement would require a detailed sectoral analysis. Existing marginal cost abatement curves suggest negative costs for abatement of many energy efficiency investments (Deichmann et al., 2012). For such investments, positive environmental outcomes accrue as a co-benefit to investments justified on financial grounds alone. Other types of investments are certainly justified on environmental grounds, but wouldn't pay for themselves without either tougher regulatory requirements or pricing measures installed by the government. This is true for many pollution reduction investments, which have large public health and environmental co-benefits that do not accrue directly to the investor. It may also be true of investments to improve the efficiency of water use, which may require higher water tariffs to internalize future rents related to scarcity. The integration of marginal cost abatement curves into a general equilibrium analysis can illustrate how an economy adjusts to specific environmental or emissions targets and how much of this adjustment happens internally through technological upgrading by private enterprises (Jorgenson, 2010).

To take a pilot step in the green growth direction and get an understanding of the macroeconomic effects of a mix of environmental policies, a General Equilibrium model was constructed. The model computes income, employment and the fiscal effects of taxes on air pollution (including PM10 and CO2), wastewater, and solid waste with the objective of achieving EU performance standards, and promoting sustainable agriculture through Conservation Agriculture such as reduced or no-tillage, improved pasture management, and efficient water use. The model includes basic assumptions about the relationship between production and environmental outcomes, which by and large do not account for internal cost abatement. The model thus sets up a worst-case scenario of the impact of tighter environmental policies on macroeconomic outcomes and social welfare and then introduces a series of variations to understand how this impact can be mitigated and eventually offset completely. The model is stylized and there is considerable scope for refinements in the context of implementing specific green policies into Turkey's 10^{th} National Development Plan and beyond.

The General Equilibrium Analysis produced the following basic results:

Given the current structure of Turkey's economy and in particular its-relatively high levels of labor market rigidity, introducing environmental taxes with the objective of reaching EU performance standards would be costly. In particular, output and employment in pollution and emission intensive sectors would fall considerably and the resources freed as a result would not be absorbed quickly in new activities. Instead, the economy would adjust through declines in rural wages and the re-absorption of labor as low productivity, informal rural employment.

Relaxing the assumption of labor market rigidities dramatically reduces the welfare costs of environmental policies. Output falls are cut in half because wages in the formal sector are permitted to adjust, allowing enterprises to offset the costs of environmental taxes through lower labor costs. An alternative way of thinking about this is to assume that the government returns all tax revenues from environmental taxes to the formal sector through reduced payroll taxation.

The welfare benefits of reduced emissions and pollution vary significantly when different environmental policies are introduced sequentially. Because of the significant positive health effects of reduced PM10 emissions and the resulting impact on labor productivity, taxes to reduce PM10 emissions have much lower welfare costs than taxes to reduce other types of pollution, even emissions which contain CO2. Very significant welfare gains can also be obtained by combining higher water tariffs with the introduction of best practice technologies in water management (these can more than offset the negative effect of water pricing on agricultural output). This result is obviously a function of the greater precision with which the negative welfare effects of PM10 pollution and the positive effects of improved water management can be modeled. Economists arguing for green investments as an insurance policy point out the potentially disastrous and non-linear impacts of failing to contain climate change (Deichmann et al., 2012). Because these benefits are hard to model and quantify, arguably the responsibility for climate action as an insurance policy should fall disproportionately on the largest CO2 emitters in the industrialized world.

The negative welfare effects of environmental taxes can be more than offset by policies that transfer environmental tax revenues to support green jobs and increased innovation. The model results in this case are highly stylized as they assume a leading role for the public sector in recycling environmental tax revenues. One scenario considered used pollution tax revenues to promote green jobs, such as in the recycling of solid waste or in improving energy efficiency in public buildings. In the second scenario, taxes from CO2 emissions are recycled through public R&D spending, boosting Turkey’s overall R&D spending and the productivity of its economy. A combined scenario of green jobs and additional innovation spending will boost GDP and employment by 2.4 percent and 3.5 percent, respectively, above the base case without any new environmental measures.

While the model results are highly stylized, they nonetheless point to several important policy recommendations for Turkey, if it wishes to achieve green growth:

First, green growth policy is to a large extent consistent with traditional growth policy. The flexibility of a country’s labor (and other market factors), the extent to which prices reflect underlying economic scarcities, the quality of a country’s investment climate, the availability of a skilled labor force and the quality of a country’s national innovation system are all ingredients of good growth policy highlighted as critical elements of good green growth policy by the analysis in this GGPP. Turkey has had an excellent track record of high growth over the past decade, but to move forward and remain in the bracket of high income economies, Turkey will need to close the performance gap to the world’s leaders in the investment climate, the availability of an educated workforce and the quality of its national innovation framework (see for instance OECD, 2012, Economic Survey for Turkey).

Second, a country that has adopted a policy framework conducive to private investment and innovation will find it much easier to encourage investment and innovation in green sectors. The analysis in this GGPP suggests that policies that simply increase environmental taxes are unlikely to improve welfare or lead to job creation in new green sectors, unless they are accompanied by policies that encourage the introduction of new technologies, the exit of inefficient and entry of new, more efficient firms, make labor markets flexible so that workers move to less polluting industries, and promote links between science and business to boost innovation. In particular, the analysis highlights the importance of flexible labor markets in Turkey that allow the economy to adjust to higher environmental taxes. By the same token, targeted social transfers to poor and vulnerable households would help mitigate any distributional impact of environmental taxes.

Third, the most important actor in greening an economy is the private sector, but consistent public signals and well-targeted support can help to catalyze change. Turkey would benefit from a mix of policy instruments better targeted at its green innovation potential. This includes not only policies to spur access to technologies and capital, but a more focused set of both supply-side 'technology-push' policies (including matching grants for collaborative early-stage technology development) and demand-side 'market-pull' policies (including prices and regulations) – that should induce green innovations across many industries. Empirical evidence shows that well-designed environmental regulations, incentives, and standards stimulate significant innovation by firms. Firm surveys in Europe show that existing or future environmental regulation is the top driver for firms to introduce environmental innovation. Similarly, international sustainability standards can help local firms upgrade their environmental practices, a form of catch-up innovation.

Finally, an important issue (which is beyond the scope of the present analysis) is the role of structural change as a potential engine of green growth. This note and the model used to motivate its conclusions have focused on cost abatement and innovation in existing sectors. However, as the structure of the economy changes, new sectors may come into being in information and communication technologies (ICT) and other services sectors that may not exist or today play only a minor role in the Turkish economy. Over the long term, it is likely that structural change will contribute significantly to mitigating the environmental impacts of economic growth. Even without such effects, this note has shown that with appropriate policies the growth – and environment trade-offs – can be substantially mitigated.

Box ES: How green is Turkey compared to developed and emerging economies (selected indicators)

According to the World Bank, in 2008 Turkey's total wealth was estimated at 11,717 USD billion, which is about US$ 160,000 per capita, or about 3-4 times less than in advanced OECD countries, but above most of the emerging economies. The lion's share of Turkey's wealth is accounted for by intangible capital, while produced and natural capitals have relatively small shares. Crop and pasture land dominate Turkey's natural capital comprising about 85%. The structure of wealth differs significantly across countries.

Turkey's adjusted net savings ratio has been declining, mirroring the downward trend in the standard national savings ratio. The adjusted net savings ratio, a proxy for the total wealth developments over time, has declined by half since the 1990s, reaching 7-8% in the 2000s. However, natural dis-saving from particular matter pollution and CO2 emissions has been reduced as a share of national income, while savings resulting from investments in human capital have increased. Turkey's rapid economic growth over the past decade has not come at the expense of a large depletion of the natural capital stock, although several sector specific risks deserve to be highlighted.

***Water.* Turkey is in the middle of the range according to an indicator of annual freshwater withdrawals as a percentage of total internal resources, but ranks lower in terms of water productivity.** In addition, health risks related to water pollution, and limited access to clean water and sanitation, must be factored into the impact of water on a comprehensive measure of national wealth.

***Forests and lands*. While Turkey ranks low on deforestation and forest degradation, it has a relatively lower forest cover (about 15% of land area).** With about half of the land area devoted to agriculture, Turkish crop yields are often lower than those of many comparable OECD countries such as Greece, Italy, and Spain. Moreover, about 70% of the arable land is at risk of erosion, and agricultural productivity is thus directly affected by the management of Turkey's natural capital.

***Biodiversity.* Turkey's investment in marine protected areas is at the lower end of the scale,** significantly below countries like Germany and Italy, which have a comparable length of shore line. There is clearly scope for Turkey to increase its investment in the protection of marine biodiversity.

***Air quality*. Turkey has relatively low levels of particulate matter (PM) pollution.** The indicator is an important factor in childhood mortality and lung disease. High PM concentration may lead to respiratory infections, asthma, increased risk of cardiovascular diseases, and cancer. Moreover, Sulfur dioxide is the major source of acid rains, which have adverse effects on fish stocks, forests, soils, and therefore diminish agricultural productivity.

- **Total wealth** is composed of: (i) intangible (human and social) capital; (ii) produced capital (machinery, equipment, structures, and urban land); (iii) natural capital, consisting of energy resources (oil, natural gas, hard coal and lignite), mineral resources (bauxite, copper, gold, iron, lead, nickel, phosphate, silver, tin, zinc), timber and non-timber forest resources, crop, pasture land, and protected areas; and (iv) and net foreign assets.
- Gross Domestic Product **is an imperfect measure** in reflecting living standards as they depend not only on the production level, but are also closely related to the accumulation of wealth, which can be depreciated or depleted over time. Accumulated wealth can be decomposed into produced, natural and intangible capital.
- **Adjusted net savings (ANS)** are calculated as a proxy for total wealth. ANS is a sum of net national savings (NNS) and education expenditure (EE), minus: energy (ED), mineral (MD), and net forest depletion (NFD), CO_2 (CO_2D) and particulate emissions damage (PMD).

Source: See main report

1. Introduction

1.1 Context and Background

As a follow-up to the UN summits in Stockholm in 1972, Rio de Janeiro in 1992, and Johannesburg in 2002, the international community prepared to come together to take stock of the achievements of the past 20 years, and renew its commitment to a sustainable development agenda.[1] This happened at a time when new challenges and opportunities have emerged, including the recent and on-going food, fuel, and financial crises, and the growing global concern about the impact of climate change and the destruction of ecosystems and biodiversity. The focus of the UN June 2012 Rio+20 Conference was on two themes: 1) a green economy in the context of sustainable development and poverty eradication; and 2) the institutional framework for sustainable development.

As its contribution to the Rio+20 Conference, Turkey has prepared a "vision paper" on green growth, with a particular focus on: 1) showcasing its efforts to achieve rapid economic growth while integrating environmental sustainability requirements in key sector policies and programs, and 2) as part of the preparation of its 10th National Development Plan and beyond, identifying potential additional policy and institutional measures to further green its economy without eroding its growth potential in the short-term.

By all accounts Turkey's impressive economic performance of the past decade[2] has been accompanied by important social and environmental progress. In a large measure this is due to the fact that Turkey has put a range of regulatory and institutional reforms in place, as well as prioritized investment programs in energy, infrastructure, pollution mitigation, and natural resource management. In addition, convergence efforts with the EU environmental *acquis* have provided an impetus and drive to strengthen environmental management. However, increasing environmental pressure associated with urbanization, growth in energy use, industry, transport, tourism, and agriculture, as well as the emerging issues associated with climate change, remains a long-term challenge.[3]

The Ministry of Development (MoD) initiated a program which included several background studies to help the Government showcase its efforts of mainstreaming the environment since the first Environment Summit in Rio in 1992, and focus attention on future measures needed for a Green Economy. To help achieve the objectives of this program, the MoD asked the World Bank to prepare a Green Growth Policy Paper (GGPP) as part of the analytical activities and stakeholder consultations that aimed to inform Turkey's vision for greening its economy. The GGPP helped inform Turkey's green growth agenda by identifying opportunities to better integrate environmental sustainability considerations

[1] The standard definition of sustainable development as per the Brundland Commission Report on Environment and Development: Our Common Future (1987), is assumed throughout.

[2] Turkey's GNI per capita for the period 2002-2008 reached US$ 9,260, more than threefold that of the period 1990 (World Bank, 2009). GNI per capita in 2010 was US$ 9,890.

[3] The EC Enlargement Strategy and Progress Report for Turkey for 2011 summarized the status of progress on environment and natural resource management as follows: *"In the environment area, Turkey has made good progress on waste management, whereas only limited progress can be reported on horizontal legislation, air quality and industrial pollution control and risk management. Turkey made very limited progress on water quality, chemicals and on administrative capacity. No progress can be reported on nature protection. Regarding climate change, Turkey made limited progress on awareness-raising on EU climate requirements, but a more robust and ambitious climate policy, both domestically and internationally, has yet to be established. There is a need to enhance administrative capacity."*

and related social and economic issues into the mainstream economic growth and competitiveness agenda.

Green growth is a relatively new concept. According to the World Bank's forthcoming flagship report,[4] *at the heart of green growth is the underlying assumption that we are not using environmental assets efficiently. Therein lies the potential for green growth—growth that is efficient, clean and resilient. Green growth policies aim to foster sustainable development by reconciling the need for environmental sustainability with that for economic growth and social improvement*[5]. The OECD report (2011), also highlights five additional sources of economic growth from environmental policies: improved productivity in the use of resources, opportunities for innovation, creation of new markets and job opportunities, boosting investor confidence, and stability in macroeconomic conditions (e.g., reduced resource price volatility).

While there is no consensus on how to operationalize green growth, most approaches would include four main elements: *mitigation* (of greenhouse gas emissions); *adaptation* (to a changing climate); *other environmental protection* (clean air and water, natural beauty and biodiversity); and *innovation and green jobs* (the hypothesis is that a shift to green growth will spur technological innovation and promote trade competitiveness in new industries) (Box 3.1). The relative priority put on each of these elements will vary across countries. It is also now generally accepted that Green growth policies operate through several channels including: (i) prices and fiscal systems; (ii) institutions, investments and behavior; and (iii) innovation and technologies. While the analysis and recommendations provided in this report are grounded in the general framework provided by the four elements of green growth, a comprehensive treatment is beyond the scope of the report; its focus is mainly on environmental protection, including GHG emissions, and the sustainable management of land and water resources in relation to agriculture.

1.2 Approach

Extensive discussions with MoD led to the identification of four main questions that encapsulate the issues and the type of insight sought by decision makers in Turkey, and that guide the analysis undertaken in this report:

i. How green is Turkey?
ii. How will compliance with key environmental regulations to meet EU directives--which is one important part of greening the Turkish economy--impact economic growth and employment (both aggregately and for key sectors)?
iii. Can Turkey sustain the current high growth path by greening its production in key growth and/or export leading sectors, identified by MoD as: agriculture, automotive, construction, electronics, iron and steel, machine industry, and white goods?
iv. What policy instruments can be used to maximize greening at least cost (or maximum benefit) to the Turkish economy?

For the purposes of timely contributing to the Rio+20 Conference, and given time and resource constraints, the MoD argued for including in the analysis key sectors which are important for economic

[4] World Bank, 2012. Inclusive Green Growth: The Pathway to Sustainable Development.

[5] Throughout the report, the expressions/words "greening," "green measures," and "green policies" will be used interchangeably to refer to this broad definition of green growth. In section III, a more specific definition of green growth for Turkey in the context of the analysis undertaken in this report will be presented.

growth (both now and in the future) and where there may be significant potential for contributing to the 'greening' agenda. Using the four criteria below led to the selection of seven sectors to include in the analysis: agriculture, plus six industrial sectors (automotive, construction, electronics, iron and steel, machine industry, and white goods):

i. Sector highlighted as key drivers of future growth in Turkey's 9th National Development Plan (NDP) (2007-2013);
ii. Sector viewed as having a large potential for 'greening';
iii. Sector has a strategy from which to draw information for analytical purposes; and
iv. Sector is the subject to compliance with key applicable EU Environmental Acquis Directives since these are a major driving force for sector reform and transformation, and entail potentially significant public and private sector investments in both the short and longer term.

The scope of the GGPP was also limited so as to avoid replicating results from recent studies. In 2010, the MoD commissioned a comprehensive study to assess the impacts of climate change, energy efficiency and greenhouse gas emissions on the economy[6], which was viewed by the Government as sufficiently covering the climate change aspects of Green Growth. While the Government requested that the GGPP should cover issues related to cleaner (or greener) production and consumption, because a key aspect of greening relates to reducing pollution and improving resource use efficiency, issues of Greenhouse Gas emissions were included the analysis.

While the study was designed as a pilot both in terms of scope and methodology, it does attempt to provide answers to the four questions of interest to Turkish decision makers described above. Within this framework, the overall objective is to help shed light on growth trade-offs faced by Turkey as it implements a 'green agenda' linked to its own objectives, as well as compliance with EU Directives and OECD principles. This study uses analytical work involving desk review and economic modeling, including: (a) using available data to provide a general benchmarking of Turkey against other comparator countries; (b) a review of the policy and institutional frameworks in Turkey, and a more focused assessment of green growth constraints and opportunities in agriculture and the six identified industrial sectors, using both desk review/research and sector focus group meetings; and (c) a pilot, economy-wide analysis of a selected number of green growth policy scenarios using a computable General equilibrium (CGE) approach.

The purpose of the analytical desk review was to understand where Turkey stands compared to other countries, and what we know about green policies across key strategic sectors of the Turkish economy. This was done using a review and assessment of the policies and institutions for environment and natural resource management already in place, viewed through a green growth lens. The desk review also highlighted further policy priorities to realize the potential benefits of green growth.

The main contribution of the pilot economic analysis is two-fold: (i) to test the feasibility of using a CGE approach to provide useful information on the (growth, employment, and fiscal) impact of a specific mix of green policies, despite several limitations in the pilot effort; and (ii) to lay the groundwork for future more comprehensive studies to help build the data and analytical capacity to support the Government's strategy for managing climate risk and implementing green growth policies, in the 10th NDP and beyond.

6 Voyvoda and Yeldan (2010), *Report on Macroeconomic Analysis of Alternative Policy Options: The project on the determination of rational steps at the national level in the field of global warming*, Centre for Economics and Foreign Policy.

1.3 Report Outline

The report is organized in seven Chapters. Following the introductory Chapter, Chapter 2 sets the stage by reviewing the structure of Turkey's economy and its performance, as well as the challenges and opportunities provided by Turkey's current growth path from implementing a 'green agenda' linked to achieving standards set by EU Directives and OECD principles; this is followed by a review of where Turkey stands compared to developed and emerging economies, in terms of what is broadly understood as a comprehensive approach to green growth. Chapter 3 uses a narrower, more operational, definition of green growth for the purposes of the analysis undertaken in the Policy Note. Chapter 4 presents an assessment of the seven strategic sectors selected for a more focused analysis. It also highlights the greening potential within these sectors. Chapter 5 reviews the range of policy instruments available in the EU and other emerging international experiences, as well as the relevance of these policy options to the objectives of the Policy Note. Chapter 6 presents the economy-wide framework and the results of the pilot economic 'impact analysis' of two types of greening scenarios: an urban scenario (linked to production and consumption by firms and households) and a rural scenario focused on agriculture. Finally, Chapter 7 concludes with an initial set of recommendations.

2. Turkey's Green Growth Challenges and Opportunities

2.1 Turkey's economy and its recent performance[7]

As Turkey continues to seek faster output growth, innovate, and create jobs, it also wants to take advantage of opportunities for greening its economy by moving towards a cleaner environment and more sustainable use of its natural resource base. From the emerging green growth literature and international cross-country evidence,[8] this would require flexibility more able economy and the availability of qualified human resources and well-designed policies to help achieve outcomes that take advantage of synergies and reduce potential trade-offs between economic and environmental objectives.

Turkey's economy is increasingly dominated by the service sector, which currently contributes about 68% of the GDP, followed by industry (23%) and agriculture (9%) (Figure 2.1). While this breakdown differs from that of Euro Area countries (72% services sector 72, 26% industry, and less than 2% agriculture), further movement towards expansion of services at the expense of industry and agriculture would presumably result in declines in intensely-used resource (including land, water and energy), as well increased emissions (pollution and waste). At the same time, the relatively high share of manufacturing in value added, and around a 70% share of manufacturing in industry (Figure 2.2) could be interpreted as a country's asset, since manufacturing is an important economic driver through its role in trade (both imports and exports), FDI, rapid absorbing of technological change, and skilled labor)[9] development.

Figure 2.1 Structure of value added (% of total), 2010 or latest available year

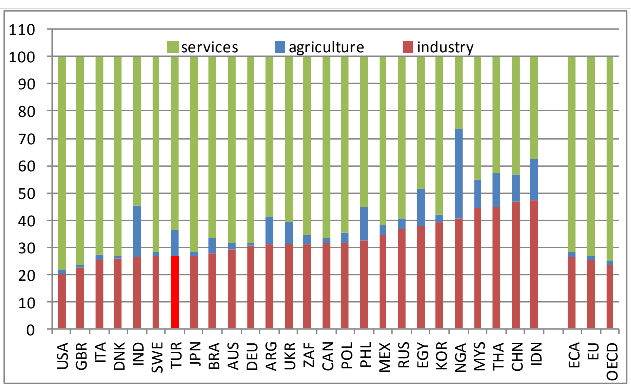
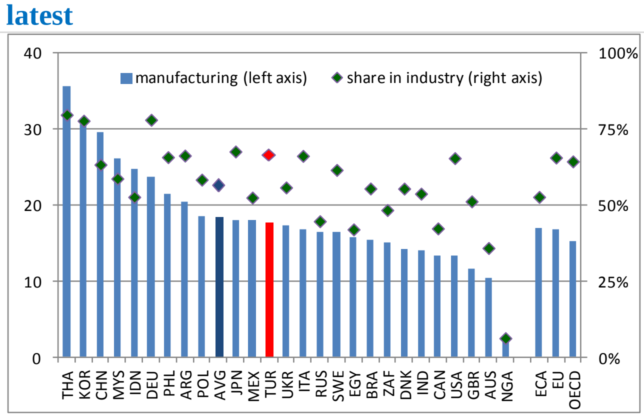


Figure 2.2 Manufacturing, % of total value added, and share of manufacturing in industry, 2010 or latest



Source: World Bank staff calculations based on the World Development Indicators.

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7 This section largely on the recent World Bank Development Policy Loan (DPL) report on Environmental Sustainability and Energy Sector Development Policy (World Bank 2012).

8 Toman (2012) and World Bank (2012c)

9 Meschi (2011)

Following a steep decline in 2009 the Turkish economy is currently experiencing a robust recovery.[10] Public finances are improving and confidence in a lasting transformation of the country's economic prospects and stability is increasing. Nevertheless, the rapid expansion of economic activity, driven by strong domestic demand, has led to significant and rising external imbalances that pose a threat to macroeconomic stability.

Turkey's macroeconomic policies and structural reforms over the past decade have yielded robust economic growth. Real GDP increased by more than 50 percent between 2001 and 2010 and the average growth rate was nearly 7 percent during 2003-07, up from an average of 4 percent during the 1990s. Growth resumed rapidly after the 2008-2009 global crisis, at 9.2 percent in 2010 and 8.5 percent in 2011. Per capita income now stands at US$10,444. General Government primary surpluses averaged about 4.6 percent of GDP over 2004-10, and gross public debt as a percentage of GDP fell from 73.4 percent in 2002 to 42.2 percent in 2011, in spite of an increase during the 2008-09 global crisis. Inflation came down from a high of around 70 percent to under 10 percent. Healthy export growth (15 percent per year over 2004-11) contributed to limiting external vulnerability.

Turkey recovered from the 2009 recession quickly, with a GDP growth of 9.2 percent in 2010 and 8.5 percent in 2011. The strong growth was facilitated by rapid credit growth and high capital inflows (supported global liquidity and healthy Turkish balance sheets). Real output rose almost ten percent over its pre-crisis peak. During the past two years, growth has been driven by domestic consumption and investment demand from the private sector, fueled by historically low interest rates. In 2010, while private consumption and private investment accounted for about 5 percentage points each to the 9.2 percent overall growth rate, net exports made a negative contribution.

Labor force participation increased and unemployment fell below pre-crisis levels. After peaking at 14.8 percent in April 2009, seasonally adjusted unemployment has decreased steadily, falling below pre-crisis levels to 9.0 percent by January 2012. Nonetheless, open unemployment in Turkey remains high in absolute terms, and the Turkish labor market is characterized by low activity rates and high job informality. The employment rate of working age (15-64) women (26 percent in 2010) is the lowest among OECD and Europe and Central Asia countries. And about 40 percent of those employed are working in the informal sector, although job informality has decreased somewhat.

Turkey's growth path is predicated on the continued progress of its unfinished structural reform agenda. Such reforms include the implementation of the new commercial code and code of obligations, labor market reform, measures to bolster long-term fiscal savings and the reduction of imported fuel dependency through an expansion of renewable energy use in electricity generation and improvements in energy efficiency. The Government continues its efforts to enhance labor market flexibility while protecting workers. The current account deficit is projected to narrow in the outer years through structural reforms, higher domestic savings and enhanced competitiveness as well as a recovery in global growth.

2.2 Opportunities for greening provided by Turkey's growth path

The Government of Turkey has set itself ambitious development goals. Turkey intends to be one of the world's 10 largest economies by 2023, the 100th anniversary of the founding of the Turkish Republic.

[10] EC 2011 Enlargement Strategy and Progress Report.

The Government's 2023 vision[11] aims for gross domestic product to reach US$2 trillion, the foreign trade volume to exceed US$1 trillion; per capita income to reach US$25,000; and, unemployment to decline to 5 percent. Turkey also aims to complete full membership negotiations with the EU, further develop Istanbul as a leading international financial hub, and become the leading manufacturing and service provider both in the region and beyond. To achieve Turkey's development goals and realize sustainable shared growth, the Government is pursuing a wide range of economic policies and structural reforms, set out in its Ninth Development Plan for 2007-2013),[12] 2012-2014 Medium-Term Program, and annual programs. Top priorities include: (a) sound macroeconomic and related structural fiscal policies to maintain stability and reduce short and medium term vulnerabilities; (b) favorable investment climate, labor market, and skills reforms to increase competitiveness and create jobs, especially for women and youth; (c) fundamental education reforms and continuing health and social welfare reform to increase productivity and help share the gains from growth through equal opportunities; and (d) continuing energy and water sector reforms and investments to further increase energy efficiency, the use of renewable energy, and energy security and help reduce greenhouse gas emissions and mitigate and adapt to climate change.

As part of its EU accession process, Turkey is negotiating the Environment Chapter (compliance with the EU Environmental *Acquis*), which offers significant opportunities for greening its economy. The impact of the EU acquis on policy making is currently strong in national and local environmental policy in two areas. First, Turkey has already made a considerable effort in harmonizing its environmental laws with those of the EU. This is expected to generate greater environmental gains especially in the industrial sector by improved management of waste and effluents and overall emission reduction of large combustion plants. Second, the new e-environment permitting system, combining all of the licenses and permits required by industrial installations into a single e-environment permit, is an important step towards implementing the EU's Integrated Pollution Prevention and Control (IPPC) Directive, a major building block of the capacity for environmental risk management.

Environmental compliance is neither costless nor easy to achieve. The environmental investments that Turkey would have to make to implement the EU Environmental *Acquis* over the next two decades are significant. Investments will be required to be in compliance with some 200 laws and regulations covering water and air pollution, waste and chemicals management, biotechnology, radiation protection and nature conservation. The EU Integrated Environmental Approximation Strategy (2007-2023) estimated the total cost to be about Euro 59 billion – of which nearly 58 percent will be in the water sector.[13] Although it is difficult to ascertain exactly how much has been spent in alignment investments, actual progress is regularly reported to the EC (see Table 5.1 on progress in water, waste and industrial pollution). Turkey's current capital investment spending on the environment is estimated to be below 0.5 percent of GDP and has not been affected by credit constraints. This share will increase gradually and may reach 2 percent of GDP during a few peak investment years.

Turkey's economy has not yet achieved stability in its energy utilization and gaseous emissions either as a ratio of its GDP or on a per capita level, and is cited among the 25 countries that display the fastest rate of growth in industrial use of energy sources. TURKSTAT data indicate, for instance, that on a per capita basis, consumption of electricity in Turkey has increased six-folds from 1980 to 2005. Per capita consumption of electricity was observed to increase from 300Kwh per person in 2005 to 400 Kwh

[11] Part of Prime Minister Erdoğan's Justice and Development Party's (AK Party) election manifesto for 2011, called "Target 2023".
[12] The Government is currently preparing Turkey's Tenth Development Plan.
[13] This estimate includes investments in the water, waste, air, pollution control, noise, chemical, nature protection and horizontal (EIA) sectors.

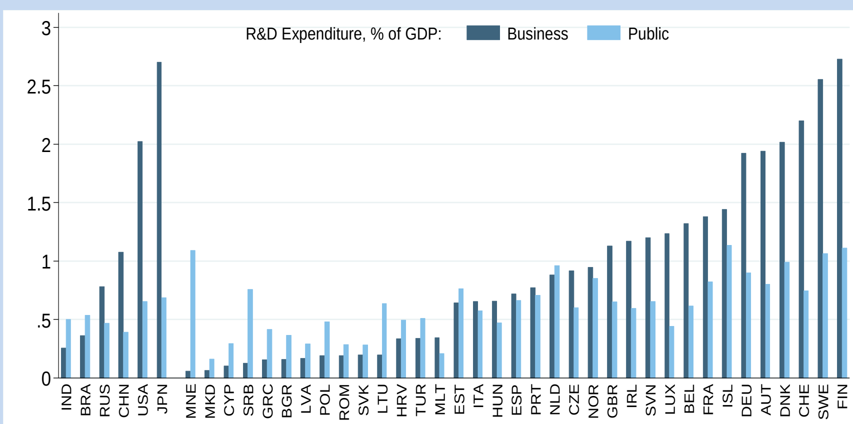
per person in 2010. According to TURKSTAT, aggregate CO_2 emissions stand at 369 million tons as of 2009, and are estimated to reach 615 million tons by 2020, and to 1,200 million tons by 2030.

How green is Turkey compared to developed and emerging economies?

As an emerging market economy, Turkey is continuing to build institutions that help meet sustainable development goals, including in the areas of social policy and employment, environmental protection, and meeting international obligations and commitments; in addition, as part of its efforts to keep its economy competitive, Turkey is also strengthening its national innovation system. These efforts are undoubtedly contributing to greening the Turkish economy, but more focused policies, particularly those linking environmental protection, employment, and innovation, could yield higher dividends as the analyses in the report suggests.

Turkey has already moved forward on some elements of green growth. Out of the four elements underlying green growth (mitigation, adaptation, environmental protection, innovation and green jobs), Turkey ratified the Kyoto Protocol in 2009, and declared at the Copenhagen COP 15 that within the framework of its special circumstances, it shall contribute to the effort of tackling climate change. In addition, the Government approved a National Climate Change Strategy in May 2010 and published a National Climate Change Action Plan in July 2011. Moreover, as part of negotiating the Environment Chapter for the EU accession process, Turkey has made considerable effort in aligning its environmental laws with those of the EU and has begun implementation is several areas, including waste and water management, and EIA.

Figure 2.3 R&D Expenditures (% of GDP)



Turkey has recognized the need to enhance innovation and technology diffusion in the economy to sustain competitiveness and growth (Figure 2.3). The 9th NDP targeted an increase in total research and development (R&D) expenditures from less than 0.7 to 2% of GDP, and aimed to raise the share of privately realized R&D from less than 30% to 60% of the total, both by 2013. These goals were updated and revised, with R&D expenditures now targeted to reach 3% of GDP by 2023, two-thirds of which are expected to be carried out by the private business sector.

While Turkey has had a National Innovation System (NIS) in place for some time, its effectiveness could be improved by strengthening the links between science, universities and commercial applications of research, the more effective protection of intellectual property rights to encourage FDI and domestic innovation, and by a more robust monitoring and evaluation system to assess, and if needed, adjust, national innovation support mechanisms. The general investment climate and the flexibility of key input and output markets will also determine the ease with which new technologies are adopted leading to increased productivity, growth and competitiveness. Moreover, within the NIS context, Turkey is yet to put forward a policy on green innovation.

While job creation is a major focus of the Turkish government, the impact of greening policies on employment depends on the characteristics of the economy's labor markets. The pace of the transition towards a greener economy can be facilitated by the flexibility of labor markets, and ease of entry and exit into industry. Employment effects of green policies, such as internalizing the social cost of pollution to meet EU environmental standards, depend on the implementation time frame. In the short-term, employment losses would result from the increase in the cost of doing business and the decline in output in pollution, water, and energy-intensive sectors. Over the longer term, firms would need to adopt new green technologies to remain competitive, and gains in other industries would emerge. On the other hand, using the revenues from these same greening policies to support innovation and improve the efficiency of labor markets could have a positive impact on employment. The general equilibrium analysis presented in Chapter 6 below provides a brief, stylized assessment of these issues.

Turkey continues to have a high unemployment rate and the strictest Employment Protection Legislation in OECD and ECA region (Figures 2.4 and 2.5). Labor market flexibility allows workers to move to other (greener) sectors more readily. Countries with more flexible labor markets experience faster structural change as labor flows easily across firms and sectors. Despite having become more flexible over time, labor markets in Turkey still have important rigid elements, particularly in temporary employment regulations, which contribute to maintaining resources in inefficient informal and semi-formal activities.

Figure 2.4 Unemployment, total (% of total labor force), 2009

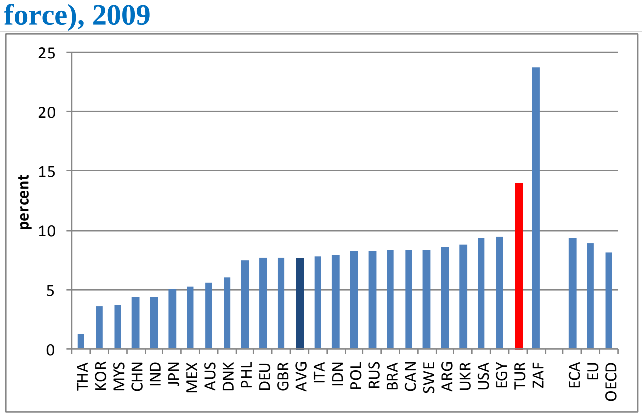
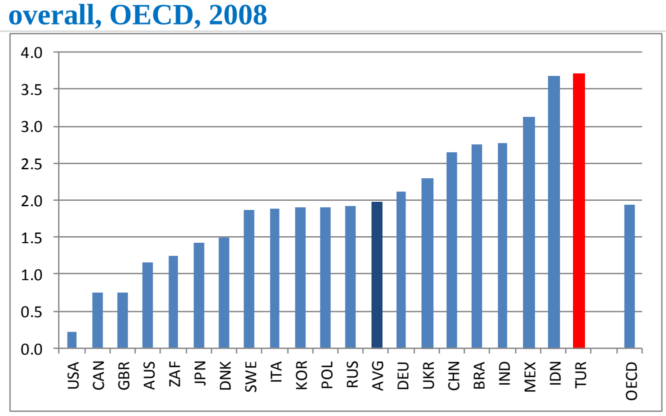


Figure 2.5 Employment protection legislation, overall, OECD, 2008



Note: Higher numbers denote stricter EPL regimes. All sub-indexes are normalized in the 0–6 range (OECD Standard)
Source: OECD. The estimate for Ukraine is from Institute for the Study of Labor (IZA).

A review of comparator indicators shows Turkey's position and highlights its greening potential. These indicators (summarized below from available data) are grounded in the OECD integrated framework for monitoring green growth progress[14]. Indicators are grouped into four information themes: Environmental productivity and resource productivity, natural asset base and life quality. Selection of Turkey's comparator countries took several factors into account: (i) countries belonging to the same World Bank regional grouping: Europe and Central Asia (ECA); (ii) several countries of the same, middle-income level per capita; (iii) countries perceived as pioneers in green growth agenda (Korea, Germany, Sweden, Denmark etc.); and (iv) country aggregates for three country groupings ECA, OECD, and EU.

(a) Wealth accounting and adjusted net savings rate

According to the World Bank, total Turkey's wealth in 2008 was estimated at 11,717 USD billion, which equates to about 160 thousand USD per capita[15]. This is about 3 to 4 times less than in advanced OECD countries, but above most of the emerging economies. The lion's share of Turkey's wealth constitutes intangible capital, while produced and natural capitals are relatively small. Crop and pasture land dominates, comprising about 85% of Turkey's natural capital. The structure of wealth differs significantly across countries. For example, it is completely different in an energy rich country like Russia, where natural capital is dominated by energy.

The adjusted net savings ratio estimates suggest that Turkey's potential for sustainable economic development is declining. The adjusted net savings ratio, which is a proxy for total wealth developments over time, has declined by half from around 15% of Gross National Income on average in the first decade of the 21st century (as compared with the last decade of the 20th century). In 2009, the ANS was below 5%, which was largely driven by economic developments and the high share of foreign savings (high current account deficits) in recent years. The factors driving the ANS down through environmental degradation were relatively minor (1-2% of GNI), which requires a more careful investigation of underlying developments (Box 2.1).

Figure 2.6 Total wealth Turkey in 2008

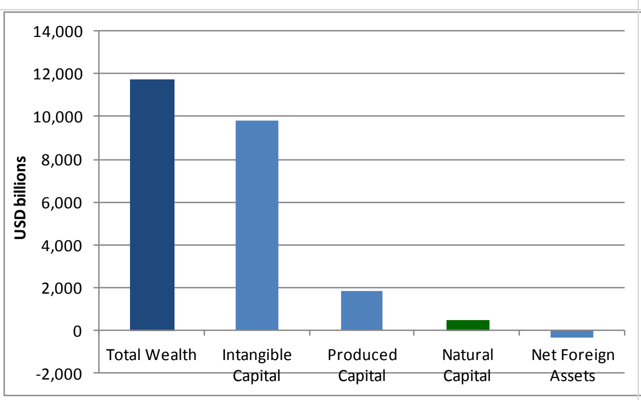
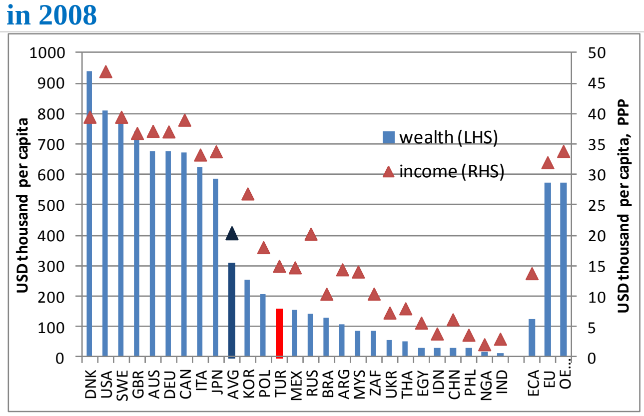


Figure 2.7 Total wealth and income per capita in 2008



[14] OECD (2011), Towards Green Growth, OECD.

[15] Gross Domestic Product is an imperfect metric in reflecting living standards as they depend not only on the production level, but are closely related to the accumulation of wealth, which can be depreciated or depleted over time. Accumulated wealth can be decomposed into produced, natural and intangible capital.

Figure 2.8 Adjusted net savings, 1990-2009, % of GNI

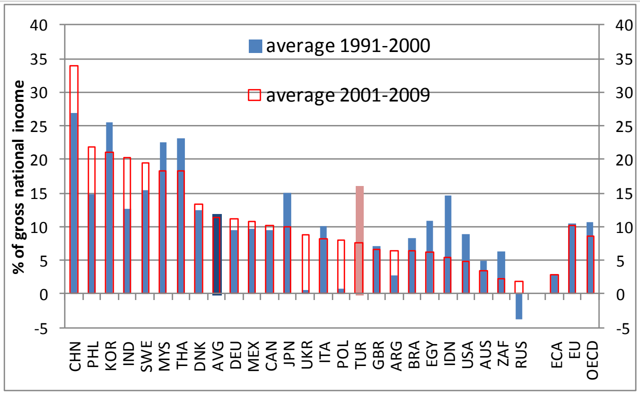
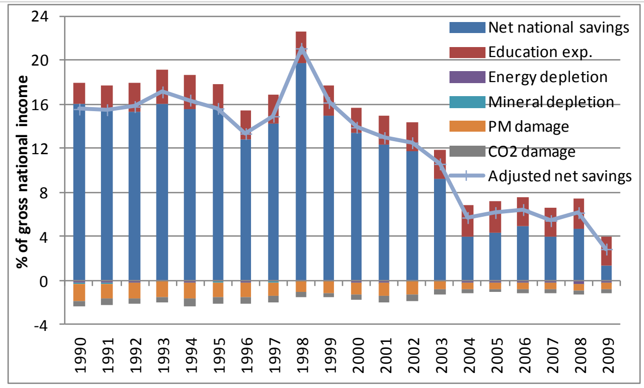


Figure 2.9 Adjusted net savings, 1990-2009, % of GNI



Box 2.1 Methodological notes on total wealth estimates and adjusted net savings

Total wealth is composed of:

- intangible (human and social) capital,
- produced capital (machinery, equipment, structures, and urban land),
- natural capital, consisting of energy resources (oil, natural gas, hard coal and lignite), mineral resources (bauxite, copper, gold, iron, lead, nickel, phosphate, silver, tin, zinc), timber and non-timber forest resources, crop and pasture land, and protected areas, and
- net foreign assets.

Adjusted net savings (ANS) are calculated as a proxy for total wealth. ANS is a sum of net national savings (NNS) and education expenditure (EE), minus: energy (ED), mineral (MD), and net forest depletion (NFD), CO_2 (CO_2D) and particulate emissions damage (PMD).

$ANS = NNS + EE – ED – MD – NFD – CO_2D – PMD$.

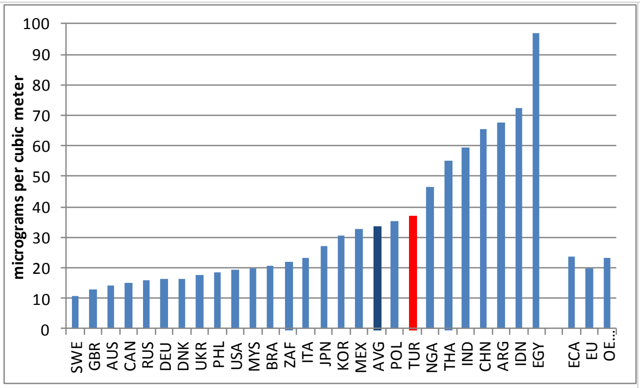
Source: For detailed methodology, see: World Bank, 2011.

Source: World Bank staff calculations based on World Bank Development Data Platform.

(b) Renewable resource base

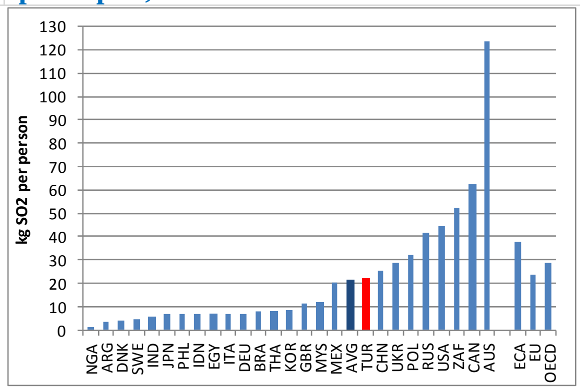
Air quality. Turkey ranks relatively high in levels of particulate matter (PM10) compared to the countries shown in Figure 2.10, although several of the sample countries have much higher levels of this indicator. Egypt, for example, ranks almost three times higher than Turkey and India is almost twice as high. Argentina, China, India, Thailand and Nigeria are also higher. Air quality is an important factor in childhood mortality and lung disease. Overall in the world, the indicator reflects urban pollution. It is significantly driven by household usage of “dirty” cooking fuels like firewood, coal, dung, agricultural residues and charcoal, at the upper end of the ranking. High PM concentration may lead to respiratory infections, asthma, increased risk of cardiovascular diseases, and cancer. Moreover, Sulfur dioxide is the major source of acid rains, which have adverse effects on fish stocks, forests, and soils, and consequently diminish agricultural productivity.

Figure 2.10. Particulate matter (PM10), 2008



Source: World Development Indicators.

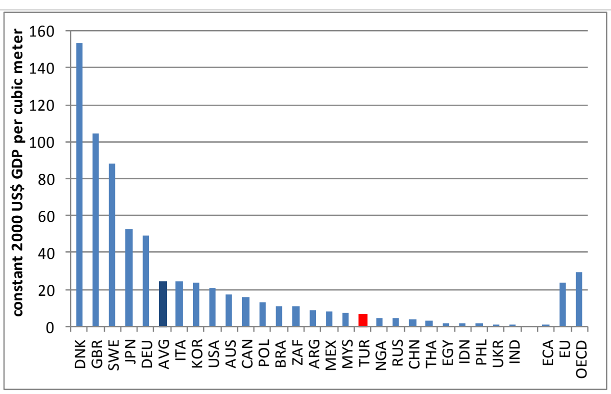
Figure 2.11. Sulfur dioxide emissions per capita, 2005



Based on Smith et all, 2011 Source: 2012 EPI database.

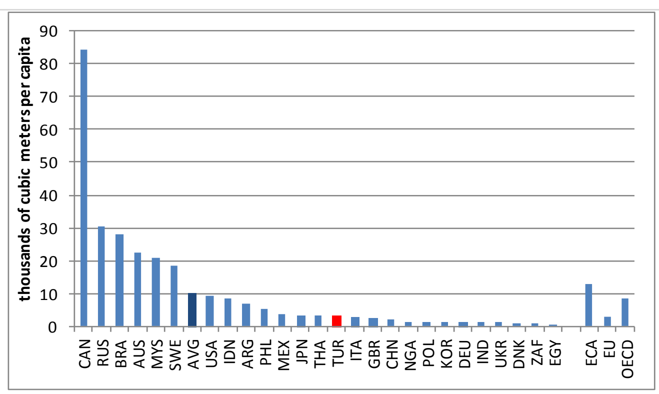
Water. Turkey is in the middle of the range, according to the indicator of annual freshwater withdrawals as a percentage of total internal resources. The level of this indicator – 20 percent – shows that Turkey is in a comfortable zone: far from water scarcity and having no indication of inefficient (too low) water usage. The level of this indicator is significantly affected by the size of the country's water resources; therefore the data is indicative for countries at either end of the scale of total resources: scarcity or abundance.

Figure 2.12 Water productivity, total (constant 2000 US$ GDP per cubic meter of total freshwater withdrawal), 2000



Source: Food and Agriculture Organization, AQUASTAT data. World Bank.

Figure 2.13 Renewable internal freshwater resources per capita (1000 cubic meters per capita)



Forests and lands. Forests provide a range of extractable commodities, from timber to wood fuel to various non-timber products, and a range of ecosystem services, from regulation of soil, water, and climate to sequestration of carbon and provision of habitats, supporting important economic activities. Preservation of these ecological services is crucial – for example, agricultural production is strongly affected by the management of these sources of natural capital.

Figure 2.14 Forest area (% of land area), 2010

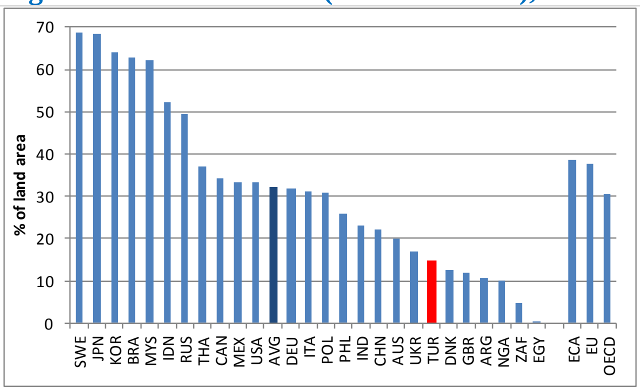
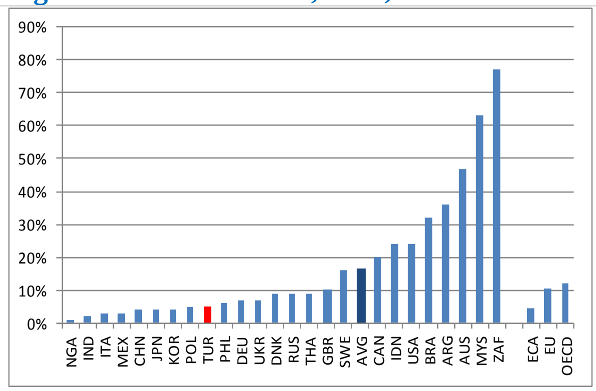


Figure 2.15 Forest loss, 2010, %



Source: World Bank Development Data Platform.

Figure 2.16 Marine protected areas (% of territorial waters), 2009

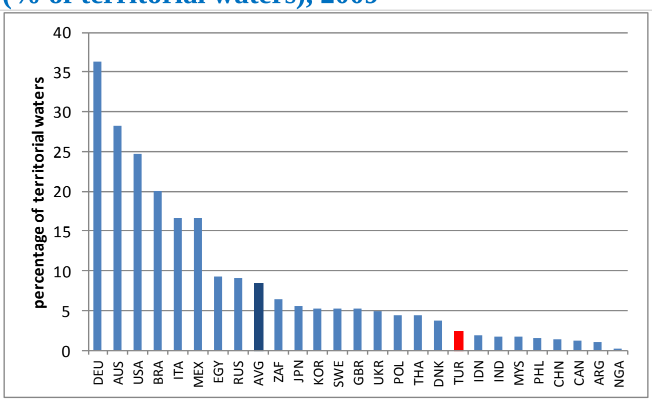
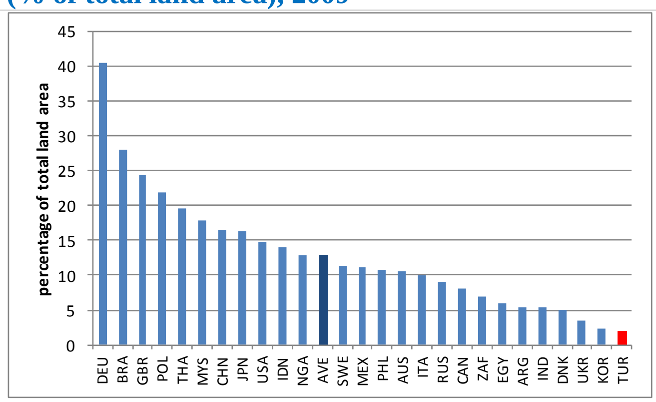


Figure 2.17 Terrestrial protected areas (% of total land area), 2009



Source: World Bank Development Platform

(c) Biodiversity

Biodiversity refers to the degree of variation of life forms, including all animals, plants, habitats, and genes. Genetic diversity, as it relates to agriculture, provides the basis for new breeding programs, improved crops, enhanced agricultural production, and food security. When species become extinct or habitats are threatened, biodiversity is reduced. Ecosystem fragmentation can contribute to species loss, especially for large predators, leading to a cycle of habitat degradation. The current rate of species

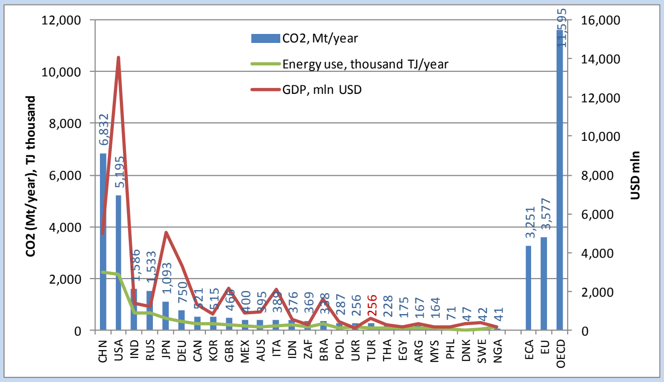


Figure 2.19 Closer look at Turkey

extinction, stemming mainly from habitat loss and degradation, is 100 to 1,000 times higher than before humans walked the planet. The loss of many environmental assets is irreversible.

Turkey is at the low end of the indicator on marine protected areas, as compared to Germany and Italy, which have a similar amount of shore line. The indicator level suggests that government policies to protect marine biodiversity in Turkey are introduced at a much lower scale than in these countries. At the same time, countries such as Nigeria, Argentina, Canada, China, Philippines, Malaysia, India and Indonesia (from bottom up) have lower values of this indicator than Turkey.

On terrestrial protected areas, Turkey has the lowest percentage of land area protected by the government. According to this indicator, it falls in the same group as Korea, Ukraine, Denmark, India Argentina and Egypt. This shows that government policies to protect terrestrial biodiversity are introduced in Turkey in a limited way. Fulfillment of the EU Birds and Habitats Directives requires unique areas to be protected and form part of the Natura 2000 network of areas of significant conservation status.[16]

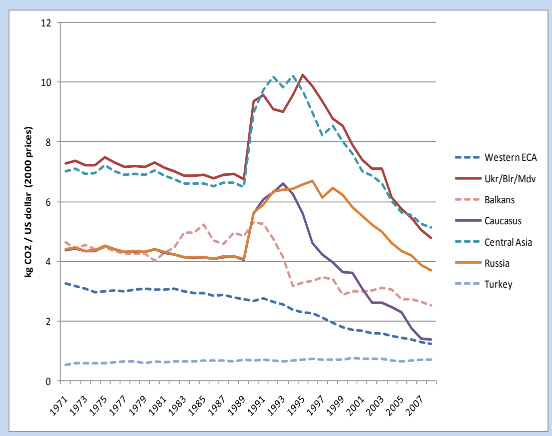


Figure 2.18 Turkey has low emission intensities

(d) Energy and emissions from fossil fuel combustion

[16] Framework legislation on nature protection has not yet been adopted. The list of potential Natura 2000 sites has not yet been compiled. The national biodiversity strategy and action plan, as well as the implementing legislation in this field remains to be adopted. There is growing concern about the possible adverse effects on potentially protected species of flora and fauna as a result of the building of new large water and energy infrastructure in the country. The amended by-law on the protection of wetlands has weakened their protection status, and falls short of the requirements of the Convention on Wetlands of International Importance. There is no clear allocation of responsibility for nature protection among the various competent institutions. The CITES Convention on the international trade in wild animals and plants is not sufficiently enforced (Turkey 2011 Progress Report, Communication from the Commission to the European Parliament and the Council, Enlargement Strategy and Main Challenges 2011-2012).

Turkey's total CO_2 emissions (Mt) are low compared to the world overall and to individual countries ranked at the top by this indicator. The CO_2 emissions Turkey produces constitute only 2.2% of the OECD total and 0.9% of the world total. They are 27 times lower than in China and 20 times lower than in the US. However, emissions increased by 41 percent from 1991 to 2001 and by another 41 percent from 2001 to 2009. By comparison, the change in emission level averaged an 11 percent increase in 1991-2001 and a 6 percent increase in 2001-2009 in the OECD countries.

Turkey has one of the highest levels of emission intensity (measured in this case by the ratio of CO_2 to energy supply) in the world. Turkey ranks in the top 25th on the list of 145 countries with available data. In our sample of 26 comparator countries, Turkey is at the lower end of the list, preceded only by major developed countries. This indicator increased in Turkey from 1990 to 2008 and only declined from 2008 to 2009. High emission intensity could be explained by the fact that primary energy sources are skewed toward high emission factors like fuels (coal and oil), or high emission technologies, or insufficient use of emission control measures, or some combination of all of these.

At the same time, Turkey has one of the lowest levels of emission intensity measured by emissions per $1 of GDP PPP and one of the lowest levels of emissions per capita across the comparators. The former indicator stayed flat during the observed period from 1990 to 2009 while the latter one was increasing, closely following the pattern of change in emissions per unit of energy used (Figures 2.18 & 2.19 and Table 2.1). These observations reflect the low *energy intensity (energy per $1 GDP)* of the Turkish economy, as well as a high share of the residential sector in total emissions. On the whole, Turkey's mitigation potential is substantial, but its major challenge would appear to be curtailment of rapid emissions growth as the economy continues to expand.

Table 2.1 Energy and Emission Indicators

	Energy/ Capita	**(PPP) GDP/ energy use**	**(nom.) GDP /energy use**	**CO_2/ Capita**	**CO_2/ (PPP) GDP**	**CO_2/ (nom.) GDP**	**CO_2 Growth % 1990-2009**
Turkey	1,333	8.9	3.6	4.0	0.3	0.7	102
Upper Middle-income Countries	2,177	5.2	n/d	5.3	0.5	n/d	n/d
Euro area / OECD Europe	3,763	8.2	5.6	8.4	0.3	0.4	-5
Eastern Europe and Central Asia	3,030	3.6	0.7	7.2	0.7	3.3	-38
World	1,835	5.5	3.3	4.6	0.5	0.7	38
Brazil	1,295	7.4	3.6	1.9	0.2	0.4	74
China	1,598	3.6	1.4	5.0	0.9	2.2	207
India	545	5.1	1.3	1.4	0.5	1.8	172
Mexico	1,698	7.9	4.1	4.5	0.3	0.6	51
Russia	4,838	3.1	0.6	10.8	0.8	3.9	-30
United States	7,503	5.8	5.3	19.3	0.4	0.5	7

Sources: "World Development Indicators", 2011 edition, the World Bank; GDP in 2005 PPP US dollar; except nominal GDP/energy use, CO2/nominal GDP and CO2 growth percent 1990-2009 (sectoral approach) from "CO2 Emissions From Fuel Combustion", 2011 edition, the International Energy Agency; GDP in 2000 US dollar. World Bank figures /Euro area, IEA figures/OECD Europe.

3. Towards a Working Definition of Green Growth in Turkey

As discussed in the introductory Chapter of this report, green growth is a relatively new concept, and several definitions have been put forward by various organizations[17]. However one of the early and enduring definitions by OECD (2011) (*"Green growth means fostering economic growth and development while ensuring that natural assets continue to provide the resources and environmental services on which our well-being relies. To do this, it must catalyze investment and innovation, which will underpin sustained growth and give rise to new economic opportunities"*) emphasizes the importance of natural assets in economic production and well-being, and therefore the need to use environmental assets efficiently. The World Bank further emphasizes the fact that 'inclusive' Green growth policies should aim to *"foster sustainable development by reconciling the need for environmental sustainability for economic growth and social improvement"* which emphasizes the social and distributional aspects of sustainable development (e.g. poverty alleviation and welfare).

While the overall framework which ties green growth to sustainable development outcomes along its three dimensions (economic, environmental, and social) is consistent with Turkey's pronouncements and strategic documents, from the review undertaken and the views of decision makers, the country is looking to achieve faster output growth, a healthier environment, and more jobs. These ambitious goals imply a green-growth focus underpinned by the following elements:

(i) **Investments and resources are allocated by taking into account the full social costs and benefits of environmental resources (both resource use and sinks)** – (correcting policy and market failures and increasing social welfare). This means that Turkey would need to accelerate the pace of implementation of the main EU Directives (for water, waste, and air pollution) and introduce economic and fiscal instruments that would prevent the inefficient use of water, energy, and land resources, internalize the social cost of pollution, and recover the cost of consumption of environmental services such as water, wastewater and solid waste.

(ii) **Faster growth is accompanied by more effective environmental protection, and efficient use of natural resources, using different policy instruments -** (to produce higher social welfare). Turkey is aiming to continue to maintain high economic growth (8%-9%), which is important for employment and poverty reduction. However, unless this growth is accompanied by an adequate increase in environmental protection, it would result in increased use of environmental resources, which in turn would lead to lower social welfare.

(iii) **Employment and Innovation policy targets green investments by using revenues from taxing pollution and inefficient use of natural resources to reduce other distorting taxes (including displacing other tax revenues that would have been needed otherwise for debt service payments).**

(iv) **Accelerated economic growth in key sectors should be socially inclusive and enhance the welfare of lower income (or other vulnerable) groups.** The distributional impacts of green

[17] See for example OECD (2011), Bowen (2012), Toman (2012), and World Bank (2012c).

growth should be oriented such that more vulnerable groups (for example, those that rely on the sustainable management of natural resources or that are negatively affected by volatile prices) are not made worse off from a welfare standpoint and whose livelihoods are enhanced and made more secure through policy.

A working definition of green growth for Turkey would be: *Green growth for Turkey means the implementation of environmental policies in strategic sectors, aimed at achieving Turkish and EU standards (as reflected in the main EU Environmental Directives), with special emphasis given to resource efficiency, clean production and consumption, and reduced emissions intensity, together with policies that foster employment and innovation in environment-related sectors, and are socially inclusive and welfare improving.* A key assumption is that these policies will accompany ongoing growth-enhancing economic policies that increase the level of investment and its efficiency, achieve stronger employment generation and higher labor productivity, manage capital inflows, and other measures to enhance competitiveness and mitigate risks.[18] This Policy Paper provides an important building block of green growth, and an opportunity to better integrate environmental sustainability considerations into the mainstream economic growth and competitiveness agenda of Turkey.

Box 3.1 Example definitions of Green Growth

"Green Growth aims at making job creation and GDP growth compatible with or driven by actions to protect the environment."

"Green Growth can be seen as a way to pursue economic growth and development, while preventing environmental degradation, biodiversity loss, and unsustainable natural resource use."

"Green growth is about maximizing economic growth and development while avoiding unsustainable pressure on the quality and quantity of natural assets. It is also about harnessing the growth potential that arises from transiting towards a green economy."

"Green Growth is the process of reconfiguring businesses and infrastructure to deliver better returns on natural, human and economic capital investments, while at the same time reducing greenhouse gas emissions, extracting and using less natural resource, creating less waste, and reducing social disparities."

"Green Growth goes hand-in-hand with ecological sustainability. In practical terms, in a green economy investing in ecological resources and services, such as a stable climate, bio-diversity and clean air and water, there can be an opportunity for profit, employment and growth rather than cost and burden on the economy."

"Green growth is the means by which the current economy can make the transition to a sustainable economy while reducing pollution and greenhouse gas emissions, minimizing waste and inefficient use of natural resources, maintaining biodiversity, and strengthening energy security."

"Green Growth is a strategy for promoting economic growth with the goal of adding an ecological quality to existing economic processes and creating additional jobs and income opportunities with a minimal environmental burden. This primarily means seeking a relative or absolute decoupling of economic growth and environmental degradation, depending on the local context. It is also essential to take into account the risks involved with future changes in the environment, e.g. by adapting to climate change and international obligations within the framework of an environmentally qualitative policy."

Source: Fay, M. (2011) Green Growth Knowledge Platform, presentation made to World Bank's Europe and Central Asia Regional Management Team (October).

[18] Turkey Economic Memorandum: Sustaining High Growth: Selected Issues. World Bank Report No. 39194, April 10, 2008.

4. Strategic Sectors: Overview and Greening Potential

4.1 Overview

The present Chapter summarizes the main findings from rapid sector assessments and focus group meetings for the six industrial manufacturing sectors (automotive, construction, electronics, iron and steel, machine industry, and white goods) considered strategic and agriculture. The strategic importance of these sectors for the present analysis stems from the fact that: (a) they are highlighted as key drivers of future growth in Turkey's 9th Development Plan (2007-2013); (b) each sector is subject to compliance with key applicable EU Environmental *Acquis* Directives--since these are a major driving force for sector reform and transformation, and entail potentially significant public and private sector investments in both the short and longer term; (c) they are viewed as having a large potential for 'greening' in terms of increasing input efficiency and lowering pollution intensity and each sector has a strategy from which to draw information for analytical purposes. While by no means a comprehensive list, Table 4.1 suggests that the selected subsectors comprise from 35-43% of total manufacturing assets, production, employment, imports and exports, and over 60% of all research and development.

Table 4.1 Selected Sub-Sectors of Manufacturing, 2009

	Share in total manufacturing industry (%)					
Sub-sector	**Total Assets**	**Production**	**Employment**	**Imports**	**Exports**	**R&D Expend-iture Rate**
Automotive	8.3	12.1	8.5	9.7	13.5	31.2
Electric and electronics [1]	5.0	10.4	5.2	15.3	6.8	16.2
Iron and steel	16.0	7.9	11.7	6.9	9.5	4.4
Machine industry and white goods [2]	8.7	5.7	9.3	11.3	8.5	9.3
Total	38.0	36.1	34.7	43.2	38.3	61.1

Source: Turkish Industrial Strategy Document 2011-2014 – Towards EU Membership, Ministry of Industry and Trade (2010).
1 – Includes Office Machinery and Computers; Radio, Television and Communication Equipment and Apparatus; Electrical Machinery and Apparatus, N.E.C.; Medical, Precision and Optical Instruments, Watches and Clocks.
2 – White goods are considered a subsector of the Machine industry according to the Classification of Economic Activities in the European Communities (NACE).

The selected sectors are also significant in terms of their relative pollution and input efficiency profiles. Basic metals (which include iron and steel) are a top emitter of waste, hazardous waste, and wastewater, as well as a top user of water and energy consumption. The automotive, machinery (plus white goods) and electrical and electronics subsectors also fall within the top 10 across most categories.[19] Agriculture is the one non-manufacturing sector initially chosen owing to its important role in the economy and its potential for 'greening.'

While the rapid sector assessments provide a first useful gauge of Turkey's greening potential at the sector level, a more detailed technical assessment of abatement costs and possibilities would be desirable. Such an assessment, as carried out for carbon emission mitigation technologies by McKinsey (2008), would allow more accurate predictions of the private benefits of investments in abatement and consequently allow public policy to be calibrated to leverage private sector reactions through a combination of price and other incentives. This point is further elaborated in Chapter 6.

4.2 Automotive

Situation analysis

In 2009, global production of motor vehicles was 61.7 million, of which 48 million vehicles were passenger cars and 13.7 million were commercial vehicles. Turkey remains one of the twenty largest vehicle producers, although its production fell below a million units in 2009. The industry experienced strong growth over the past five years, mostly in passenger cars, although growth ceased in the last quarter of 2008, and an overall fall in production was attributed to the global recession in 2009. Turkey ranks 17th globally in automotive production, and 7th in Europe.

The Turkish automotive industry is one of the economy's pioneering and most dynamic sectors. It is highly international, with around 76 percent of Turkish vehicle production in 2009 and 68 percent in 2010 being exported, mainly to Europe. Meanwhile, around 56 percent of Turkey's 2009 motor vehicle sales were imported. This growth of both exports and imports occurred as the major global manufacturers integrated their Turkish plants into their global production planning. Increasingly, specific models are produced in Turkey for global or regional sales, while vehicles that are not produced locally are imported. Turkey's inclusion in this type of global production planning is made possible by the Customs Union Agreement with the EU, in operation since 1996.

There are currently 15 passenger and commercial vehicle manufacturers in the country, in addition to seven tractor manufacturers. The Automotive Manufacturers Association (Turkish: 'Otomotiv Sanayicileri Dernegi') is a Turkish industry trade group, which represents the Turkish automotive industry. The total capacity of the OSD members (15 manufacturers including two tractor manufacturers) amounts to 1,561,155 vehicles per year as of 2010. These manufacturers, together with spare parts producers, employ more than 265,000 people, ranking in the top 10 globally. In 2010, the automobile industry exported 70% of the 1.1 million vehicles produced in Turkey. At the same time, the total export value of the automotive industry reached US$ 16 billion, one third of which consisted of parts and components.

[19] With the exception of energy consumption, where TurkStat reports across 9 manufacturing subsectors in total.

Box 4.1 With some € 20 billion annually, the automobile industry is the largest private investor in R&D in Europe (4% of the industry's annual turnover), a significant part of which is devoted to technologies to reduce GHG emissions, improving engine efficiency and performance, with another part devoted to vehicle safety.
Source: European Commission

The automotive sector is very dynamic, with an average annual growth rate of 4.2% from 2000 to 2010, but it is highly dependent on the EU countries for which 70% of the exports are destined. However, the strong domestic market and the steady increase in Research & Development activities in the sector bode well for continued sector growth, as the industry plans to invest (over the medium term) about US$ 2 billion for technology renewal, capacity increase (expected to reach 1.5 million vehicles by 2015), and new model development. By the end of 2010, there were 16 supply companies and 11 vehicle companies running 37 R&D centers which employ 4.000 workers[20]. In addition, specialized training allows the industry to get needed skills in Turkey (e.g., recently established automotive vocational high school). Moreover, Turkish automotive companies have been integrated into the European Network Exchange (ENX) for data transfer. This system also enables Turkish suppliers to outfit European Automotive manufacturers.

In terms of environmental footprint, over its production and service life stages, the automotive industry is a major contributor to air pollution (e.g., volatile organic compounds (VOC) and CO2 emissions), solid waste (e.g., packaging, metal scrap, parts and consumables), hazardous waste (e.g., paint sludge, oils, batteries, electronics), and waste water (e.g., oils and chemical discharges, especially from uncontrolled/unregistered repair shops). However, the automotive industry in Turkey is on par with its European counterparts in terms of environmental improvements (Box 4.2) which are strongly linked with increases in productivity and product quality.

Box 4.2 European automotive environmental footprint

From 2005-2009, the European automobile association claims that significant progress has been achieved all while vehicle prices have declined, as indicated by the following indicators (on a per vehicle basis):

Energy	-6.5%
CO2	-5.8%
VOC	-4.8%
Waste	-23%
Water use	-14.3%

Source: ACEA (2009)

Sector potential

The automotive industry is implementing an ambitious greening program that includes: (a) energy efficiency (e.g., insulation, co-generation, and reuse of heat from boilers, and gradually

[20] With some € 26 billion annually, the automobile industry is the largest private investor in R&D in Europe (5% of the industry's annual turnover, or about Euro 1,500 per vehicle), a significant part of which is devoted to technologies that reduce GHG emissions, improving engine efficiency and performance, with another part devoted to vehicle safety (ACEA 2009).

switching to renewable energy); (b) adoption of improved vehicle and motor technologies (e.g., lighter body material, tire performance, direct fuel injection, multi-fuel and hybrid fuel vehicles, hybrid cars, EU vehicle emissions standards); and (c) improved waste management (including separation and recycling) and physical-chemical water treatment plants in all production facilities. Moreover, measures are being introduced to reduce the environmental impact of the service life of vehicles (waste management during maintenance and repair, and end-of-life scrap recycling), and more specifically towards compliance with the EU End-of-Life Vehicle Directive (ELV 2000/53/EC) which requires EU Member States to ensure that a minimum of 85% of vehicles are reused or recovered (including energy recovery) by 2015.

4.3 Iron and Steel

Situation analysis

The iron and steel industry is the largest industrial emitter of CO_2 in the world, with global emissions of about 2.8 Gt a year. Two production technologies are widely used in the industry: integrated steel plants (ISP) comprised of blast furnaces and basic oxygen furnaces, and electric arc furnaces (EAF). While ISP processes use coke to reduce iron ore in blast furnaces, the EAF process primarily uses scrap metal (melted through high electric voltage), or Direct Reduced Iron, produced with coal or gas, as a substitute for scrap.

About 85% of the industry's CO_2 emissions derive directly from the process and fuel combustion in primary steelmaking, which emits around 1.6-2.2 tCO_2 per ton of steel (excluding coke/sinter-making); the remaining 15% results from indirect emissions, mainly electricity consumption in EAF production. In addition, steel making is also a major source of solid and hazardous waste, water pollution, and noise.

With some 30 million tons in 2010, Turkey ranks 10^{th} in the world and 2nd in Europe in terms of total steel output. Its production has almost doubled since 2001 (second fastest increase behind China) and is expected to top 35 million tons, $16 billion in exports, and $3.4 billion in net export balance in 2012. With continued strong domestic and international demand, the sector could reach 70 million tons of steel annually by 2023. On the other hand, the Turkish iron and steel industry is one of the largest scrap importers in the World. In 2010, Turkey's share in total scrap imports was 18%, with 19.2 million tons (mostly from The EU, Russia, USA and the Ukraine) worth US$ 7.1 billion (15% of the country's current account deficit).

Despite the sector's heavy footprint globally, Turkey's steel production is considered much greener because 80% of its total production capacity (42.7 million tons in 2010) uses EAF technology while the rest is in dirtier, less energy- efficient ISP technology.

Sector potential

The industry has made important strides in reducing energy use (Box 4.3). Yet, the sector has potential for further greening through reducing carbon emissions in the production process (especially ISP), and reducing the intensity of other pollutants (e.g., heavy metals). Moreover, the sector's heavy dependence on the importing of scrap metal holds further greening potential through the substitution of local sources, support for the emergence of small metal recycling enterprises, and additional employment.

Table 4.2 Main Features of Iron & Steel Technology

	Prod Share	Input	Energy use	Energy cost in total cost	Pollution	Technology enhancements/ greening already achieved
EAF Electric Arc Furnace	80% (LE)	Scrap metal (75-80%) imported (EU, USA, Russia, Ukraine)	- Electricity: 65% - Natural gas: 30% - Diesel: 5%	15%	Lower CO2 emissions ___________ - Dust (PM10) - CO2 - NOx - Heavy metals - Organics - Toxics (dioxins/furans ___________	Over 2000-2008: +15%/yr production -1.3% energy use
ISP Integrated Steel Plants	20% (HE)	Iron ore and coke (coal)	- Coal: 75% - Electricity: 10% - Natural gas: 15%	20%	Higher CO2 emissions	Over 2000-2008: +5%/yr prodion -3% energy use Switch from Open Hearth Furnace (OHF) to Basic Oxygen Furnace (BOF)

Box 4.3 Energy Efficiency Improvements in ISP

Since the 1990s, ISPs have implemented substantial EE improvements to increase competitiveness, as continuous efficiency gains are essential for these plants to maintain international competitiveness, even for the better-performing Erdemir.

(i) Erdemir initiated an EE improvement plan that included investments in furnaces, boilers, waste heat recovery, utilizing by-product gas, continuous casting, and fuel systems, which reduced energy consumption from 0.67 toe per ton of carbon steel (tcs) to 0.51 toe/tcs by 2004. This was comparable with the best practice level of 0.53 toe/tcs reported in the 1990s (when the investment plans were initiated). However, by 2004, leading ISPs achieved levels of 0.33 toe/tcs. In 2005, Erdemir announced plans for energy and environment investments totaling US$106 million during 2005-14.

(ii) The energy consumption rates of Isdemir and Kardemir have long been substantially higher than the global average. Isdemir has since made some EE improvements that reduced the energy consumption rate by 23 percent. In 2005, Isdemir was involved in a three-year program of energy and environment investments totaling US$ 80 million. Employee-owned and -operated Kardemir also improved its performance, but by 2004, had only reached the level Erdemir had achieved in 1990. Since then, Kardemir is utilizing a more EE process (moving from an Open Hearth Furnace process to a Basic Oxygen Furnace process) and is looking into gas recovery for energy utilization and carbon emissions reduction.

Source: World Bank (2011)

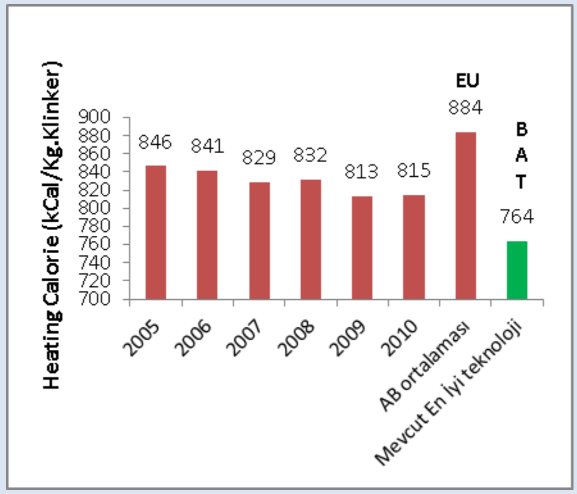
4.4 Cement

Given the complexity of the construction sector, only cement was considered as part of the analysis.

Situation analysis

Both globally and in Turkey, the cement industry is a major emitter of carbon (5% of total GHG emissions). With 67 production facilities (48 fully integrated and 19 grinding and packaging facilities) and an 80-million-ton capacity, Turkey is among the top 10 cement manufacturing countries and a leading world cement exporter. In 2010, production reached 65.7 million tons, and domestic sales reached 49.5 million tons, a 10% and 16% increase respectively from 2009. In addition to a large internal market, Turkey is also a major exporter of cement (over 16 million tons in 2010 with a value of about one billion US dollars).

Figure 4.1 Energy Use in Clinker Production



Source*: EIE, Cement Sector Comparison Study; 2) International Energy Agency/OECD, Energy Technology Transitions for Industry, 2009, Chapter 3 Cement, Figure 3.7*

Box 4.4 Cost of Compliance in Cement Sector

According to the industry, a 15% waste to energy substitutions would cost $750 million and result in one percent in CO_2 emissions reduction (3 million tons).

In addition, the estimated cost of reducing chromium to EU-mandated levels (2ppm/ton of cement) is $5-9/ton of cement, compared to an average product price of $ 70-100/ton.

Source: *Sector Note & Focus Group Meetings*

While the local housing industry will continue to be a growth engine for the construction sector in the short and medium term, ongoing energy investments mainly in Hydroelectric Power Plants (HEPP) and road works are also expected to lead a steady increase in infrastructure investments. For example, the Turkish government is planning a number of ambitious urban transformation projects in the largest metropolitan areas of the country. It is estimated that in the coming years, the urbanization rate of Turkey will increase.

Key pollution issues in the sector with direct health impacts include high levels of chromium (a heavy metal) with concentrations of 30 ppm/ton, fifteen times the level called for by the EU REACH Directive, and high levels of CO_2, NO_x, dust, and sulphur emissions. In addition, the sector also produces solid and hazardous waste and is subject to regulation on waste incineration.

Sector potential

While the cement sector has undergone significant

modernization, there remains potential for additional greening, including in terms of resource use and efficiency and pollution reduction. In terms of energy use, the cement sector is already close to Best Available technology (BAT) performance in terms of energy output efficiency (Figure 4.1). Success in this sector is due in large part to the fact that most production facilities are either new or have undergone technology upgrades. But potential still exists to: (i) reduce energy use through by switching to alternative fuels and increasing energy efficiency, (ii) increase the efficiency of waste heat recovery, and (iii) increase the use of recycled materials and wastes as alternative energy generation—and savings—sources.

65. **With respect to pollution mitigation**, in addition to measures required in order to comply with the EU IPPC Directive, there is scope for reducing CO2 emissions from combustion of fossil fuels and the quality of raw materials used in the production of cement. However, costs and benefits need to be carefully weighed as the initial compliance investment estimates obtained for this study are in some cases prohibitive (Box 4.4). In addition, while waste producers may be willing to sell their waste for energy conversion, the switch by the cement industry will only happen if it is cost effective, and if the institutional environment provides incentives/regulation to allow/induce municipalities to divert combustible waste and sludge to be used for energy generation.

4.5 Machinery Industry

Situation analysis

With a total production of about USD 25 billion, a contribution to GDP of nearly 4.5%, and approximately 200,000 jobs, the machinery industry holds a strategic place in Turkey's economic development. In addition, because of its' wide span (agriculture, electrical, food, construction mining, and textile machinery), the sector's multiplier effect is important for encouraging investment and demand for intermediate goods and services. It also has considerable impact on national competitiveness as a whole. Since 1990, the industry has consistently grown about 20 percent per annum[21], a growth that has relied largely on highly competitive and lean Small and Medium Enterprises (SMEs), which have formed the backbone of Turkey's industrial production.

As a driver of growth in the sector and in Turkey's overall industrialization, Turkish SMEs have distinguished themselves in the global market by harnessing Turkey's low-cost/high-skilled human capital. Turkey's machinery sector receives around 85 percent of input from domestic supply, reducing the dependency on foreign sources and helping other local industries.

Turkey's machinery industry is, to a large extent, labor-intensive, and is expected to remain so in the near future. The character of Turkey's labor workforce has played a major role in the competitive might of its machinery sector, guaranteeing competitiveness through low-cost labor and engineering services. Without a significant leap towards a capital-intensive model, however, Turkey's machinery industry cannot compete on a global scale. At present, the overall advantage Turkey's machinery industry lies in its accumulation of companies with different capabilities, strategies and products, which provides the overall industry a technological edge.

[21] Except for the impact of the impact of the 2008 global economic crisis which deeply impacted the sector.

Combining engineering know-how with a low-cost/high-skill workforce, the Turkish machinery industry has managed to offer a range of products and components that are both high quality and affordable. The sector has also expanded its share in Turkey's exports, steadily growing towards a 10% share of total exports. Germany, France, the UK, Italy and Iran are all major export destinations for Turkish machinery products. However, machinery imports continue to exceed exports; these come mostly from China, Germany, Italy, France and the USA. The industry has ambitious goals of exporting US$ 100 billion with a share of 2.3 percent of the global market by 2023 (requiring a sector compound annual growth rate of 17.8%), attracting higher levels of FDI, and increasing investment in R&D, training, and quality and certification systems.[22]

Box 4.5. The sector is highly innovation-driven. For example, 3G technologies have led to the introduction of 3G-compatible devices, and the demand for energy-efficient products is creating a new consumption trend in white goods.

Area for improvement

In terms of resource use and environmental footprint, the sector's contribution is not well assessed and documented, as it is made up of thousands of SMEs.[23] However, the nature of the production processes are indicative of the fact that the sector should be a candidate for energy audits to identify potential energy efficiency and/or fuel substitution measures, as well as measures to reduce and recycle waste materials (especially metals and plastics), wastewater, solid waste, and hazardous substances. Finally, while the industry is clearly aware of the technological gap it needs to bridge to achieve its ambitious global-player goal, it suffers from lagging R&D investments, lack of qualified workforce in certain areas, and a cost-effective greening strategy that would enhance its competitiveness.

4.6 White Goods[24]

Situation analysis

Turkey's household appliances industry, which started as an assembly industry with foreign partners, has achieved tremendous progress and is now a flagship of the Turkish economy. The industry currently contributes about 1% of GDP and $US 2.7 billion exports in 2010. This sector has evolved from companies working under licensing agreements to accumulate its own know-how, carving out a niche in world markets with its own designs and technology. The sector's core consists of around 6 large- and 50 medium-scale manufacturers, with around 500 other firms supplying parts and components.

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22 Turkey's Industrial Strategy (MIT, 2011)
23 The number of entrepreneurs in the sector is about 18,000 (a proxy for the number of SMEs).
24 Drawn from Turkish Industrial Strategy Document, Ministry of Industry and Technology.

In recent years, Turkish manufacturers have increasingly engaged in strategic partnerships with foreign firms, expanding overseas with mergers and acquisitions to better position themselves and improve their brand visibility in Europe, MENA and elsewhere. Today, for example, BEKO is among the top appliance suppliers in Europe and its expansion outside Turkey has helped it achieve market dominance. In response to increasing global competition, the sector has also placed emphasis on innovation and new product development

The sector has increasingly oriented itself towards exports, with great success. Between 2000-2010, the sector increased its exports seven-fold (Figure 4.2). This success story is due to a multi-faceted policy including: use of advanced technologies in manufacturing, significant investments in R&D projects and facilities, full adaptation to international quality standards (e.g., ISO Series of quality assurance), focus on customer satisfaction, market preferences, world-class marketing and consumer services. The alignment of Turkey's legislation with EU harmonization and customs union requirements has also provided the sector with a competitive advantage. The sector's long-term objective is to become a key player and a leader in the EU market. To strengthen its competitiveness, the sector is investing not only in product quality and R&D, but also in energy-efficient products increasingly demanded by the market. For example, recent labeling and eco-design communiqués have been issued for many appliances demonstrating the sector's commitment and ability to growing green. See Box 4.6 on recent energy efficiency labeling requirements.

Box 4.6. The energy labeling affixed on products such as refrigerators, deep freezers, washing machines, dishwashers, electric ovens, and air conditioners presents, among other product information, the energy class (RED: least efficient; GREEN: most efficient), and annual energy consumption in kWh/year.

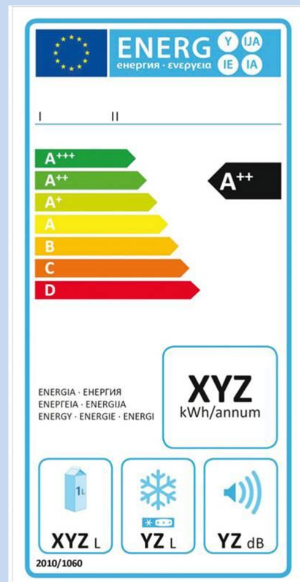
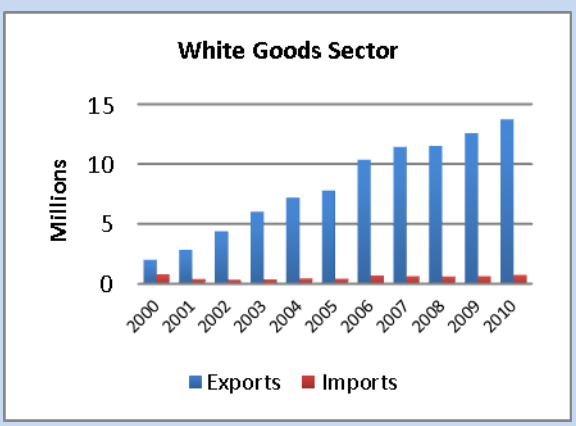


Figure 4.2 White Goods Sector



Source: TURKSTAT

Sector Environmental footprint. In addition to the main raw material (Cr-Ni steel) used in white goods manufacturing—currently imported with plans to substitute local production--the most important domestic components are compressors, electrical motors and plastic injection systems, which are all considered pollutant-intensive (e.g., petroleum products, chemicals and electricity-intensive products) and fall under major EU directives on waste & hazardous waste, water pollution, WEEE and IPPC. In addition, only 10-15% of the plants are regulatated in terms of energy intensity and usage of inputs meeting the EU directives. An added pressure on the sector is the emerging competition from countries like Croatia, Poland and Hungary, which will invariably have an impact on the capacity of the sector to further green its production (through the entire value chain).

Sector potential

The sector has good potential for further greening because of its link to market demand and emphasis on innovation and R&D. In addition to energy efficiency in production, the increased collection and reuse of metals is a major component in the sector, and plastics would have a positive impact on reducing costs and decreasing pollution. There is also a considerable gap between the requirements of the WEEE directive and Turkey's current situation. Given the burgeoning amount of e-waste produced in this industry and because of its trade and linkages with the EU market, the sector will need to move closer to adhering to compliance with EU standards.

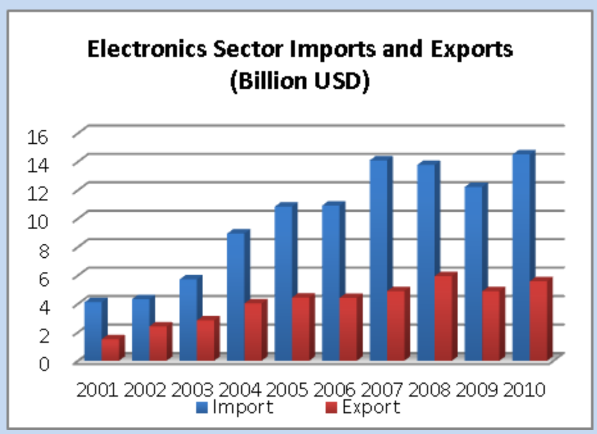
Electronics

Situation analysis

Beginning with foreign license agreements with companies mostly from the US or Europe, Turkey's electronics industry has changed and matured considerably since the late 1980s. The sector has been adding value to the Turkish economy as a flagship of innovation, quality and competitiveness and export-driven growth (1.5% contribution to GDP and US$ 6 billion exports in 2010). From 2000-2010, the sector increased its exports nearly four-fold (Figure 4.3).

Among its six categories of products (telecommunications equipment, Consumer electronics, computers, defense industry electronics, professional and industrial equipment, and components), consumer electronics has achieved remarkable success, accounting for over half of the European market for CRT TV sets. Driven to keep its competitive edge, the sector is investing significantly in R&D particularly in LCD display and AISC technologies.

Figure 4.3 Electronics Sector



By placing an emphasis on adding value through innovation and R&D, Turkey's electronic industry has quickly captured the local market and is now a global player. The sector provides about a quarter-million jobs in production, engineering and services, and grosses over 30 billion dollars with over one-third in manufacturing and the remaining in engineering and after-sales services. About one-fifth of this gross revenue was generated from exports.

The sector is also one of the largest recipients of FDI. Foreign firms bring their technology, efficient production techniques, and contacts to the sector. However, access to finance, public support to R&D, access to qualified human resources, and issues with the legal and institutional framework, continue to hamper the growth potential of the sector (which is also the case for the automotive and white goods sectors).

Sector environmental footprint. In addition to energy use, hazardous waste is the most important issue in the manufacturing of consumer electronics, including heavy metals such as lead, cadmium and mercury, which contaminate water resources and pose serious threats to human health and ecosystems. As consumer electronics penetrate deeper in the market product turnover increases and product lifespans shorten, leading to a continuous stream of hazardous waste (e.g. roughly half of the phones are replaced within a year, approximately 10-15% of which are simply discarded, 10%-15% are recycled for scrap metal, and the rest end up in a the second-hand market and/or join the municipal waste stream).

Area for improvement and potential

Because of these environmental issues, the sector is specifically targeted by the EU WEEE Directive. The WEEE directive imposes the responsibility for WEEE disposal on the manufacturers of such equipment, who are required to collect their e-waste free-of-charge and ensure that they are disposed of safely. However, there is a considerable gap between the requirements of the WEEE directive and Turkey's current situation, especially given the burgeoning amount of e-waste produced. As in the white goods sector, much of the old equipment and waste is collected by informal scrap dealers and sold on secondary markets.[25] This is a pressing challenge but constitutes an opportunity for greening this economically important sector.

4.7 Agriculture

Box 4.7. In 2010 R&D investments by the electronics industry (excluding those from the public sector) reached a quarter-billion dollars, roughly 2% of the sales volume, similar to the automobile industry and on a par with internal industry leaders.

Situation analysis

Turkey is estimated to have the seventh largest agricultural economy in the world, larger than Italy and just below France's in terms of Agricultural Value Added. Agriculture has been growing at an average rate of around 1.2-1.5% per year during the past two decades, with significant annual variations, slightly lower than the annual population growth rate during the same period. The sector is still the largest employer in the country and it is an important contributor to GDP (8-10%), exports, and food security. Notwithstanding the natural, steady decline of agricultural employment and the share of the sector in the economy (Figure 4.4), this sector continues to be the principal source of employment in rural areas—in 2009 an estimated 84% of women living in rural areas were employed in the sector. The importance of agriculture in Turkey is further enhanced when the whole agri-food chain is considered. In particular, the food industry is one of the major manufacturing sectors and plays an important role in the economic growth of the Turkish economy, including rural development.

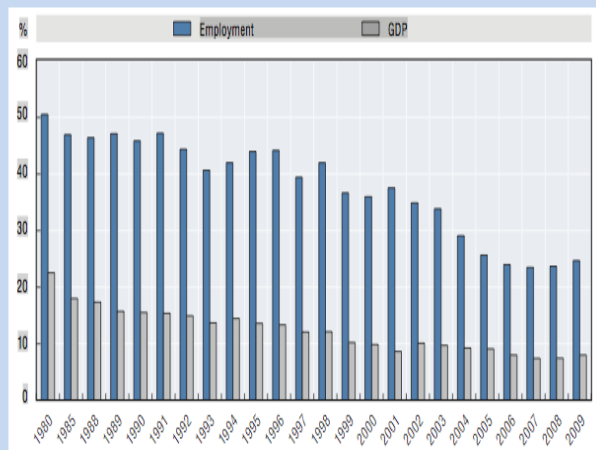
Turkey has an agricultural area of almost 39 million ha, out of which 21 million ha is arable, 3 million ha are permanent crops, 5.2 million ha are irrigated, and 15 million are

[25] See World Bank (2011), Turkey: Balancing Development, Sector Competitiveness, and Challenges of Complying with the EU Environmental Aquis: Analysis of Household Appliances Sector and Implementation of Waste Electrical and Electronic Equipment Directive (2002/96/EC). Sector Note.

pastures/grasslands,[26] which makes its resource base highly dependent on agro-climatic conditions. Agricultural production in Turkey is dominated by crops, fruits, and vegetables, which represented 66% of the agricultural output value in 2006-08. Turkey is the world's largest producer of hazelnuts, cherries, apricots, and poppy seeds; and the second largest producer of figs, strawberries, quinces, cucumbers, and leeks. Livestock production and animal products constitute the remaining 34% of agricultural output value.

Turkey is fortunate in its endowment of resources which has created the impression that resources are available to allow for many years of agricultural growth. The ninth Development Plan projects an annual growth of 3.6% for the period 2007-2013. This output is significantly more ambitious than the growth documented during the previous two decades. There are still more than 3 million ha of agricultural land suitable for irrigation where the infrastructure has not yet been built, but most of this area is in the Eastern side of the country where there are security concerns and a scarcity of labor due to strong urban migration. Climate change poses an additional threat to the capacity of the resource base. Demand has been increasing not only because of population growth (1.35% per year since 2000) but also because of increasing per-capita consumption. Increasing wealth is expected to boost demand for products with a higher resource footprint, such as meat. Thus the resource base may prove to be a limit to agricultural potential sooner than anticipated.

Figure 4.4 Percentage of Agriculture in GDP and Total Employment



Sector policies. Turkey's main policy objectives for agriculture are: ensuring food security; food safety and the stability of the food supply; raising self-sufficiency and exploiting export potential; providing stable and sustainable income levels in agriculture; enhancing competitiveness; fostering rural development; and building the institutional capacity necessary for moving into alignment with the EU's agricultural and rural development policies. As part of the regular monitoring of public support to the agricultural sector of its member countries, the OECD assessment of agricultural policy reform progress in Turkey since the mid-1980s indicates that progress towards improving market orientation has been variable, with frequent ad hoc changes being made to policy settings during periods of economic crisis and political instability. Policies pursued from the mid-1980s to 2000 were financially unsustainable, and ambitious reforms that were initiated in the late-1990s culminated in a comprehensive policy reform in 2001. The initial impact of reform was substantial and has achieved some gains in productivity and efficiency, but the implementation of policy reforms soon encountered difficulties and farmers received mixed signals from the government. Border protection based on commodity output remains the core form of agricultural support so that in Turkey consumers primarily finance producer support. The share of Total Support

[26] Source: FAOSTAT. The area under permanent pastures seems to be overestimated; a more realistic area would be around 12.4 million ha. Of these, only 8.7 million ha have been studied and classified.

Estimates (TSE)[27] in GDP remained virtually unchanged between 1986-88 and 2007-09, at around 3.7%, which is the highest in the OECD area.

Area for improvement

While the Government has expended considerable efforts in dealing with rural poverty, progress on the environmental sustainability of agriculture is mixed at best. In addition to a lack of reliable monitoring data, three main issues directly affect the sector's longer-term sustainability: the efficiency of resource use, externalities, and resilience to climate risk.

Turkish crop yields are often lower than those of many comparable OECD countries such as Greece, Italy, and Spain (Figure 4.5), although fertilizer use is similar. Such lower yields (and thus lower land productivity) can only be partly explained by different climatic conditions (Turkey is drier than Italy). According to the own calculations of the World Bank team based on FAOSTAT[28], chemical fertilizer use per hectare in terms of nutrient equivalent in Turkey (85 kg/ha) is similar to Italy (85 kg/ha), but higher than Spain and Greece (70 and 56 kg/ha), even though Turkish yields are lower (Figure 4.5). Controlling for the amount of fertilizers used reduces the agricultural sector's competitiveness by preventing production costs from rising, and at the same time it can limit GHG emissions, as well as the water pollution problems for surface and ground water. In 2005-06, 12.4% of the ground water samples collected by Ministry of Agriculture had reported a Nitrate concentration level above the limit of 50 mg/l[29] – the 2004 limit set by the Turkish Nitrate Directive.[30]

Erosion primarily affects topsoil, where most of the organic matter and nutrients are concentrated. Turkish soils are particularly vulnerable to land degradation: most of the country is mountainous and hilly, with significant climatic variability and large semi-arid and sub-arid regions, particularly in the continental interior. As a result of its climatic and topographic conditions, and largely unsustainable natural resources management practices in production systems, soil erosion is a major problem in Turkey. According to the National Environmental Action Plan of Turkey, 73 % of the arable land is at risk of erosion. Available scientific studies show that Turkey's potential erosion rates are in the range of 4 to 74 tons of soil per ha per year; this leads to a displacement of several tens to hundreds of millions of tons of soil per year, releasing much of the sequestered carbon. While soil erosion is in part a natural occurrence, there is general consensus in Turkey that it causes important loss of soil fertility and that combating soil erosion is fundamental for achieving both environmental and economic development objectives.

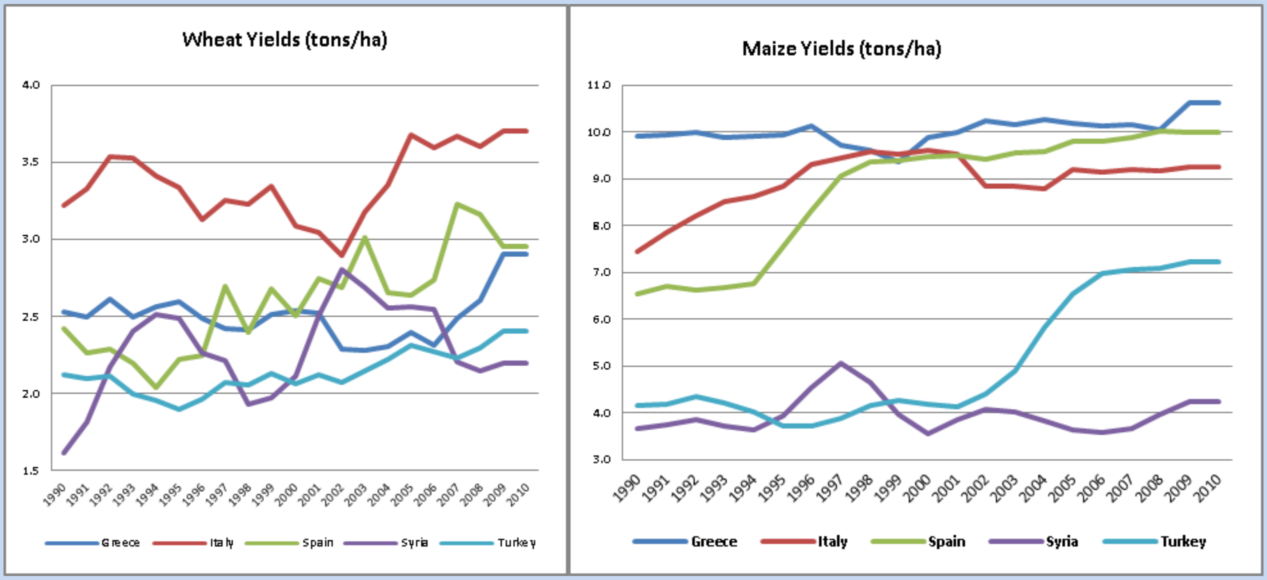
[27] The OECD Total Support Estimate (TSE) is an indicator of the annual monetary value of all gross transfers from taxpayers and consumers arising from policy measures which support agriculture, net of the associated budgetary receipts, regardless of their objectives and impact on farm production and income, or consumption of farm products. Source: OECD (2011), Evaluation of Agricultural Policy Reforms in Turkey, OECD Publishing. http://dx.doi.org/10.1787/9789264113220-en

[28] The team combined three types of fertilizers as used in 2009 (nitrogen, N total nutrients, phosphate, P_2O_5 total nutrients, and potash, K_2O total nutrients) and divided it by the total number of hectares of arable land and permanent crops (thus excluding pastures because of their low fertilizer use).

[29] Basri EVCİ at http://iwlearn.net/abt_iwlearn/history-of-iw-learn/pns/partner/nutrientfiles/turkey-files/evci_turkeynitrate.ppt/view, slide 30

[30] The national legislation "Regulation on Protection of the Waters against Nitrate Pollution Caused by Agricultural Resources" has been adopted on February 18, 2004.

Figure 4.5 Comparison of Cereal Yields with Selected Countries (1990-2010)



Source: Sector Note (based on FAOSTAT data)

However, the absence of a widespread system of soil conservation practices has resulted in a failure to improve soil quality. Practices involving the burning of crop residues, over-grazing, excessive plowing and tillage, and conversion of grasslands, are major causes of the problem. There are proven approaches and technologies to address the problems of soil fertility and pasture degradation, including Conservation Agriculture[31], a group of technologies such as reduced or no-tillage with the potential to help achieve both economic and environmental objectives. While some Turkish universities and research centers are aware of these potentials, very little has been done in practice to increase the adoption of these technologies.

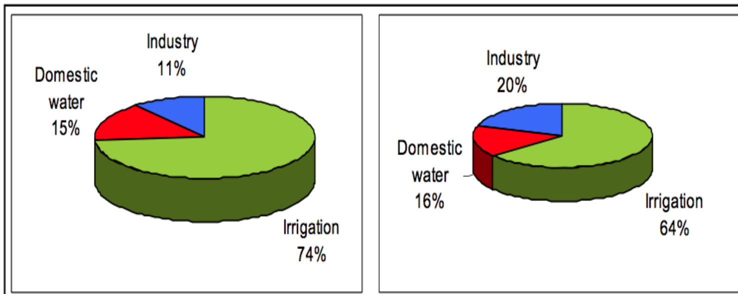
In the context of overall water scarcity, agriculture uses around three quarters of the country's freshwater resources. According to the 2009 Turkey Water report, the country is projected to use all of its 112 billion m^3 of "Total Exploitable Water" by 2023 (with agriculture, domestic water, and industry as the main users) (Figure 4.6). In fact, because of its large semi-arid and sub-arid regions, Turkey is heavily dependent upon irrigation, which has three times higher

Box 4.8. The 2009 Turkey Water Report projects doubling the use of irrigation between 2008-2023 (from 34 to 72 billion m^3), but with no direct link to agricultural production. Moreover, doubling agricultural production in 15 years may not be feasible because the area suitable for irrigation development–estimated at around 8.5 million ha–would not be sufficient.

[31] Conservation Agriculture is a technology defined as follows by FAO: (i) minimal soil disturbance (i.e. no-till): the tilled area must be less than 15 cm wide or 25% of the cropped area (whichever is lower); soil cover: ground cover must be more than 30%; and (iii) crop rotation.

productivity than rainfed areas.[32] However, agriculture's dependence on water resources needs to consider the wider perspective of other uses (including minimum environmental flow to maintain the integrity and functioning of ecosystems) and the costs and benefits involved.[33] The land consolidation program that Turkey is implementing on a large scale in its irrigated area is contributing to improve irrigation water efficiency.

Figure 4.6 Water Projected Demand and Availability



2008		2023	
Irrigation	: 34 billion m^3 (74%)	Irrigation	: 72 billion m^3 (64%)
Domestic water	: 7 billion m^3 (15%)	Domestic water	: 18 billion m^3 (16%)
Industry	: 5 billion m^3 (11%)	Industry	: 22 billion m^3 (20%)
TOTAL	: 46 billion m^3	TOTAL	: 112 billion m^3

Source: Turkey Water Report 2009 (http://www2.dsi.gov.tr/english/pdf_files/TurkeyWaterReport.pdf)

Irrigation technology in Turkey remains gravity-based, with the majority of irrigation water (around 81%) distributed through "open systems" that carry water through open canals instead of "closed" (i.e., piped) systems. Open systems have higher losses, are not amenable to volumetric water use, and contribute to less efficient surface irrigation methods. A DSI policy of using "closed" systems was initiated in 2003, but progress in uptake and impacts has yet to be documented.

Water pricing can be an important element of a policy aimed at increasing agricultural water efficiency. While the issue may be controversial,[34] it ought to be part of an integrated approach to water resources management where both the supply- and demand-side measures need to be part of a credible and sustainable water policy. It is estimated that Turkish farmers currently use an average of 7,000 m^3 per hectare and they are charged on a per-hectare basis depending on the crop. This revenue source is estimated to cover about 70% of the operation and maintenance costs.

Irrigation-related salinity- alkalinity and waterlogging problems are an important issue. These problems are caused by excessive irrigation and insufficient drainage systems. The total area drained in irrigation schemes is around 0.4 million ha, which is just a quarter of the 1.6 million ha area salinized by irrigation. Thus around 1.2 million ha of salinized irrigated area – or one quarter of the total irrigated area – does not have adequate drainage. This represents a major obstacle for agricultural productivity.

[32] 5.2 million ha of irrigated land out of 24 million ha contributes to around half of the crop production. This Turkish ratio is higher than the global average (3.6 in Turkey versus 2.2 at a global level) where one-third of agricultural production is obtained by irrigating 18% of arable land.

[33] According to FAO Aquastat, during the 1990-2000 decade, the use of irrigation water increased by 35-38%, while according to OECD, during 1990-92 and 2002-04 agricultural water use increased by more than 80%[33]. In the same period, agricultural GDP increased by only 11-12%.

[34] Molle, F.; Berkoff, J. 2007. Water pricing in irrigation: Mapping the debate in the light of experience. In: Irrigation water pricing: The gap between theory and practice, Chapter 2, eds F. Molle and J. Berkoff. Comprehensive Assessment of Water Management in Agriculture. IWMI/CABI. Forthcoming.

Sector potential

Some of the main obstacles to agricultural growth – such as over-tillage and over-irrigation – are environmental in nature. Reducing the extent of soil tillage, improving pastures, and reducing the amount of irrigation per hectare would increase yields, productivity, and achieve growth and environmental objectives at the same time. A greening policy aimed at increasing the adoption of Conservation Agriculture/no-till, pasture improvement, and water use efficiency in agriculture would translate into significant productivity gains, as estimated in Chapter 6 (see Table 6.4. Benefits from Adopting Greening Approaches in Agriculture).

The EU accession process can help in adopting agricultural policies and technologies with economic and environmental benefits. The accession process includes Agriculture and Rural Development[35] and the Environment[36], and provides policy/legislative alignment and significant funding through the Instrument for Pre-Accession for Rural Development (IPARD). IPARD includes, inter alia, provisions for the implementation of pilot agri-environmental measures[37], such as the EU Cross-Compliance Standards on Good Agricultural and Environmental Conditions[38]. In order to produce both environmental and economic benefits, the legislative alignment needs to be adapted to existing local customs and institutions. Because of this, the accession negotiations can play a key role in achieving both economic and environmental benefits.

[35] The EC Enlargement Strategy and Progress Report 2011 for Turkey states: "*There is some progress to report in the area of agriculture and rural development. Significant progress has been made in the implementation of the Instrument for Pre-Accession Assistance for Rural Development (IPARD) programme, leading to the Commission Decision to confer the management of EU funds, as well as in preparations achieved for the second phase of the IPARD programme. Agricultural support policy differs substantially from the CAP and there is still no strategy for its alignment. The failure to fully remove barriers to beef imports also constitutes a major shortcoming*."

[36] The EC Enlargement Strategy and Progress Report 2011 for Turkey states: "*In the environment area, Turkey has made good progress on waste management, whereas only limited progress can be reported on horizontal legislation, air quality and industrial pollution control and risk management. Turkey made very limited progress on water quality, chemicals and on administrative capacity. No progress can be reported on nature protection. Regarding climate change, Turkey made limited progress on awareness-raising on EU climate requirements, but a more robust and ambitious climate policy, both domestically and internationally, has yet to be established*".

[37] In this Note the term "agri-environmental measures" will be used in a broader and more flexible way than the EU detailed specifications.

[38] Such standards includes soil protection by maintain soil organic matter and soil structure through appropriate measures, protection of ground water from pollution and against Nitrates pollution, conservation of natural habitats and of wild flora, etc.

5. Green Growth Policies: Overview and Implications for Turkey

This Chapter reviews the current green growth policy set in Turkey, highlighting gaps relative to the objective EU directives and OECD principles. The Chapter also reviews the catalogue of EU policy instruments and highlights other policy tools available from emerging international experiences, as well as the relevance of these policy options to the seven strategic sectors covered by the Policy Note.

5.1 Green Policies in Turkey

The current arsenal of Turkish environmental policy instruments is mostly limited to energy taxes, environmental impact assessments, and pollution penalties. In addition, fees are charged for municipal services to cover wastewater and solid waste management, and a nominal charge is applied to irrigation water. Still, it is a clearly recognized fact that these instruments will not suffice under a more active environmental policy design, and will need to be expanded to include other forms of policy measures such as additional pollution taxes, emission trading and permits, and abatement investments towards reduced energy intensities. However, given the current lack of an adequate quantitative modeling paradigm for environmental policy analysis in Turkey, the effectiveness of such policy interventions and their economic impacts as well as the trade-offs they involve are not well-known. There is a strong need therefore for the design and utilization of analytical models for environmental policy analysis.

This study aims to make a first step at addressing the need for better policy modeling techniques by presenting a stylized model of the Turkish economy and demonstrating how investments in abatement technologies and green growth can largely offset the significant negative output effects of a simple set of pollution taxes. However, more specific policy simulations would require a more finely- tuned model structure, incorporating better technological knowledge of cost abatement in the main strategic sectors and of the endogenous private sector reaction to pollution taxes.

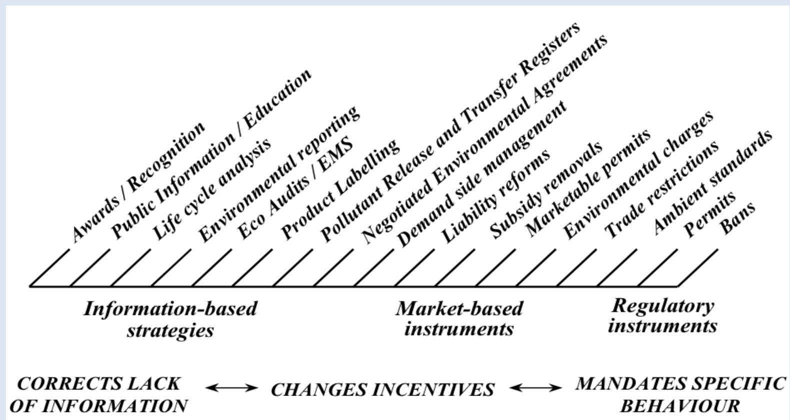
5.2 A common agenda for green policies

Green growth will require a mix of measures that can increase growth, while economic activity shifts into modes of production and consumption with lower environmental impact (OECD 2011). Turkey has already integrated many efficiency and pollution-reducing measures into production and consumption activities, largely driven by existing policy signals from national legislation, EU Accession requirements or by market demand for cleaner and greener products. But bringing this wide array of policies together under one common agenda would be a new step forward. Using some common principles the green policy mix should: (i) integrate the natural resource base into the same dynamics and decisions that drive growth; (ii) develop ways of creating economic payoffs which more fully reflect the value of the natural resource base of the economy (pricing); and (iii) focus on mutually reinforcing aspects of economic and environmental policy (OECD 2011).[39] While these overarching goals point to the direction and future of Turkey's growth, it is important to first understand the menu of policy options and then map them along the lines of existing green growth constraints. Hence, complementing this Policy Paper with a diagnostic assessment remains an important item for the Ministry of Development and the World Bank's contribution to the Ministry's future work.

5.3 A policy menu

While industry (supply) and consumers (demand) have a lead role in ultimately getting the economy to greener growth, the government has an equally important role in terms of creating an enabling culture that will encourage better environmental performance and widespread adoption of practices that can lead to greener growth.

Figure 5.1 Examples of the range of environmental policy instruments



There is a wide range of instruments and these can be used in combination to stimulate resource efficiency and better environmental performance that could ultimately lead to a better environmental quality. These instruments can be categorized into three groups (Figure 5.1):

- **Regulatory instruments** that mandate specific behavior
- **Market-based instruments** that act as incentives for particular activities
- **Information-based instruments** that seek to change behavior through the provision of information

Further categorization of these policy instruments can be made based on the nature of the interaction between government and industry, and the level of obligation of the policy instrument. With such an approach a distinction will be necessary among the following:

- **Specified compliance**, where government imposes obligatory standards on the regulated party

[39] Opportunities for complementary policies exist but as Strand and Toman (2010) conclude, there are few obvious candidates for triple-win policies delivering strong benefits for short-term economic recovery, and long-term growth + environmental benefits. Triple-win policies bridge the temporal differences of often competing objectives understood that policy tradeoffs, and decisions made, are part of a dynamic adjustment process. Compliance with EU Directives is a good case in point. Sectors expected to be hit hard by requirements may be eligible for a phased approach to compliance and the government may want to create incentives for early adopters.

- **Negotiated compliance**, where the regulators and the regulated interact in setting the obligatory standards
- **Co-regulation**, where there is a high level of interaction among the parties, but the agreed standards are not mandatory
- **Self-regulation**, where industry acts unilaterally in setting standards that are not legally enforceable

Different policy instruments are usually not used in isolation from each other: regulatory instruments typically operate in conjunction with the threat of an economic penalty, economic instruments need an appropriate legal framework, and the provision of information is a necessary element in the implementation of most types of policy instruments. For example, the IPPC Directive is a typical regulatory instrument, but its implementation can benefit from parallel approaches like negotiated compliance, market-based instruments, and informational tools.

5.4 Regulatory instruments

Regulation has been the predominant strategy for pollution control in the EU and across most OECD countries, and one in which a public authority sets standards and then carries out inspection, monitoring, and the enforcement of compliance with these standards, and also punishes transgressions with formal legal sanctions. These regulations may, for example, specify an environmental goal - such as the reduction of NOx emissions by a specified date - or they may mandate the use of a particular technology or process.

Such approaches give the regulator maximum authority to control where and how resources will be allocated in order to achieve environmental objectives, and provide the regulator with a reasonable degree of predictability as to how much pollution levels will be reduced. There are certain specific situations where regulatory instruments might be seen as the most appropriate and effective means of achieving a desired environmental outcome, an example being the control of hazardous substance releases through restrictions or bans.

Environmental quality in the majority of industrialized countries is based on programs for direct regulation. The efficiency of regulations depends on the instruments used to influence the behavior of the polluter. The majority of the programs for direct regulation rely on *specified compliance*, where precise and specific demands are imposed on the regulated entity or industrial community with little bargaining and few exceptions allowed. Although generally successful, this arguably authoritarian style has drawbacks in that the regulated entity can become alienated and might unite in opposition against the rule makers.

Some of these drawbacks can be offset with the use of a *negotiated compliance* approach, where setting and enforcing standards are performed more cooperatively. This "shared responsibility" between the government and industry enhances the likelihood of a more open exchange of information between the parties, and allows greater flexibility regarding the means of meeting the standard. In a number of countries, so-called *non-prescriptive regulations* exist. With these, attainment of certain targets (for example, recycling targets) is required, but a concrete means of achieving such targets is left to the industries involved. Such approaches hold the potential to improve the economic efficiency of the regulation, and may stimulate the emergence and adoption of innovative preventative approaches.

5.5 Market-based instruments (MBIs)

Instead of banning unwanted activities or dictating acceptable ones, MBIs seek to address market failure of "environmental externalities" either by incorporating the external cost of a firm's polluting activities within the firm's private cost (for example, through taxation), or by creating property rights and facilitating the establishment of a proxy market (for example, by using tradable pollution permits).

MBIs can be more efficient economically than regulatory standards in achieving a desired reduction in pollution because they act as *incentives* for the development of more cost-effective pollution control and prevention technologies and provide greater *flexibility* in the choice of technology or prevention strategy. In addition, they may provide the government with a source of *revenue* that may be used to support environmental and/or social initiatives. Introduction of MBIs, however, is often faced with significant constraints. It is advisable to identify and evaluate existing economic incentives that have a direct or indirect link to the targeted performance - such as subsidies encouraging overuse of resources - prior to introducing new economic incentives. ***Taxes***, ***charges***, and ***fees*** are among the most commonly used MBIs. For example, France introduced water charges, and emission taxes on sulfur, volatile organic compounds and NOx which are earmarked for pollution abatement investments by the polluting industries (Sterner, 2003). Setting high-enough levels for these to achieve desired goals, however, is often politically infeasible. Furthermore, successful implementation of such initiatives requires a system of monitoring, revenue collection, and enforcement. These are also prone to fueling corruption.

Liability rules, holding firms responsible for all of the environmental damage they cause, even if they have fulfilled their legal obligations and have exercised "due diligence," can be another example of effective MBIs, provided that an appropriate enforcement mechanism and legal system exist. ***Subsidies*** that can be provided in the form of, for example, ***low-interest loans***, ***direct grants***, or ***preferential tax treatment*** are also among MBIs that are proven to be effective in stimulating desired environmental performance. In line with earlier arguments, these need to be carefully assessed prior to their introduction ***in order to avoid hidden incentives for counter-productive behavior.***

Emission trading schemes (ETSs) are another MBI that, if applied properly, could be highly effective. In the case of an ETS, the right to emit a certain unit is certified and the total amount of emissions is set at a maximum level (cap) for a specified group of controlled entities (for example, countries or companies). If the emissions cap is below the business-as-usual level, the emission certificates become valuable and incentivizing tools for emissions reductions. As such, the ETS would lead to a more cost-effective allocation, since emitters with abatement costs above the market price of the certificate can refrain from taking costly emission reduction measures and buy lower-cost certificates instead. These certificates are supplied by emitters with lower abatement costs, who realize additional emission reductions and sell their surplus certificates. Contrary to a tax on emissions, an ETS ensures reaching the environmental target (which is equal to the emission cap), and uses the market to determine the price associated with reaching that target. It also achieves this target at a lower total cost than a uniform tax.

There are functional trading schemes for several air pollutants. In the United States there is a national scheme to reduce acid rain and several regional ones for nitrogen oxides. But for GHG the most successful scheme is the European Union Emissions Trading System (EU ETS), which is at the core of the EU's policy to combat climate change, and is the main tool for cost-effectively reducing industrial greenhouse gas emissions. The scheme is akin to the largest international system for the trading of greenhouse gas emission allowances, and covers some 11,000 power stations and industrial plants in 30 countries (the 27 EU Member States plus Iceland, Liechtenstein and Norway). The scheme covers CO_2 emissions from installations such as power stations, combustion plants, oil refineries and iron and steel works, as well as factories making cement, glass, lime, bricks, ceramics, pulp, paper and board.

Turkish Environmental Law now recognizes the use of carbon markets for climate action and studies are underway to establish one by 2015. Turkey became a participating member of the Partnership for Market Readiness (PMR) in 2011, and is interested in exploring the potential use of market-based instruments for greenhouse-gas emissions.

5.6 Information-based instruments

Information-based instruments that apply directly to the product are used as an alternative to direct control and to providing incentives for pollution reduction. For example this could be through requiring ***public disclosure of environmental information*** - or through building capacity in the regulated community - such as training in specific issues. ***Eco-labeling*** or ***environmental product declaration*** measures that aim to influence consumer behavior, issuing ***high-profile awards*** for desired performers, and promoting ***R&D and demonstration programs*** are other examples of information-based instruments. Eco-labeling has been most successful in the Nordic countries because eco-labels were popular with consumers and most large producers voluntarily followed suit.

Innovation and technology

Policy formulation should also consider the implications it has on technical change and innovation. Since innovation is viewed as key to solving many environmental challenges, it is important to understand the mechanisms by which innovation is fostered or limited. Demand-side instruments, such as public procurement, can help foster markets for new products and services, for example through demonstration effects, and counter gaps in the supply of finance at the early stages (OECD 2011). On the supply side, access to finance is one of the key constraints for business-led innovation, which is inherently risky and may only pay off in the long-term.

Constraints to innovation are not unlike those for green growth in general. They require both market and, at times, non-market responses that encourage risk-taking which may lead to significant rewards. For example, technological barriers could be due to a lack of knowledge which greater international cooperation would solve (Some examples are listed in Table 5.1).

Table 5.1 Policies to promote green innovation

Policy challenge	General assessment for Turkey	Policy options
Insufficient demand for green innovation	Government subsidies to SMEs for green innovation exist but no market-based instruments, standards or regulations	– Demand-side policies, such as public procurement, standards and regulations, in specific markets and circumstances – Market-based instruments to price externalities and enhance incentives
Lack of innovation capability	Private-sector-lead green innovation is advanced by large, exporting firms	– Broad-based policies to strengthen innovation
Technological roadblocks and lack of radical innovation	Leading innovation concentrated in the academic environment	– Investment in relevant R&D, including thematic and mission-oriented research – International cooperation
Research and investment bias to incumbent technology	Absolute level is low, but can be scaled-up and more strategic	– R&D support, tax incentives – Adoption incentives/subsidies – Technology prizes
Lack of finance	More opportunities need to be created, including PPPs	– Co-investment funds – Market development
Regulatory barriers to new firms	Not a major constraint	– Regulatory reform – Competition policy – Front-runner approaches
Lack of capabilities in SMEs to adopt green innovation	Capacity needs are high (i.e. professional education, vocational programs)	– Access to finance – Skills development – Linking SMEs to knowledge networks – Improving information supply – Reducing regulatory burdens
Non-technological innovation	Problematic in major urban areas (e.g. transport logistics)	– City and transport planning – Regulatory reform
International technology transfer	Weak implementation of Intellectual Property Rights (IPR) and patent pools	– Development of capabilities – Trade and investment policies – IPR protection and enforcement – Voluntary patent pools and collaborative mechanisms

Source: OECD (2011)

5.7 Matching policies with key constraints

Policy development should also consider the *constraint* in which it is trying to address. Constraints come in many forms, but they can be thought of as reflecting some type of 'failure'- be it market-based, institutional or even political. Understanding the nature (or determinants) of the constraint are preconditions to policy selection. The policy lever should be designed such that it relaxes (or removes) this constraint, allowing the economic agent to adjust accordingly and operate more efficiently. There are also important temporal dimensions to consider. Policy-lags may affect the decision of whether to take on new investments or delay action. This is especially true with more costly EU requirements, where the imposition of new regulations may warrant a negotiated or phased approach to compliance.

Nevertheless, an important step in developing policy options is to match policy types to the constraint. Table 5.2 includes some example policy options among some typical green constraints.

Table 5.2 Policy options to green growth constraints

Green growth constraints	General assessment for Turkey	Policy options
Inadequate (soft) infrastructure	Weak institutional support for entrepreneurial activities	– Public-private partnerships – Public investment – Tariffs – Transfers
Low human and social capital and poor institutional quality	Governance issues exist, but country is a dynamic and emerging economy	– Subsidy reform/removal – Growing and stabilizing government revenue
Incomplete property rights, subsidies	Weak implementation	– Review, reform or remove
Regulatory uncertainty	Long planning tradition exists, but checks and balances need strengthening	– Set targets – Create independent governance systems
Information externalities and split incentive	Some information campaigns exist (eco-labeling), but more can be done to scale up and focus in on EU-bound products	– Labeling – Voluntary approaches – Subsidies – Technology and performance Standards
Environmental externalities	Prices do not reflect scarcity or other non-market values (e.g. pollution taxes)	– Tradable permits – Subsidies – Taxes
Low returns to R&D	Firm-specific R&D robust (e.g. large, exporters)	– R&D subsidies and tax incentives – Focus on general purpose technologies
Network effects	Exist, but need to be enlarged to take advantage of possible synergies (e.g. industrial parks or even in cities)	– Strengthen competition in network industries – Subsidies or loan guarantees for new network projects
Barriers to competition	A vibrant private sector has developed	– Reform regulation – Reduce government monopoly

Source: OECD (2011)

5.8 Policies for key strategic sectors

The strategic sectors covered in this policy note have a number of opportunities for greening, yet face a number of constraints – usually in the form of market, institutional or policy failure. Market failures can arise if the production of a good also creates some form of residual that is not 'priced' in the market. This is often the case with pollution – where the market does not reflect the true social cost of producing this good or service. In this case the rationale for government intervention is to internalize these environmental 'externalities,' which is viewed as correcting a market failure. An example of this is CO_2 or PM_{10} emissions from the cement or iron & steel sectors. According to the 'polluter-pays-principle' the sector should be responsible for absorbing the additional costs of reducing pollution. Institutional failure is more difficult to define precisely, but can arise when there is a lack of government intervention or institutions to regulate certain behaviors. For example, the absence of a mechanism for water pricing in agriculture can be viewed as an institutional failure that leads to inefficient use. Policy failure is usually the circumstance where policy fails to achieve its intended objective. Many energy policies fall into this category, where subsidizing fossil fuels runs counter to efficiency objectives – resulting in over-consumption.

Re-incentivizing through policies is more complicated than it first appears, however the EU Directives offer some guiding principles that Turkey has to follow. Some examples of the major constraints faced, applicable EU Directives and some possible policy responses to guide the sector in its transition to a greener development path are presented in Table 5.3 below.

Table 5.3 Example policy responses among key strategic sectors

Sector	Greening potential	Major constraints	Major EU Directives and progress to date	Possible policy responses
Agriculture	Promoting soil conservation practices such as zero-tillage and pasture improvement	Lack of knowledge; resistance to change; limited availability of special equipment; and insufficient access to capital to finance the initial investment		Agri-environment schemes such as the Environmentally Based Agricultural Land Protection program (ÇATAK); Pilots sponsored through Priority Axis 2 of the IPARD program Local education and promotional campaigns to raise awareness of conservation tillage
	Irrigation water conservation	Inefficient use of water; leakages; nitrate pollution	Nitrate Directive	Public sector support for the diffusion of new knowledge through training and advice (extension) (e.g. support programs for nutrient reduction in meeting the Nitrate Directive) Water pricing reflecting scarcity value coupled with technical assistance programs on water-saving technologies and drainage (a form of tax)
Automotive	Energy efficiency Waste – recycling	Low-cost inputs leading to inefficient use Product innovation with greater recycled content	End-of-Life Vehicles	Full- or social-cost of inputs used (a form of tax) Producer responsibility – with take-back programs fed into secondary recycling markets; eco-labeling
Construction (buildings)	Energy efficiency	Institutional arrangements and financing		Taxes on emissions/ output
Cement	CO_2 emissions Hazardous waste	Market-failure (CO2 not priced)	IPPC/ ETS Hazardous Waste	Taxes on emissions/ output; with eventual participation in Emission Trading System (ETS) Outright bans – restrictions; fines or penalties for violations
Electronics	Mercury, cadmium, lead and other toxic substances contained in e-waste	Short life-cycles leading to increasing volume; stakeholder coordination issues with the WEEE Directive	Hazardous Waste WEEE Directive	Life-cycle regulations requiring safe disposal per the Hazardous Waste and WEEE Directives; creation of hazardous (e-)waste collection points

Iron and steel	CO_2 and PM_{10} reductions	Blast furnace technology is dated and emissions-intensive	IPPC/ ETS	Taxes on emissions/ output; with eventual participation in Emission Trading System (ETS)
	Reduction of emissions of dust, CO, heavy metals, Nitrous Oxides, Organic Gases and Steams, Dioxins and Furans	Importation of 'dirty' scrap requiring pre-treatment	Waste and Hazardous Waste Directives	Regulations on imported scrap; greater domestic recycling content to reduce reliance on imported scrap; eco-certified or labeled products
Machine industry	Handling of waste and e-waste	Institutional and market failure (absence of institutional structure for handling waste and the potential of recycling e-waste in secondary markets)	WEEE Directive	Waste management fees (both regular and hazardous); regulations on landfilling; eco-labeling
White goods	Handling of waste and e-waste	Institutional and market failure (absence of institutional structure for handling waste and the potential of recycling e-waste in secondary markets)	WEEE Directive	Waste management fees (both regular and hazardous; regulations on land-filling; eco-labeling

Note: The status of Directive harmonization and implementation is drawn from **Turkey's 2010 and 2011 Progress Reports**, Communication from the Commission to the European Parliament and the Council, Enlargement Strategy and Main Challenges 2010-2011 and 2011-2012.

6. Economy-wide Impacts of Greening Scenarios: A Pilot General Equilibrium Analysis

This Chapter presents the results of a pilot economic analysis focusing on the impacts of measures to further green the Turkish economy, with a particular focus on the seven strategic sectors (automotive, construction, electronics, iron and steel, machine industry, and white goods, as well as agriculture), and consistent with the definition of "green growth" in Turkey in Chapter 3 above. The results are based on a Computable General Equilibrium (CGE) model which simulates the basic structure of the Turkish economy, with a particular focus on the six strategic industrial sectors and agriculture, but without a detailed technology options specification and marginal abatement cost curves (MACs) for pollution mitigation. Future follow- up work could expand, enrich, and customize the approach used in this pilot study by building and linking MACCs for each of the strategic sectors (also including energy, water, and land) to the CGE model. Therefore, the results presented here should be regarded as stylized and suggestive only.

6.1 Introduction

Greening policies in Turkey are very much linked to the country's aspirations in terms of sustainable development and poverty reduction, and its commitments in terms of achieving international environmental standards and contributing to the global effort on mitigating the impact of climate change. This is a very broad agenda, and the aim of the present report—and the analysis below--is to contribute to understanding some of the key trade-offs involved in greening the Turkish economy, and in particular the impact on economic growth and employment. Moreover, it is important to note that while –as discussed in Chapter V—the range of green policy measures is quite broad, the present analysis focuses mainly on taxes and investments as the main instruments for green growth in Turkey, and does not deal with institutional and implementation issues related to these policies, an area that will need to be investigated separately. Moreover, the structure of the modeling analysis in this Chapter puts much of the burden of pollution cost abatement on the public sector, through ear-making pollution tax revenues for green jobs, and innovation. In reality, much of the abatement is likely to happen endogenously by the private sector, thus reducing both pollution tax revenues and the need for public investment in abatement activities.

In its quest to pursue green growth policies, the Turkish Government (through MoD) had three main questions: (i) How will compliance with key environmental regulations to meet EU Directives--which is one important part of greening the Turkish economy-- impact economic growth and employment (both in the aggregate and for key sectors; (ii) Can Turkey sustain the current high growth path by greening its production in key sectors; and (iii) What policy instruments can be used to maximize greening at the least cost (or maximum benefit) to the Turkish economy.

To begin to respond to the these questions, an applied dynamic general equilibrium model (computable general equilibrium (CGE) type[40]) of the Turkish economy was constructed to assess the impact of a selected number of policy instruments and public policy intervention mechanisms aimed at greening growth and adding green jobs to the economy.

[40] This model extends a previous CGE model which was designed to analyze Turkish energy and climate change policy (Voyvoda and Yeldan 2010).

For example, policy makers could respond with additional measures that may include a set of broad, market-based incentives designed to accelerate technology development and deployment in Turkey as part of its possible national objective towards greening its economy, together with ensuring high employment and sustainable growth patterns. The main objective of this analysis is to demonstrate the means to obtain a coherent attempt at integration of sustainable development priorities into national development planning and implementation of environmental policy objectives both at the macro economic and sectoral levels. To this end, a dynamic, multi-sectoral macroeconomic model has been devised for Turkey to study issues of environmental and macroeconomic policy interactions over both the commodity and the factor markets; the impact of various policies on the environment and on abatement; and to investigate various alternatives on environmental policy design along with their likely consequences from the points of view of growth, fiscal and foreign trade balances, employment, and economic efficiency.

The model is in the tradition of an applied general equilibrium paradigm where the production - income generation – consumption – saving – and investment decisions of the economy are depicted within a market equilibrium setting. Optimizing economic agents are modeled as responding to various price signals as affected by the government's various tax/subsidy policies. The economy operates in an internationally open environment where the exchange rate and the foreign capital inflows interact with the exports and imports of the domestic sectors.

While Annex 1 presents the detailed model specification and algebraic structure, and Annex 2 the data model calibration and base path, after a brief description of the model, the main focus of the remainder of this Chapter documents findings from the analytical investigation of alternative green policies for Turkey. The study spans the 2010-2030 growth trajectory of the Turkish economy with a detailed emphasis on: (i) GHG emissions (CO2 equivalent[41]) and particulate matter (PM10); (ii) water pollution from household and industrial effluent; (iii) solid waste pollution from household and industrial activity; (iv) water and fertilizer use and soil degradation in agricultural activities; and (v) the relevant market instruments of abatement. It is important to note that the choices of these areas of greening are directly related to the key EU Environmental Directives (discussed below).

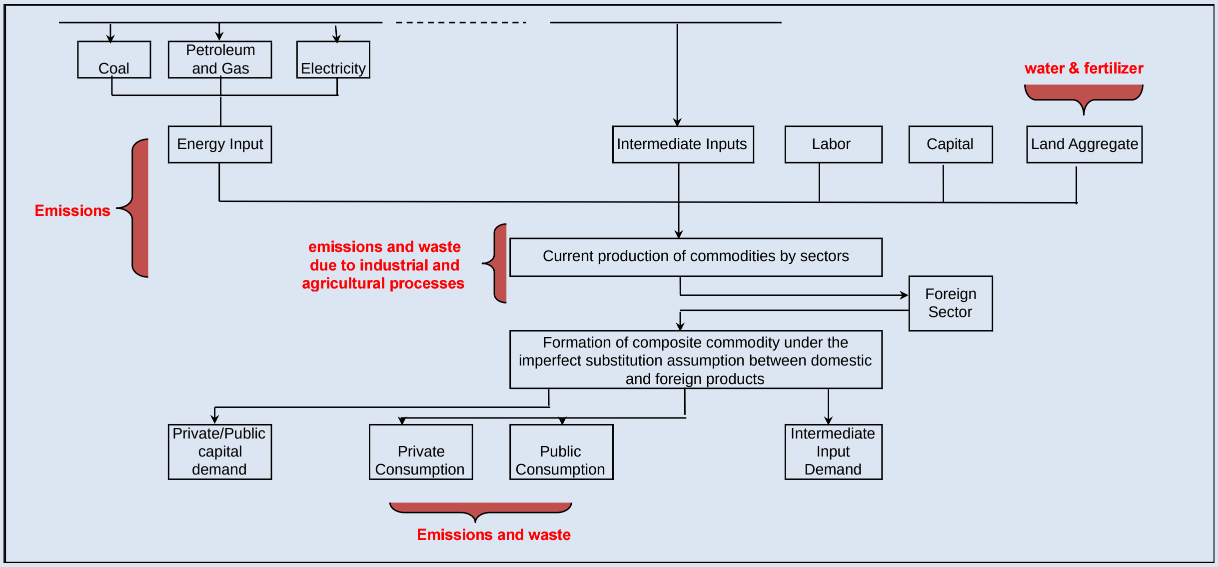
6.2 Model structure and basic features

The CGE approach, compared with other modeling techniques (such as linear programming or input-output analysis) for environmental policy evaluation proves more attractive with its ability to trace the relationship between production costs, their relevant technologies, consumer choices, and interaction of the green policy instruments with the fiscal and foreign trade policies throughout the economy in an internally consistent way.

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. "Dynamics" are integrated into the model via "sequentially" updating the static model into a medium-run of twenty years over 2010 through 2030. Economic growth is the end result of (i) rural and urban labor population growth; (ii) investment behavior on the part of both private and public sectors; and (iii) the total factor productivity (TFP) growth performance of the Turkish economy.

[41] CO2 emissions is used to represent GHG emissions as CO2 equivalent (eq.).

Figure 6.1 Flows of commodities, factors and emissions in the model



The supply-side of the economy is modeled as twelve aggregated sectors. In line with our focus on strategic industrial sectors and environmental policy evaluation, the disaggregation scheme develops into the energy sectors and critical sectors of GHG and Particular Matter (PM10) pollutions in detail. It thus aggregates a large number of other activities that, although being far more important contributors to total gross output, are not germane to the strategic growth and greening problem. The 12 sectors specified are: Agricultural production, Coal Mining; Petroleum and Gas; Refined Petroleum and chemicals; Electricity Production; Cement Production; Iron and Steel Production; Machinery and white goods; Electronics; Automotive; Construction; and Other economy.

While labor, capital and a composite of primary energy inputs, electricity, petroleum and gas and coal, together with other intermediate inputs, are the factors of production, for modeling agricultural production activities the model further delineates between rainfed and irrigated land. Water and fertilizer use (nitrate and phosphorus) are explicitly recognized as part of land use in agriculture production. Emissions arising both from production activities and from consumption activities are modeled within the specification of the economy. Figure 6.1 shows the new environmental components within the structure of the model. An extremely important characteristic of the application of the model is that most runs assume Labor market rigidity, consistent with broad stylized facts of today's Turkish labor market. This adds to the cost of adjustment to environmental tax measures and strengthens the case for following a coordinated portfolio of environment and growth measures for green growth, as discussed below.

Sectoral 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 is a CES aggregate of three major sources of energy supply: coal, electricity and petroleum and gas. 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. The CES allows for more substitution responses above and beyond the standard

Cobb-Douglas specification where unit elasticity is implicitly assumed. In addition to these, in agriculture the model accommodates *land aggregate* as an additional composite factor of production. Agricultural land aggregate is further decomposed as a constant elasticity of substitution (CES) function of *irrigated* and *rain-fed land*. This decomposition is responsive to rental rates of the type of land respectively, solved endogenously by the model. Water used in irrigated land is set as a Leontief coefficient. Fertilizer use is similarly modeled as a Leontief technology as a ratio of aggregate and used. This means that fertilizer and irrigation water are used in fixed proportions with agricultural output, so reductions in either input as a consequence of environmental policy would lead to a proportionate reduction in output.

6.3 Environmental Pollution and Instruments of Abatement

Two types of environmental pollutants are explicitly considered in the model:

- Air pollution, in the form of CO2 and PM10, from three main sources: (a) industrial processes; (b) (primary and secondary) energy usage; and (c) household energy use. These can be reduced in a variety of ways (fuel substitution, improved energy efficiency).
- Waste discharges (both solid and liquid), also from three main sources: (a) urban waste (formulated as a ratio of urban consumption); (b) waste from industrial processes; and waste from water use in agricultural production. The model assumes a fixed quantity of waste generation per unit of output, so as with agriculture, reductions in these waste streams through policy will have proportionate negative effects on output.

Different allocation mechanisms of carbon dioxide are assumed based on the source of emission. Non-combustion emissions from industrial chemical processes (e.g. cement manufacturing) are hypothesized to be proportional to gross output.[42] 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):

Table 6.1 Environnemental Tax Instruments Modelled

TAX INSTRUMENTS USED IN THE CGE MODEL	
CO2TAXP	CO2 Tax on sectoral output
CO2TAXN(I)	CO2 Tax on intermediate input use
CO2TAXC(I)	CO2 Tax on consumer demand
PM10TAXP	PM10 Tax on sectoral output
PM10TAXN(I)	PM10 Tax on intermediate input use
PM10TAXC(I)	PM10 Tax on consumer demand
WASTETAX	Waste tax on households
WASTETAXIND	Waste tax on industry
WSUTAXHH	Waste water tax on households
TAXWSUIND	Industrial waste water tax
TAXNITAG	Tax on fertilizer use in agricultural land
PROTAX(I)	Producer tax
SALTAX(I)	Sales tax
TM(I)	Tariff rate
TE(I)	Export tax
HTAX	Direct income tax
PYRLTAX	Payroll tax paid by employers
SSTAX	Social security tax (paid by formal labor)
CORPTAX	Corporate tax
TAXWSUAG	Fee on water use in irrigation

[42] Following Gunther *et al*. (1992).

The main greening instrument used, a pollutant tax/fee, is applied on a per-unit basis (to CO2 emissions, production, intermediate input usage, and consumption, respectively) and to PM10 and waste generated. Table 6.1 lists all the tax instruments used in the model. The revenues generated are either directly added to the revenue pool of the government budget, or directed towards a particular set of green job creation or innovation activities. The set of environmental tax/fee instruments are tabulated in Table 6.1. This set-up is stylized, and results should be interpreted with care. Model limitations and possible extensions are discussed below.

6.4 Data

The model is built around a multi-sectoral social accounting matrix (SAM) of the Turkish economy based on TURKSTAT 2002 Input Output Data. The I-O data is re-arranged accordingly to give a structural portrayal of *intermediate flows* at the intersection of the commodities row and activities column in the 12-sector 2010 macro-SAM. More details of the sectoral input-output flows of the macro SAM in correspondence with the TURKSTAT I-O data are given in Annex 2).

6.5 Policy Scenarios and Analysis

The policy analysis for investigating the macroeconomic impacts of alternative "greening measures" or "green policy instruments" is divided in two parts: greening the *urban* economy, and greening the *rural* economy.

(a) Greening the urban economy

This is done through two policy packages:

The first policy scenario targets the control of solid waste and waste water in industry and the household sectors, as well as the reduction of urban air pollution (PM10 emissions) across industry and the households. This is done through the introduction of a set of tax/fee instruments to be implemented as a form of the *polluter-pays* principle, and covers the requirements of the main EU Directives on air quality, waste water and solid waste.

In terms of solid waste, of the total amount generated by industry annually (estimated at 12.5 million tons) about 40% of it is known to be recovered and/or reused (and thus "greened"). The remaining 7.2 million tons would require further treatment. For the household sector, 26.1 million tons is the total amount of solid waste generated annually. Particular matter intensities (PM10) are reflected in concentrations exceeding both the Turkish standard of 60μg/m^3 (an all other more stringent international standards).

In the first set of policy analysis, the policy targets reflect EU directives on waste management; wastewater and air pollution that are the main vehicles for greening solid and industrial waste, and PM10 concentrations are over the base-path. The analysis also includes targets provided in Turkey's *National Climate Action Plan* (NCAP) which calls for a 25% reduction in the quantity of landfill-biodegradable waste by 2015, 50% by 2018, and 65% by 2025. The NCAP further calls for reaching 100% of target for the disposal of municipal waste in integrated SW disposal facilities, complemented by waste recycling programs consistent with the EU Integrated Waste Management directives.

To summarize, with reference to Table 6.1, the policy package in the first scenario is made up of a total seven new greening measures: taxes on PM10 emissions applied to industrial processes, industrial energy combustion, and private household energy consumption; and urban solid waste and waste water fees applied to industrial sectors and households.

Overall, the importance of this scenario is aimed at highlighting--among other things--the adjustment mechanisms that the Turkish economy would have to accomodate in response to a green policy of taxing negative environmental consequences. It can be argued that:

- Confronted with environmental taxes that alter their own efficient production decisions and input mix, the private sector would initiate a host of adjustments, including the adoption of technologies that help reduce pollution intensities per unit of output produced, as well as using inputs more efficiently (e.g., energy input, water). Given the new costs imposed on production by environmental taxes, in order to remain competitive the private sector will look for adopting less polluting and more input-efficient technologies (e.g., the case of the iron and steel industry), as well as target gains in productivity through innovation (e.g., the case of the automotive industry).

- From the public sector side, in addition to needing to ensure that the enabling environment for private sector investment (e.g., labor market, finance, innovation policy) is conducive to the acquisition/development of green technologies and innovation, there is also the need to consider mechanisms for allocating the green tax revenues in such as way as to limit their economic burdens. The modeling analysis also takes account the productivity improvements expected to result from of the overall population's lower exposures to different pollutants (not just specific workers).

A detailed analysis of private behavior and public policy analysis (as described above) was beyond the scope of this exercise. The focus of the modeling analysis was primarily to compare the impacts on production costs and GDP of different instruments (allowing as well for the aforementioned productivity gains); second, to illustrate how production costs from pollution taxes are larger in the presence of economic rigidities; and third, to investigate potential mitigating effects of those impacts through various public expenditure policies.

The second policy scenario extends the first by implementing carbon taxes designed to *focus on GHG emissions abatement. A carbon tax is levied on the polluting agents: industrial processes,* energy combustion in industry, and households. In addition, this scenario also simulates an innovation/R&D-driven growth trajectory by using tax revenues towards research for innovation across the *strategic sectors* as identified in the *Industrialization Strategy Document, 2011* of the Ministry of Science, Industry and Technology. Carbon tax proceeds are earmarked under a special fund to promote R&D and knowledge acquisition in the strategic industrial sectors.[43] Earmarking tax revenue funds for innovation translates into gains in productivity and emission intensities of the relevant sectors, thereby mitigating the contractionary effects of the tax distortions and providing an industrial basis for green growth and employment.

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[43] The strategic sectors were identified in the Industry Strategy Document of the Ministry of Industry and Energy as Iron and Steel, Machinery, Automotive, Electronics , White Goods, and Construction.

Potential increases in green jobs and productivity enhancements through pollution abatement activities (Box 6.1 for European experience). An important characteristic of the policy design modeled in this study is the disposition of the pollution mitigation tax/fee revenues collected. Under a passive fiscal policy, the tax revenues would serve as additional public revenues to be disposed of as increased public consumption elsewhere, and/or transfers back to the private sector (including through reductions in spending of other revenues for public debt service, as in this model). In the design of the second policy scenario, we introduced the possibility of using environmental tax revenues to fund additional employment in solid waste and water pollution abatement activities. In this simple first-order calculation, government spending finances the addition of otherwise unemployed workers for these purposes given the revenue available and the fixed urban wage rate (Box 6.2). A quite restrictive assumption in this stylized set-up is that no new capital investment is needed in order for these workers to productively carry out the waste reduction activities. More generally, further refinement of the specification of pollution abatement options across sectors and types of pollutants is a high priority for a more complete and richer CGE analysis of green growth in Turkey.

Box 6.1 Generating jobs through Pollution abatement technologies: Europe's experience

The potential job gains in green industries are not small, though they are as difficult to accurately identify as are the costs of environmental regulation. By the late 2000s, the wind energy sector was thought to have generated some 100,000 jobs in Germany, 42,000 in Spain, and 22,000 in Denmark, and for the solar photovoltaic (PV) sector, some 70,000 jobs in Germany and 26,000 in Spain. European firms are highly competitive in such areas as pollution-abatement technology and solid waste management, and job gains in these sectors are significant as well. Experience shows that policies matter. An ecological tax reform is credited with helping Germany reduce emissions and increase employment. More generally, very preferential tariffs for renewable energy were used in varying degrees in all three countries. The ecological tax reform in Germany also raised the cost of energy, triggering large energy efficiency gains. The increased revenue was used to reduce nonwage labor costs, which helped create 250,000 jobs.

Source: World Bank (2012b) Golden Growth: Restoring the luster of the European economic model (Spotlight 2: Greening

Policy scenario 2 also incorporates the impacts of reduced pollution intensity sector productivity based on improved health from mitigating air pollution to achieve EU air quality standards, as this is one of the driving factors of a greener economy (Box 6.2). A detailed environmental health valuation based on air pollution levels and the historical growth and population trajectories suggests that without any intervention, the growth in PM10 in Turkey will cost between 1% - 4.5% of GDP from 2010-2030 in the absence of control measures (Table 6.2). Both the health impact and productivity gains should be considered as lower bounds since other environmental health issues (e.g., from water-borne diseases and the fact that the number one water issue in Turkey is related to low level of wastewater treatment) have not been accounted for.

Box 6.2 Generating green jobs and productivity enhancements through pollution abatement activities

A three-step approach is used as part of the new environmental component of the CGE model.
Step 1: Since the urban wage rate is given in real terms (at *W**), added employment for wastewater and solid waste mitigation can be written as:

$$W^{*}L_{G,J} = \lambda_J(taxrev_J) \quad (1)$$

In (1) above, $L_{G,J}$ stands for new employment at the *j*-th category of environmental abatement activities *(urban solid waste treatment across industry and households, and urban water treatment across industry and households)*, and $taxrev_J$ refers to the corresponding tax revenues collected from the respective abatement sector *J*. Realistically, since not all tax revenues are likely to be channeled for the new employment wage fund, through the parameter λ_J, a portion of the aggregate tax revenues are used for sustaining the wage fund, and the rest accrues to the public revenues as residual. Wage income from this added *green employment* accrues to the private disposable income.

Step 2: Reducing pollution intensities through the activities of the added green workers. The new employment generated ($L_{G,J}$) is used for pollution abatement activities at the respective industry to reduce the PM10 and waste intensities, ζ_J through the exponential form (2) below, where in the numerical implementation of the model scenarios, the structural parameter α_J is arbitrarily taken as 1,000:

$$adjust\zeta_J = e^{-\alpha_J L_{G,J}} \quad (2)$$

Step 3: Enhancing productivity is further modeled as gains due to improved health from mitigating PM10 pollution, through the following production shift:

$$adjustAX_J = e^{\gamma_J \frac{(Pol_t - Pol_{BASE})}{Pol_{BASE}}} \quad (3)$$

Where the Hicks-Neutral productivity coefficients are adjusted upwards given the rate of abatement gains, $\frac{(Pol_t - Pol_{BASE})}{Pol_{BASE}}$, and the parameter γ_J controls the structural effectiveness of this relation.

This functional form is calibrated to a standard that could meet the 40µg/m^3 EU standard, implying an expected gain of some 2.0% of GDP from PM10 mitigation, which is achieved by setting the structural parameter γ_J at 0.002, implying a modest productivity gain is a modest 0.01% per annum.

Source: CGE model and analysis (Annex2)

Generation of productivity enhancements through earmarking carbon tax revenue for R&D and innovation. In addition to the experiments of the first scenario, which were focused on internalizing externalities through taxes/fees to mitigate air, water, and solid waste pollution, and earmarking funds for green jobs, the second scenario introduces a policy of mitigating CO2 emissions through a tax instrument and earmarking funds for innovation. The base path trajectory reveals that aggregate CO2 emissions (currently 369 million tons) will reach a total of 983.7 million tons by 2030. Given the projected GDP, by 2030 CO2 intensity-(emissions per dollar GDP) is estimate to reach 0.59 kg/$ (in fixed 2010 prices) (currently 0.72 kg/$). To effectively reduce the CO2 emissions, a carbon tax is imposed on polluters, as was done for PM10 above. The distinguishing characteristic of the policy intervention is the use of proceeds from a carbon tax to support investment in productivity-enhancing innovation activities. Since the model does not allow capturing private sector innovation choices and investments in response to green policies directly through specifying private-sector-induced innovation functions (Box 6.3), it is done instead through an institutional mechanism overseen by the public sector (Box 6.4). While these tax proceeds typically would be captured by the fiscal authority and be disbursed either as increased public expenditures on goods and services, and/or transfers, the carbon tax revenues are earmarked for a special research fund to sustain R&D and innovation activities to boost productivity gains in the strategic sectors identified. Public R&D investments are taken to have high economic rates of return, although in practice this depends on the quality of National Innovation Systems, and the success of public innovation support schemes has varied significantly across countries.[44]

Box 6.3 Environmental Regulation and Innovation: The Porter Hypothesis

While it is generally understood that tighter environmental standards will be costly, at least in the short to medium term, the Porter Hypothesis (Porter and van der Linde 1995) holds that properly designed environmental regulation—in particular market-based instruments such as taxes or cap-and-trade emissions allowances—can trigger innovation. Recent research is providing insight into the relevance of the PH. While on the theoretical side, more arguments are emerging that try to justify the hypothesis, empirically, the evidence only supports the "weak" version (i.e., stricter regulation leads to more innovation). So far at least, there is no significant empirical evidence of the "strong" version of the hypothesis (i.e., stricter regulation enhances business performance—or win-win).

Source: Ambec et al. (2001)
Source: CGE model and analysis (Annex2)

The following are the main findings from the analysis.[45]

The results of the policy scenarios of greening the urban economy are summarized in Figures 6.2 (GDP paths), 6.3 and 6.4 (pollution emissions intensity), and Table 6.3 (details numerical results), and Table 6.7 (overall summary of scenarios).

Simulation results of the urban greening policy through combined taxes/fees on PM10 pollution, wastewater and solid waste *(i.e., the scenario of pollution taxes on PM10 and urban solid and water waste coupled with TFP gains from health benefits of PM10 abatement)*

- A significant reduction in the level of pollution intensities, consistent with the standards set forth in the relevant EU Directives.

[44] Lerner (2009).
[45] An important caveat is that the analysis and results presented here do not account for the transaction costs and other institutional measures needed to implement proposed greening policies, and as such, the results should be interpreted with caution and as indicative of the possible effects of the greening policies considered.

Table 6.2 Health Impacts

PM_{10} Impact on GDP*	Standard	% GDP impact from all sectors	% GDP impact from strategic sectors**
Turkey Standard	60μg/m^3	0.8 – 2.0%	0.1 – 0.3
WHO Standard	50μg/m^3	1.0 – 2.6%	1.0 - 0.4
EU standard	40μg/m^3	1.2 – 3.1%	0.2 - 0.5
US EPA standard	15 μg/m^3	1.7 – 4.5 %	0.2 – 0.7%
* From 2010 – 2030			
** The share of industry sectors is assumed to be 14.5% of total PM_{10} emissions following from a similar share for CO_2 (TurkStat, 2011)			
Furthermore, we assume a linear relation between CO_2 and PM_{10}			

- But this is also accompanied by a relatively significant reduction in the *growth potential* of GDP (10-14% over its 2030 real value). This is indicative of the trade-offs involved, as pollution abatement costs increase the price of doing business in the absence of any adjustments in abatement technology, in the presence of the given historical rigidities (especially in labor markets). It cannot be over-emphasized that the figures show a *relative* decline in GDP relative to what would be achieved by 2030 without the greening measures. However, the results do *NOT* imply an *absolute* contraction of GDP due to environmental policy. Indeed, GDP in 2030 is 2.4 times its 2010 base value with the greening measures (not including absent green jobs and innovation-induced TFP gains), versus 1.27 times without any green measures (base path business as usual); in terms of average annual growth rates, the difference is 4.4% versus 5.0%.

- Note also that these GDP figures do not include productivity gains or any other health benefits from pollution, or other green benefits. Nevertheless, the ***combined impact*** of the wastewater, solid waste, and air pollution taxes may raise concerns for fiscally-concerned decision makers.

- A ***disaggregated application of individual pollution taxes*** allows a differentiation of their impacts and reveals that: (a) The tax on PM10 alone has a relatively small negative impact on GDP (less than 0.5%) and 3.8% pollution reduction; and when health-related pollution abatement productivity effects are accounted for, it's overall impact is positive (+4.6% GDP and 21% pollution reduction). (b) Taxing solid waste has the highest negative impact on GDP. This is due to the combined effects of two factors: current solid waste disposal levels are very low (thus the size of the intervention to meet the set target is very large, leading to a 44% reduction in pollution); and since these waste flows are modeled as ratios of household consumption expenditures, the waste tax thus has a direct negative effects on consumption demand. The costs would be lower with a more realistic, flexible relationship between consumption and the generation of solid waste. In comparison, the economic impacts of the wastewater tax are much lower because both the target coverage and the tax rate are lower, leading to a 19% reduction in pollution. (iii) The CO2tax leads to a 9% abatement and a 7.4% reduction of GDP. These disaggregated results indicate that air pollution and wastewater could be prioritized within the green urban scenario because of their positive health and productivity effects and their low economic impact.

These results reflect that the environmental taxes imposed to meet tighter EU standards (in this case adhering to Directives on air, wastewater, and solid waste) will impose costs, at least in the short- to medium-term. Internalizing the costs of environmental degradation will also make firms less competitive than companies that are not subject to similar pollution controls elsewhere.[46]

The output impacts of this first scenario depend on the technological relationships we assume in the model. Finer-grained CGE models, which incorporate sector-specific MACs and thus incorporate more detailed options for private sector reactions to pollution and environmental taxes typically find much smaller output losses (see Jorgenson et al., 2010). What this scenario demonstrates is how important it is to have a proper understanding of abatement technologies.

Results of this initial scenario also depend on the recognized rigidities of the Turkish labor markets. Much of the existing rigidities are documented in the literature in a CGE modeling framework (e.g., Telli et al (2006); and Bekmez et al (2002). Amplified adjustment costs are also found in the context of a rigid labor market in response to climate change policies in the example of South Africa (Hassan et al (2008)). Moreover, the findings of the scenario (with rigid labor markets and no adjustments technologically or otherwise) are in line with previous economy-wide modeling exercises of climate change in Turkey (Telli et al (2008), and Kumbaroglu (2006)).

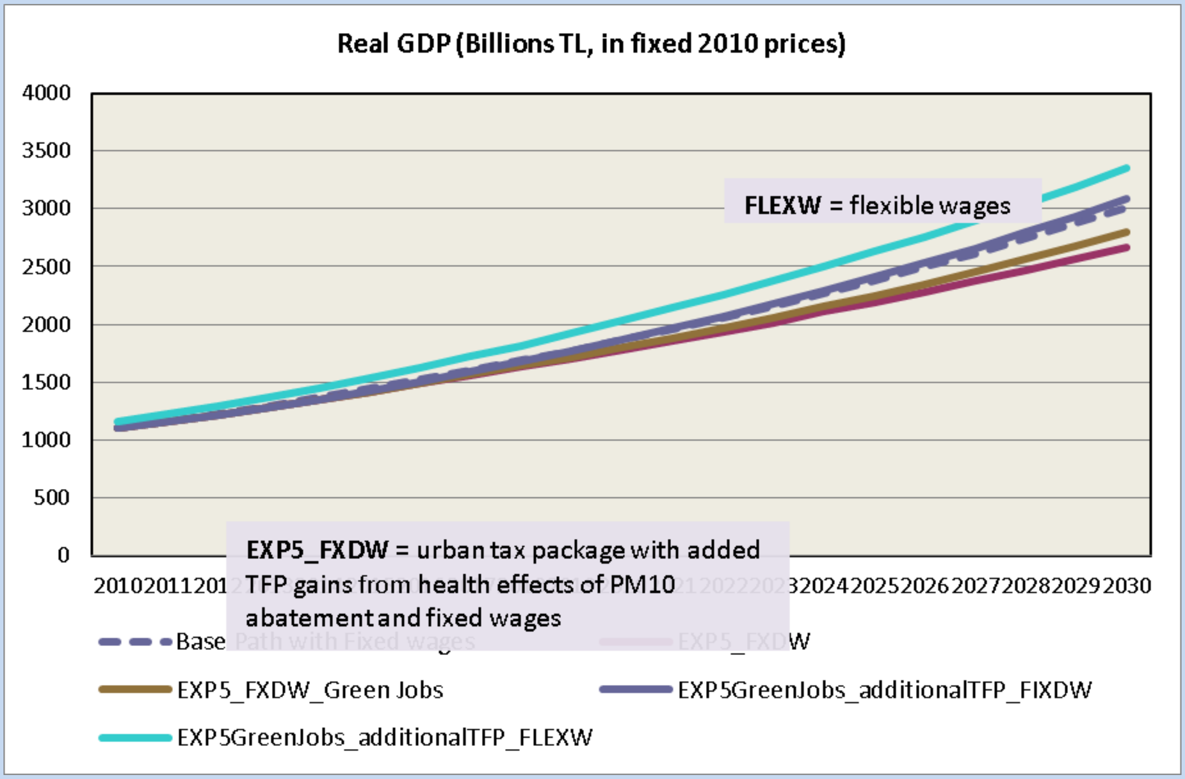
Rigid structures in the labor market raise the cost of adjustment to the new taxation environment. Confronted with the wage rigidities (as formulated by assuming constant real wages in the non-agricultural labor market), producers try to respond by other forms of substitution between capital and energy inputs, as well as greater reductions in the scale of output.

Relaxing the assumption of labor market rigidity can cut the estimated output losses from introducing environmental taxes by about half. A re-formulation of the “tax only” experiment with a fully flexible labor market resulted in halving the loss of the GDP compared to the base path in 2030 (Figure 6.2). However, as a result the wage rate also falls by 13% over its base run value, thereby cushioning most of the taxation burden on enterprises. Further insight is provided by the case of a PM10 tax in the context of a flexible labor market, which results in a slight but positive impact on GDP compared to the case of fixed wage rate. The distributional as well as overall impacts of environmental taxes thus depend significantly on the structure of the labor market, highlighting the importance of this topic for further investigation. Subsequent scenarios in this report retain the assumption of labor market rigidities as manifest in a fixed urban wage rate.

The overall message that emerges from this scenario is: (1) the economic impact of pollution abatement costs with environmental taxes varies with sector and pollutant, but can be large under certain assumptions about limited flexibility in input substitutions; (2) productivity gains from reduced health impacts can considerably soften the cost burdens, as can the use of tax revenues for financing innovation; (3) green policies through taxation complemented by labor market policies to increase flexible adjustments will create lower economic impacts from greening. Model extensions should focus on

[46] A discussion of this aspect of green policies in the context of European firms can be found in the recent World Bank report: Golden Growth: Restoring the Luster of the European economic model (Spotlight 2: Greening Europe’s Growth) (World Bank 2012b).

Figure 6.2 Summary of policy scenarios for greening the urban economy



Source: CGE model and analysis (Annex2)

better characterizing of the private sector reaction to environmental taxes using a detailed understanding of available technologies and their profitability, given changing relative prices to get a more finely-tuned quantitative understanding of the economic impacts of greening policies.

Simulation results of an urban greening policy through taxes/fees on air pollution, wastewater and solid waste, and financing green jobs by earmarking tax revenues for that purpose *(i.e., the scenario of pollution tax only & jobs fund)*[47]

[47] As noted, for modeling purposes, green jobs/employment is defined as follows: tax revenues are collected by the government and used to hire workers at the ongoing (fixed) real wage rate from the pool of unemployed workers. These jobs are used in various greening activities (reflected in reduction of the emissions coefficients of the relevant pollutants), and the corresponding wages are added in the model as income for the single household sector. In this sense, greening increases labor force and private consumption, which contributes positively to growth. Revenues allocated to green jobs could also be interpreted as transfers from the government to the unemployed to engage in greening activities by the private sector, thus indirectly subsidizing greener production activities by providing green labor to the companies (free of cost), and constituting an innovative

- Total employment would increase so does the wage income to the private sector. With about 600,000 new jobs "created" in the green activities in the Turkish economy as a whole[48] .Green wages reach almost 1.5% of aggregate private disposable income. An example where the potential for green jobs has been identified through the study is energy efficiency in buildings, where specific incentive schemes which could be financed from green taxes, could result in some 110,000 jobs by 2023 over the base case where no incentives are provided (Table 6.3). In addition, if one accounts for health-related productivity gains from PM10 abatement, GDP from all three urban greening taxes leads to GDP only 1.3% by 2030 below its baseline growth path (again, with NO reduction in GDP – simply a lower rate of growth).

- Pollution intensities are significantly reduced to the levels consistent with the standards set forth in the relevant EU Directives.

Simulation results of an urban greening policy through taxes/fees on PM10 *and* CO2 emissions, as well as wastewater and solid waste, along with earmarking funds for financing green jobs and innovation expenditures *(i.e., scenario of pollution tax, carbon tax, and jobs and innovation funds)*

- When tax policy on pollution is further complemented by adding a carbon tax to control CO2 emissions, but these tax revenues are used for R&D funding and innovation solely in the *strategic sectors*, the gains in productivity boost GDP to 2.4% and result in addition employment (green jobs) of 3.5% above the base path by 2030. As noted in scenario 1, a CO2 tax without some kind of offsetting productivity and energy efficiency improvement has notable negative effects on GDP growth. This highlights again the importance of exploring these issues in greater depth than was possible in this analysis in order to provide advice on tradeoffs based on greater analytical realism.)

- Both solid waste (from households and industry) and wastewater are reduced by half from baseline levels. In addition, significant emission reduction is achieved (30% reduction in PM10 and 25% reduction CO2 emissions by 2030.

- Also, CO2 intensities per $GDP decline below the base path trajectory. Under urban greening with taxation and jobs-financing expenditures, CO2 intensity is reduced to 0.63 kg/$GDP, and is further reduced with the assumed opportunities for *strategic innovation* to 0.44 kg/$GDP by 2030, on a par with the OECD average (again indicating the importance of further refining this aspect of the analysis).

- The total revenue of the urban greening policy reaches 3.6% of GDP by 2030.

- Environmental taxes/fees amount to the following:

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case of public-private partnership. This way, the government is using pollution taxes to achieve two important objectives: reduce unemployment and improve environmental quality. Future model improvements could consider adding a 13th sector (pollution abatement industry) with appropriate care to ensure that payments for this are charged against capital expenditures such that there is no double counting of capital used in production and intensity remediation.

[48] The modeling exercise estimates the potential of the Turkish economy to create green jobs, however it does not give the distribution of these by sector. Modeling the green job creation potential at each sector would necessitate more detailed information on sectoral production structures, which is beyond the limits of this study.

- 0.52% of GDP for industry and 0.55% of GDP for households in the short-term (2015), which falls to 0.20%, and 0.10%, respectively, by 2030;
    - 0.17% of GDP for PM10, rising to 0.66% of GDP by 2030
    - 0.18% of GDP for CO_2, rising to 0.7% of GDP by 2030
- The marginal cost of CO_2 emissions abatement (MAC) reaches $62/ton by 2020 then falls to $52/ton by 2030. As noted, this tax is set to meet quantitative emissions goals established under the EU Directive and the NCAC. On the other hand, the resulting marginal cost in 2020, , is quite a bit higher than the numbers often encountered in the policy literature (and the lower figure for 2030 reflects that this is the model's end date versus more and tougher restrictions to be met in the further future).

- At the sectoral level, key impacts include the following (by 2030):
    - Higher than average CO_2 emissions reduction (30% compared to 25%);
    - Iron and Steel, among the most pollution-intensive sectors, achieves a reduction in PM10 and CO_2 emissions by almost 60% over the base path;
    - Solid waste abatement reaches EU directives requirements;
    - Electronics, Construction, and Automotive expand by 15%, 7%, and 9% respectively, leading to gains in employment, while Machinery and White Goods remain almost on par with their base path trajectory;
    - Iron and Steel and Electricity sectors contract. For Iron and Steel, this is due to the burden of taxation, and the sector's structural dependence on coal as an intermediate input; and
    - Export performance of the strategic sectors follows their expansionary outlook. Automotive, with an expansion of 11% over the base path in 2030, becomes the leading sector, increasing its share in aggregate exports (including services) to 15%. Electronics exports are observed to expand by 22%, and also constitute a major export driver.

Figure 6.3 Summary of policy scenarios for greening the urban economy

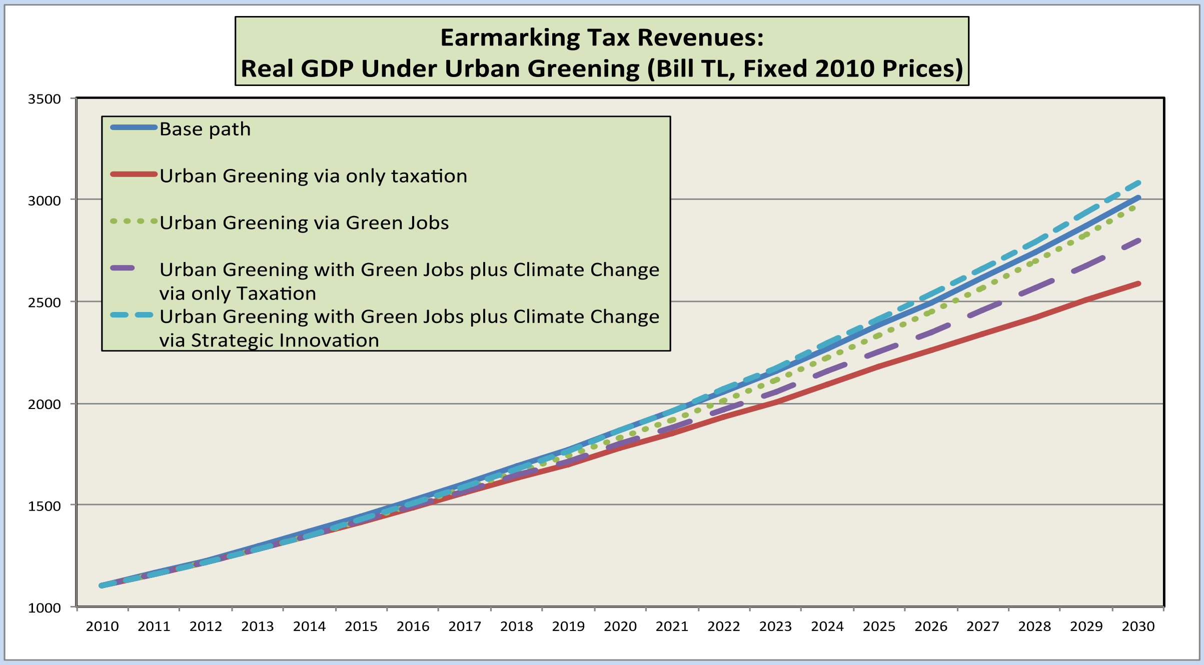

Figure 6.4 CO2 intensities

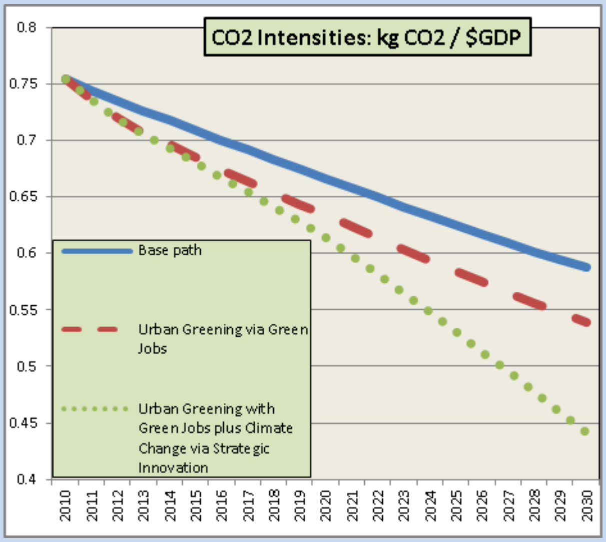

Figure 6.5 PM10 intensities

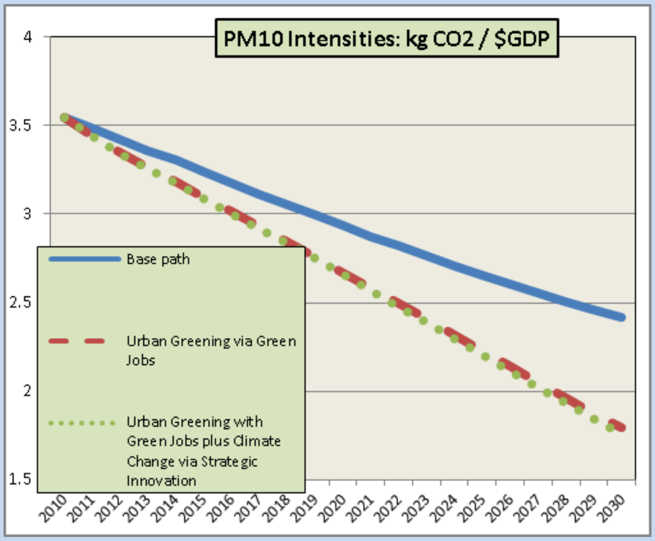

Table 6.3 Detailed results of the green urban policy simulations

	Base Path			EXP1: Greening Urban Economy via Taxing PM10 and Urban Waste and Initiating "Green" Jobs			EXP2: Exp1 + Climate Change Mitigation via Innovation in Strategic Sectors		
	2015	2020	2030	2015	2020	2030	2015	2020	2030
Macro Results (Billion TL, 2010 fixed prices)									
Real GDP	1443.8	1863.5	3012.7	1424.9	1827.9	2973.0	1426.8	1862.9	3083.6
Aggregate Investment	290.6	361.5	554.1	286.3	353.1	539.5	287.9	364.1	571.2
Aggregate Private Consumption	996.8	1278.0	2074.9	973.5	1236.5	2005.0	973.2	1256.8	2068.6
Exports	337.2	462.7	828.2	318.5	429.0	749.5	320.4	447.2	799.4
Imports	384.9	498.6	840.6	366.1	464.9	761.9	368.1	483.1	811.7
Environmental Pollution Indicators (Million tons)									
Solid Waste: Total Industry	19.3	28.1	58.4	7.1	3.4	1.5	7.2	3.5	1.5
Solid Waste: Households	33.9	43.5	70.6	15.8	6.9	3.0	15.7	6.9	3.0
Water Pollution: Total Industry (Billion liters)	1.6	2.4	5.1	1.1	1.5	2.5	1.1	1.6	2.8
Water Pollution: Households (Billion liters)	4.9	6.3	10.3	3.6	4.3	5.2	3.7	4.3	5.3
PM10: Total	2599.1	3038.5	4045.5	2453.4	2715.1	2960.4	2448.3	2752.7	3008.2
PM10: Energy related	1995.9	2252.4	2753.2	1868.1	1963.1	1736.6	1864.6	1993.1	1761.0
PM10: Industrial Processes	356.7	473.4	791.3	346.5	452.3	746.1	344.7	453.5	751.5
PM10: Households	246.5	312.7	501.1	238.9	299.7	477.8	239.1	306.0	495.8
CO2 eq: Total	568.9	689.9	983.7	542.0	643.5	890.8	537.5	631.1	756.5
CO2 eq: Energy related	421.9	502.5	685.0	398.4	462.7	605.2	394.3	448.6	465.3
CO2 eq: Industrial Processes	57.0	75.7	126.4	55.4	72.3	119.2	55.1	72.5	120.1
CO2 eq: Agriculture	36.7	44.2	64.0	36.6	43.7	63.1	36.5	43.9	64.0
CO2 eq: Households	53.2	67.5	108.2	51.6	64.7	103.2	51.6	66.1	107.1
Pollutant Intensities (kg / GDP)									
Total CO2 / GDP (kg/$GDP)	0.71	0.67	0.59	0.68	0.63	0.63	0.68	0.61	0.44
Total PM10 / GDP (kg/$GDP)	3.24	2.93	2.42	3.10	2.67	2.67	3.09	2.66	1.76
Total Industrial Waste / GDP (kg/$GDP)	0.02	0.03	0.03	0.01	0.00	0.00	0.01	0.00	0.00
Total Household Waste / GDP (kg/$GDP)	0.04	0.04	0.04	0.02	0.01	0.01	0.02	0.01	0.00
Environmental Taxes(Fees) (% Ratios to the GDP)									
Total Waste Fees: Industry				0.52	0.38	0.20	0.53	0.39	0.20
Total Waste Fees: Households				0.55	0.38	0.20	0.55	0.37	0.19
Total Water Pollution Fees: Industry				0.16	0.34	0.70	0.17	0.36	0.74
Total Water Pollution Fees: Households				0.17	0.33	0.66	0.17	0.33	0.66
Total PM10 Taxes				0.28	0.56	1.13	0.28	0.56	1.12
Total CO2 Taxes							0.18	0.35	0.70
Total Environmental Taxes(Fees) (% of GDP)				1.69	2.00	2.90	1.87	2.37	3.60
Employment (Million workers)									
Total Employment in Production	24.006	24.451	25.960	23.069	23.146	24.121	23.171	23.886	25.414
Urban Employment	20.232	21.409	23.566	19.281	20.080	21.698	19.384	20.830	23.012
Rural Employment	3.774	3.042	2.394	3.789	3.065	2.423	3.787	3.056	2.402
"Green" Employment				0.612	0.647	0.858	0.617	0.677	0.915
TOTAL Employment	24.006	24.451	25.960	23.682	23.793	24.979	23.788	24.562	26.328
Ratio of "Green" Wages to Private Disposable Income				0.897	0.923	1.141	0.920	0.958	1.195
Fiscal Balances (Ratios to the GDP)									
Government Revenues	25.43	25.38	25.40	26.27	26.45	27.07	26.42	26.76	27.68
Public Investment	4.54	6.53	6.54	4.76	6.81	6.97	4.80	6.89	7.12
Public Consumption	14.10	14.07	14.08	14.56	14.66	15.00	14.65	14.83	15.34
Public Sector Borrowing Requirement	-1.10	0.46	0.45	-1.06	0.51	0.50	-1.06	0.49	0.47
Memo: Foreign Deficit	5.02	3.88	2.33	5.18	4.05	2.45	5.16	3.92	2.32

(b) Greening the rural economy through sustainable agriculture

While greening the rural economy requires focusing on broader natural resource management issues including biodiversity conservation, forestry, and water resources, the focus of the present study is more modest and covers mainly agriculture, not only because of its socio-economic importance, but also because of its environmental footprint in terms of water use, agro-chemicals, and soil degradation. (see agriculture section above).

The main issues considered, and places where greening measures could augment the broader sector policies implemented by the Government, include; (i) the lower levels of productivity and land degradation in rainfed agriculture; (ii) the overuse of pasture resources and its impact on livestock productivity; (iii) the low levels of efficiency of water use for irrigation; and (iv) the externalities related to production intensification (agro-chemicals and salinization).

Given the issues discussed in section 5.1 above, in addition the low productivity levels and significant land degradation in rainfed and pasture areas, and the fact that agriculture uses about 74% of the country's water resources for irrigation--in the context of growing water scarcity, increasing demand by other sectors and uses, and the looming problem of reductions in base flow due to climate change in the future--and given that the Government plans to further develop an additional 3 to 4 million hectares of irrigation by 2030 (e.g., the GAP project and other developments), as well as the status of irrigation technology, lack of volumetric pricing, intensive use of fertilizer and pesticides, as well as poor drainage infrastructure (leading to yield-reducing salinization problems), the of greening policies we chose to investigate in this study are aimed at a "triple-win:" more efficient use of land and irrigation water, reduced land degradation and improved soil carbon (mitigation), and enhanced productivity together with increased resilience to future climate change (adaptation).

The following three specific greening measures were modeled and evaluated

(i) Adoption of Conservation Agriculture/no-till (including minimal soil disturbance, proper management of crop residues, and crop rotation) in an area of 5 million ha which is currently traditionally tilled;
(ii) Rehabilitation of 5 million ha of degraded pastures; and
(iii) Irrigation efficiency improvements in the 5.2 million ha currently irrigated plus the 3.3 million ha of irrigation schemes yet to be developed.

For each of these greening measures, both costs (i.e., investments) and benefits have been estimated. Benefits have been distinguished between "on-site" (such as increased farm productivity and improved pasture), and "off-site" (such as the benefits derived from reduced sedimentation and its impact on downstream infrastructure and water quality). The estimated Net Present Value over 2014-2030 of adopting the greening measure on a large scale, as indicated above, tops US$11 billion (Table 6.4). Key assumptions and caveats underlying these estimates are detailed in the background note on agriculture sector. The economy-wide impacts of these greening measures were evaluated through the CGE model.

Greening the rural economy through sustainable agriculture is done with a set of three complementary scenarios:

(i) ***Scenario 1: Improving water use efficiency in irrigated agriculture*** (labeled EXP_AG01): Water irrigation reduced to two-thirds of the base path utilization. This is done through the introduction of a ***marginal water fee*** determined endogenously by the model and representing the shadow price of the binding water availability for irrigation.

    TUIK projections suggest that water usage for irrigation will reach 80.7 billion m3 by the end of 2030. This suggests an increase of about two and half-fold in comparison to the current usage level of 34.1 billion m3. Expansion of water use parallels the expansion of the amount of irrigated land assumed at an annual rate of 0.5% under the business-as-usual scenario of the base path[49].

Table 6.4 Benefits from adopting greening approaches in agriculture (million US$)

Greening Measure	**Area** (million ha)	**Net Present Value (NPV[50]) from On-site Productivity Gains (A)**	**NPV from Off-site Reduced Social Costs (B)**	**NPV of Total Gains (A+B)**
a. Conservation Agriculture/no-tillage	5	3,031	3,031	6,062
b. Pasture improvement	5	1,959	1,959	3,917
c. Irrigation efficiency improvement	1.2+3.2+8.5[51]	1,264	222	1,486
TOTAL		**6,254**	**5,212**	**11,465**

(ii) ***Scenario 2: Improving water use efficiency in irrigated agriculture and earmarking revenues from water fees for improved irrigation technology*** (labeled EXP_AG02): While under the first scenario above, the revenues from the water fee accrue directly to public revenues with no further earmarking, under this scenario, irrigation water fee revenues are used to sustain further R&D and extension services to improve productivity (crop yields) in the rural economy. A similar approach to modeling the process of revenue use for innovation was done in the case of urban greening policies, above, is also used here (Box 6.5).

(iii) ***Scenario 3*: *Improving water use efficiency in irrigated agriculture, earmarking revenues from water fees for improved irrigation technology, and introducing conservation tillage and improved pasture management*** (labeled EXP_AG03). This scenario introduces greening measures aimed at *pasture land improvement and conservation tillage in rainfed* agriculture. Of the Turkey's total pasture land (around 15 million ha in), it is estimated that about 5-7 million ha are severely eroded. Estimates suggest that improved pasture management will likely result in a 30% gain in value-added dry matter yield production-- assumed to equate to about a 30% increase

[49] This assumption satisfies the neutrality condition for the base run as dictated by the CGE literature. More analysis would be needed to reflect a more realistic picture of the current irrigation techniques, which is for the moment beyond the limits of this study.
[50] NPV over 2014-2030 period at 12% discount rate
[51] Irrigation efficiency improvements include: providing drainage to 1.2 million ha salinized irrigated areas, installing piped systems including sprinklers in all 3.3 million ha new irrigation developments to be carried out in the future, and increase/improve water charges to induce savings for the total irrigable area of 8.5 million ha.

Box 6.5 Generation productivity enhancements through earmarking revenue from irrigation water fee for R&D/innovation in irrigated agriculture

As part of the new environmental component of the CGE model, a two-step approach is used to model the productivity gain from innovation stemming from earmarking irrigation water fee revenues.

Step 1: innovation-driven productivity gains are modeled as:

$$adjustz_{AG} = e^{c(TotWaterFeeRevenues)} \qquad (6)$$

Given the positive yield gains, the agricultural productivity coefficients are updated via

$$AX_{AG}(t+1) = adjustz_{AG} AX_{AG}(t) \qquad (7)$$

Note: The innovation functions are adapted from earlier application by de Melo and Robinson (1992) for the case of generating productivity gains from trade externalities.

Source: CGE model and analysis (Annex2)

in value-added livestock. Complemented with improved control of soil erosion and switching to *conservation tillage* practices in agriculture, the annualized gain in *net present value* terms is estimated to reach 3.67 (billion TL) (2.1 billion $). This gain reaches 1.8% of the real agricultural output supply in 2015, and amounts to 1.02% of its real value by 2030. This is reflected in the CGE model as an exogenous increase in the rate of productivity growth in agricultural output by 0.02% per annum starting in 2015.[52] To further capture the effects of improved land quality through mitigating soil erosion from poor pasture management, the available supply of *rainfed land* increases by 1.5 million ha annually starting 2011 until 2015.

The results of the policy scenarios of greening the *rural* economy are summarized in Figures 6.5 to 6.7 and Table 6.5.[53]

Simulation results of a greening policy aimed at of increasing water use efficiency in agriculture, through a reduction of irrigation water from a projected BAU scenario of 81 billion m3 to 54 billion m3 in 2030 *(i.e., scenario EXP_AG01)*

- A marginal value of water resources of 28 cents TL/m3 ($ cents 16). The corresponding *marginal abatement cost* curve[1] indicates a rate of $55 per ha of irrigated land in 2011, increasing gradually to $60/ha by 2030, noting that the current irrigation water charge is in the range of $100 to $200 per hectare (as there is no volumetric system of charges).

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[52] The assumption here is that conservation tillage requires a few years before its impacts on crop yield can become effective, thus 5 years was assumed to be the "warm up" period.

[53] keeping in mind the important caveat that analysis and results presented here do not account for the transaction costs and other institutional measures needed to implement the proposed greening policies, and as such the results should be interpreted with caution and as indicative of the possible effects of the greening policies considered.

- Potential revenues generated from the higher water fees would represent 0.1% of GDP and 0.62% of the value of agricultural output.
- But GDP would be 0.35% lower than the base path upon impact in 2011, and it would be 0.4% lower in comparison to the 2030 base path level (Figure 6.6). Again, the 2030 results reflect a slower rate of GDP growth with greening, but not an absolute decline.

Simulation results of a greening policy aimed at of increasing water use efficiency in agriculture, and using the additional water fee revenues for extension and innovation to improve production technology and irrigation efficiency that would translate into productivity gains *(i.e., Scenario EXP_AG02)*

- An increase of GDP by 1.8% over its base path value by 2030 (in real terms).
- Productivity gains of 0.4% in 2011 gradually increasing to 0.95% by 2030.
- These expansionary effects from the productivity gains emanating from translating fee revenues into research and extension lead to a further increase in the marginal value of water resources to 32 cents TL/m3 ($ cents 18) with a corresponding *marginal cost* of water irrigation 60$/ha by 2030.

Simulation result of a greening policy aimed at increasing water use efficiency in agriculture, and using the additional water fee revenues for extension and innovation to improve production technology and irrigation efficiency, coupled with the expansion of conservation and pasture improvement, would translate into productivity gains *(i.e., Scenario EXP_AG03)*

- An estimated gain of 3.6% in GDP by 2030.
- Expansion of the rain-fed land (to simulate conservation tillage and improved pasture management) induces important substitution effects reducing the burden of the water fee and leading to a reduction of the marginal cost of irrigation water starting in 2015 (lowering to 38 $/ha by 2030).
- Potential revenues generated from the higher water fees would represent 0.06% of GDP and 0.36% of the value of agricultural output.
- The policy is employment-neutral in the sense that less than 20,000 rural jobs are added by 2030. This is to be expected since some measures, like conservation tillage, tend to increase labor use, but others, like improved irrigation technology, would have the opposite impact.

(c) Integrated comprehensive greening scenario: combining greening the urban and rural economies

The final scenario consists in evaluating the economy-wide impacts of the following package of measures, combining measures under both the urban and greening scenarios:

- Internalizing environmental externalities by imposing pollution taxes on industrial and household solid waste and water discharges, PM10 and CO2e emissions;
- Earmarking (part of) the revenue from pollution taxes for financing green jobs for otherwise unemployed workers at the ongoing urban wage rate;
- Earmarking the carbon tax revenues for improved R&D and innovations for the *strategic industrial sectors* (as defined within the *Industrialization Strategy Document, 2011);*
- Introducing "use efficiency" fees on irrigation water for cost recovery;

- Earmarking the irrigation fees for rural R&D and innovation to boost agricultural productivity growth; and
- Improving pasture land and soil erosion control and introducing conservation tillage practices.

Figure 6.6 Real agricultural output supply in Turkey

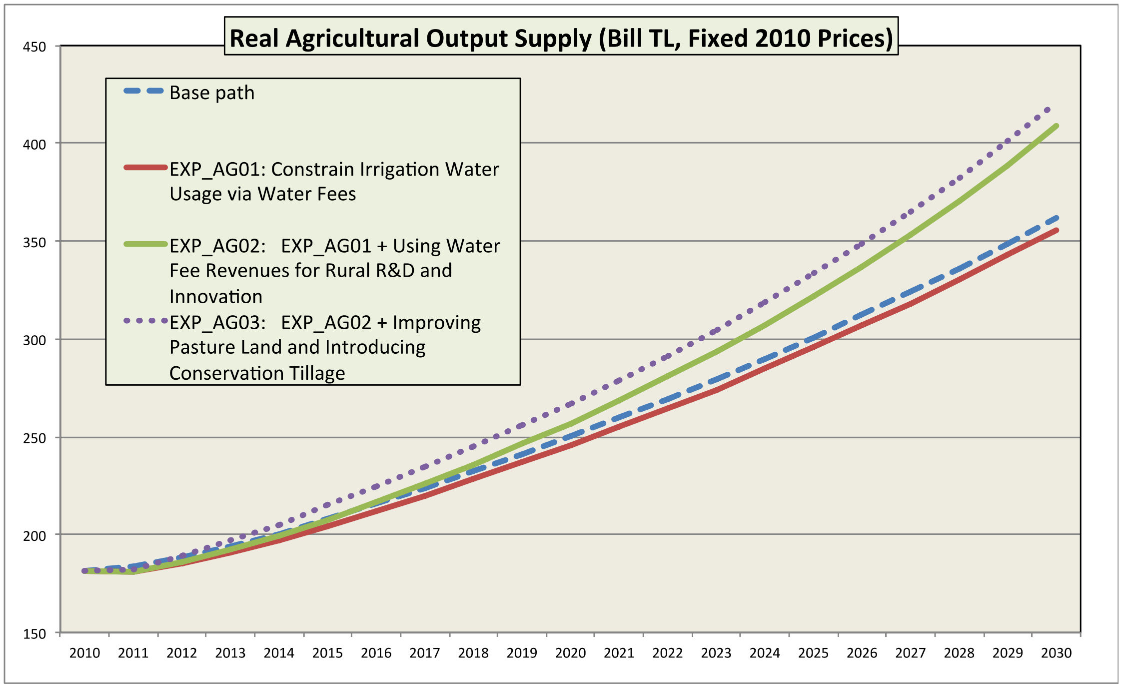

Figure 6.7 MAC curves of irrigation water abatement in Agriculture

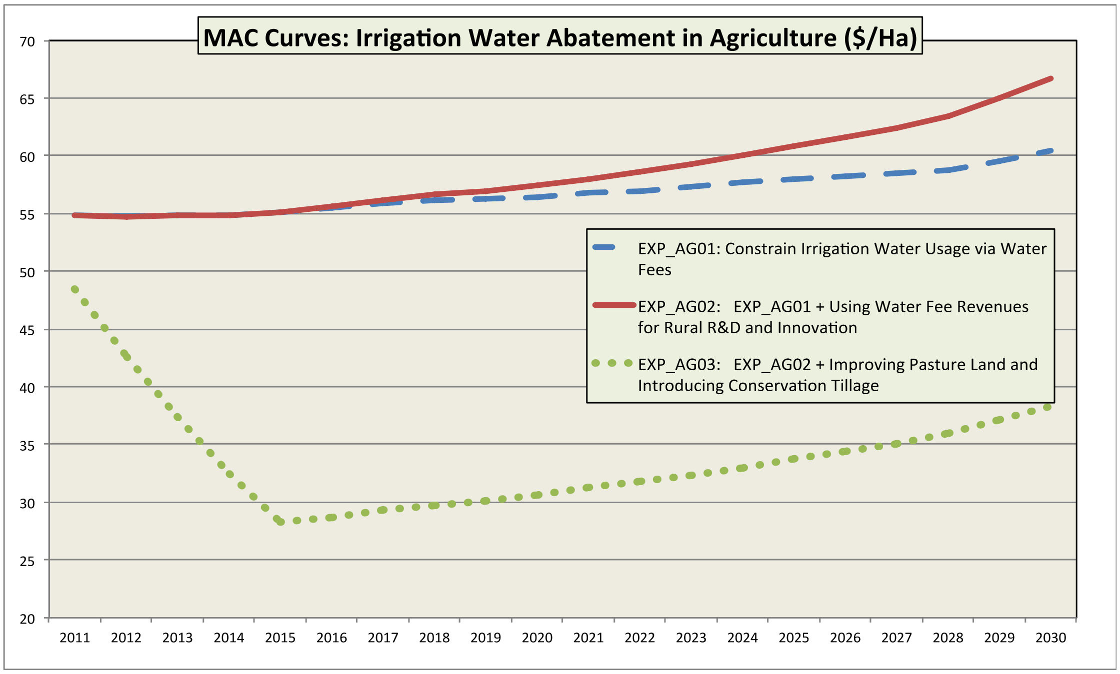

Table 6.5 Summary Results: Base Path versus Rural Greening Policy Scenarios

Summary Results: Base Path versus Rural Greening Policy Scenarios

	Base Path			EXP_AG01: Constrain Irrigation Water Usage via Water Fees			EXP_AG02: EXP_AG01 + Using Water Fee Revenues for Rural R&D and Innovation			EXP_AG03: EXP_AG02 + Improving Pasture Land and Introducing Conservation Tillage		
	2015	2020	2030	2015	2020	2030	2015	2020	2030	2015	2020	2030
Macro Results (Billion TL, 2010 fixed prices)												
Real GDP	1443.8	1863.5	3012.7	1439.1	1856.6	2999.8	1437.7	1860.8	3069.1	1450.1	1885.0	3121.5
Aggregate Investment	290.6	361.5	554.1	290.3	361.1	553.1	289.7	360.4	557.5	291.0	363.5	565.4
Aggregate Private Consumption	996.8	1278.0	2074.9	992.8	1272.5	2065.3	991.6	1274.0	2104.2	1000.3	1290.7	2140.9
Exports	337.2	462.7	828.2	336.6	461.8	826.5	335.6	460.1	829.7	337.5	464.7	842.4
Imports	384.9	498.6	840.6	384.3	497.7	838.9	383.2	496.0	842.0	385.1	500.6	854.7
Rural Tax/Fees												
Eqm Water Fee on Irrigated Land (TL/m3)				0.286	0.286	0.286	0.286	0.291	0.316	0.147	0.155	0.181
Total Water Fees/GDP (%)				0.097	0.096	0.094	0.097	0.097	0.103	0.050	0.052	0.058
Total Water Fees/Ag Output (%)				0.616	0.616	0.615	0.616	0.624	0.664	0.312	0.328	0.375
Rural Economy Factor Markets Results												
Irrigation water in Agr (Bill m3)	42.4	52.9	80.7	28.4	35.4	54.1	28.4	35.4	54.1	28.4	35.4	54.1
Fertilizer Usage in Agr (Mill kg)	1722.4	1765.9	1856.2	1599.3	1639.7	1723.5	1599.3	1639.7	1723.5	2129.5	2183.3	2295.0
Total Land (mill Ha)	24.6	25.2	26.5	22.0	22.6	23.7	22.0	22.6	23.7	28.3	29.0	30.5
Rainfed Land	19.3	19.8	20.8	19.3	19.8	20.8	19.3	19.8	20.8	26.9	27.5	28.9
Irrigated Land	5.3	5.5	5.7	3.6	3.7	3.8	3.6	3.7	3.8	3.6	3.7	3.8
Capital Supply Ag (Bill TL)	93.1	117.5	180.0	92.9	117.2	179.5	92.6	117.0	181.3	93.3	118.3	184.2
Total Employment (Mill workers)	24.006	24.451	25.960	23.969	24.407	25.903	23.913	24.344	26.051	24.022	24.556	26.420
Rural Employment	3.774	3.042	2.394	3.770	3.037	2.390	3.772	3.043	2.404	3.776	3.050	2.412
Urban Employment	20.232	21.409	23.566	20.199	21.370	23.513	20.142	21.301	23.646	20.246	21.506	24.009
Rural Labor Migration (Mill workers)	0.271	0.138	0.058	0.272	0.138	0.058	0.271	0.137	0.057	0.270	0.137	0.058

The results of this integrated policy package indicate the following:

- GDP increases in real terms to 3,186 billion TL in 2030 (in fixed 2010 prices), 5.8% higher than the base path (again, itself reflecting economic growth over the periods);
- Consumption contracts slightly as a result of fiscal greening measures (67% of the GDP in 2030 compared to 68% in the base run) ;
- Investment is doubled between 2015 and 2030;
- There is no major impact on trade balance (trade deficit around 12 billion TL in fixed 2010 prices in the base run and combined greening scenarios)
- Innovation leads to Automotive and Electronics becoming the leading sectors of growth, significant gains are also achieved in Machinery and Construction;
- In comprehensive greening scenarios (referring to urban and rural greening) total employment rises to 26.7 million workers (Table 6.6) (5.3% above the base path, slightly lower than the increase in GDP over the base path), while sectoral results reveal that employment gains are strong in Automotive (59.3%); Electronics (34.7%); and Machinery & White Goods (11.7%);
- Solid waste both in industry and the household sector meet the EU-inspired coverage and management standards, and water pollution (wastewater) is reduced by half;
- Aggregate emissions of PM10 is cut by 25% (meeting WHO standards), and gaseous emissions as measured by CO2e is reduced by 21.3% in 2030;
- The intensity of CO2 emissions per $GDP is observed to fall to 0.44 kg/$GDP –the level of the OECD average for 2008.

These quantitative results should not be taken literally, bearing the significant limitations of the model in mind. They demonstrate how a comprehensive approach, relying on multiple policy instruments to pursue multiple environmental policy objectives (across the urban and rural space) could yield significant social welfare impacts. The model especially highlights the role of public policy in greening through recycling environmental taxes to support green jobs and innovation. In reality, however, the reallocation of resources through the public sector is likely to be far less significant, as induced private sector abatement activities and innovation would result in an expansion of "green activities" and lower tax revenues.

Finally, several strong caveats must be borne in mind. The results from the general equilibrium analysis above are based on a number of assumptions and the boundaries of the modeling paradigm used. The CGE model is an approach in which the adjustment path as characterized by the simulation exercises reflects a "well-defined" and "smooth" general equilibrium system based on consumer and producer optimization in the absence of any rigidities and/or structural bottlenecks. Thus, the adjustments of the model economy in response to various policy shocks should not be taken as literally a measure of the global stability properties of the real economy. For these reasons, while the results are intuitive and suggestive of benefits in reality as well, they should at best be regarded as crude approximations of the long-run equilibrium effects of environmental and investment policies on production, employment, current account, capital accumulation and consumer welfare.

It has been noted previously that the model uses very simplified approaches to represent complex processes of substitution, alternative technology adoption, and innovation. The additional importance of how macroeconomic growth policies interact with environmental policies cannot be over-estimated. In this study, concurrent applications of more macro-oriented measures to stimulate overall TFP growth, and increase jobs through public expenditure, serve to offset the sector-and-pollutant-specific reductions in the *rate* of GDP growth. The net positive impacts on GDP growth in various scenarios do not, however, reflect a *win-win* in the sense that the environmental measures are somehow uniquely responsible for the growth benefits. The health-related productivity improvements and (arguably) the specific application of CO2 tax revenues for (induced) energy efficiency improvement do reflect win-win outcomes, and the specific funding of green jobs in the water and solid waste sectors reduces the economic burden imposed by the waste taxes in the model. However, the other benefits depend on a source of expenditure, not that it is specifically environmental tax revenue. For example, the general increases in total factor productivity taken as being induced by application of CO2 tax revenues to unspecified innovation investments could be as easily achieved in the model with no environmental policies, simply by channeling some other sources of revenues to these activities. Similarly, unemployment reduction could be induced through taxes or subsidies on job creation that are not tied to environmental revenues or activities, as well as through labor market reforms. While pursuit of green policy goals adds to the value of also utilizing other macroeconomic-level growth policies to mitigate the cost and thus increase the net social benefit of green measures, solid macroeconomic policies remain a priority in their own right.

Table 6.6 Summary Results: Base Path versus Comprehensive Greening

Summary Results: Base Path versus Comprehensive Greening

	Base Path			EXP4: Combined Scenario, Rural and Urban Greening		
	2015	**2020**	**2030**	**2015**	**2020**	**2030**
Macro Results (Billion TL, 2010 fixed prices)						
Real GDP	1,443.8	1,863.5	3,012.7	1,433.2	1,884.2	3,186.2
Aggregate Investment	290.6	361.5	554.1	288.4	366.3	582.4
Aggregate Consumption	996.8	1278.0	2074.9	976.8	1269.4	2129.4
Exports	337.2	462.7	828.2	320.9	449.6	812.8
Imports	384.9	498.6	840.6	368.5	485.5	825.2
Environmental Pollution Indicators (Million tons)						
Solid Waste: Total Industry	19.3	28.1	58.4	7.2	3.5	1.5
Solid Waste: Households	33.9	43.5	70.6	15.8	7.0	3.0
Water Pollution: Total Industry (Bill t)	1.6	2.4	5.1	1.1	1.6	2.8
Water Pollution: Households (Bill t)	4.9	6.3	10.3	3.7	4.6	5.6
PM10 Total	2,599.1	3,038.5	4,045.5	2,446.7	2,759.8	3,045.5
PM10: Energy Related	1,995.9	2,252.4	2,753.2	1,863.2	1,997.9	1,779.3
PM10: Industrial Processes	356.7	473.4	791.3	344.1	454.0	759.9
PM10: Households	246.5	312.7	501.1	239.4	307.9	506.3
CO2 eq. Total	568.9	689.9	983.7	538.5	635.5	774.7
CO2 eq: Energy Related	421.9	502.5	685.0	394.0	449.8	470.5
CO2 eq: Industrial Processes	57.0	75.7	126.4	55.0	72.6	121.4
CO2 eq: Agriculture	36.7	44.2	64.0	37.8	46.7	73.3
CO2 eq: Households	53.2	67.5	108.2	51.7	66.5	109.3
Pollutant Intensities (kg / GDP)						
Total CO2/GDP (kg/$GDP)	0.71	0.67	0.59	0.68	0.61	0.44
Total PM10/GDP (kg/$GDP	3.24	2.93	2.42	3.07	2.64	1.72
Total Industrial Waste/GDP (kg/$GDP	0.02	0.03	0.03	0.01	0.00	0.00
Total Household Waste/GDP (kg/$GDP	0.04	0.04	0.04	0.02	0.01	0.00
Environmental Taxes(Fees) (% Ratios to the GDP)						
Total Waste Fees: Industry				0.53	0.39	0.19
Total Waste Fees: Households				0.55	0.37	0.19
Total Water Pollution Fees: Industry				0.17	0.36	0.73
Total Water Pollution Fees: Households				0.17	0.33	0.66
Total PM10 Taxes				0.28	0.56	1.12
Total CO2 Taxes				0.18	0.35	0.69
Total Water Fees on Irrigated Land				0.04	0.04	0.05
Total Environmental Taxes (Fees)				1.91	2.41	3.64
Note: Eqm Water Fee on Irrigated Land (TL/m3)				0.11	0.13	0.15
Note: Total Water Fees/Ag Output (%)				0.24	0.28	0.32
Employment (Million Workers)						
Total Employment in Production	24.006	24.451	25.960	23.196	24.002	25.846
Rural Employment	3.774	3.042	2.394	3.789	3.064	2.418
Urban Employment	20.232	21.409	23.566	19.407	20.939	23.428
Green Employment				0.618	0.679	0.927
Total Employment	24.006	24.451	25.960	23.814	24.681	26.774
Rural Labor Migration (Mill workers)	0.271	0.138	0.058	0.268	0.138	0.058
Ratio of Green Wages to Private Disposable Income (%)				0.90	0.93	1.15
Fiscal Balances (Ratios to the GDP)						
Government Revenues	25.43	25.38	25.40	26.46	26.80	27.71
Public Investment	4.54	6.53	6.54	4.81	6.90	7.13
Public Consumption	14.10	14.07	14.08	14.66	14.85	15.36
Public Sector Borrowing Requirement	-1.10	0.46	0.45	-1.06	0.48	0.46
Memo: Foreign Deficit	5.02	3.88	2.33	5.14	3.89	2.28

Figure 6.8 Real GDP under comprehensive scenario

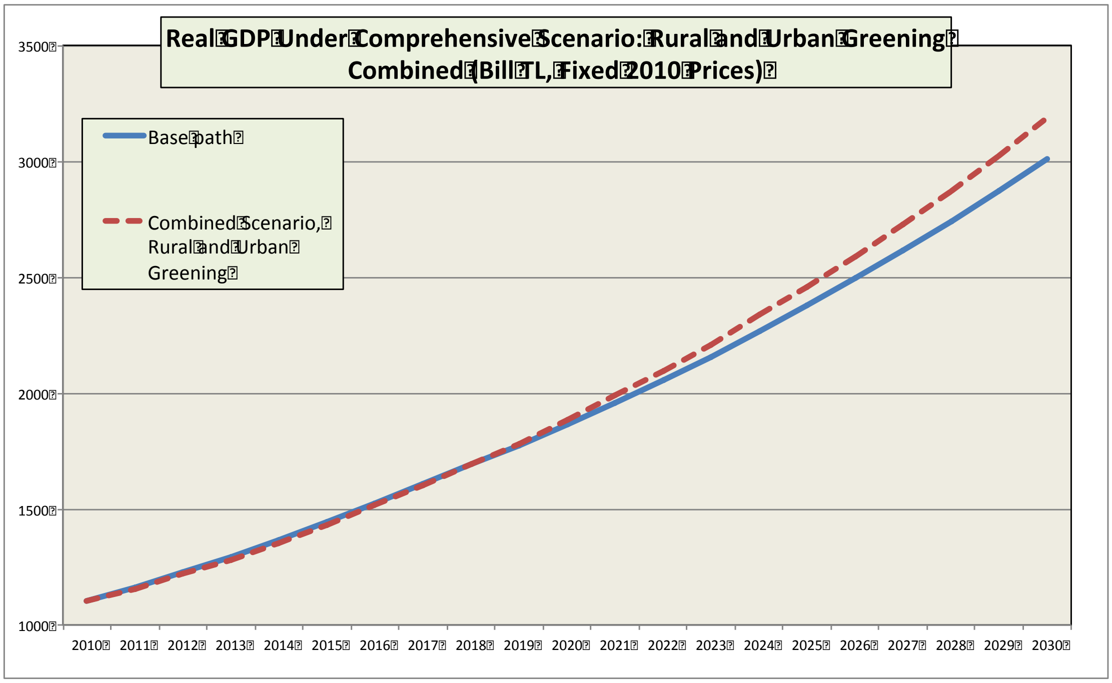

Figure 6.9 CO2 intensity under the comprehensive green scenario

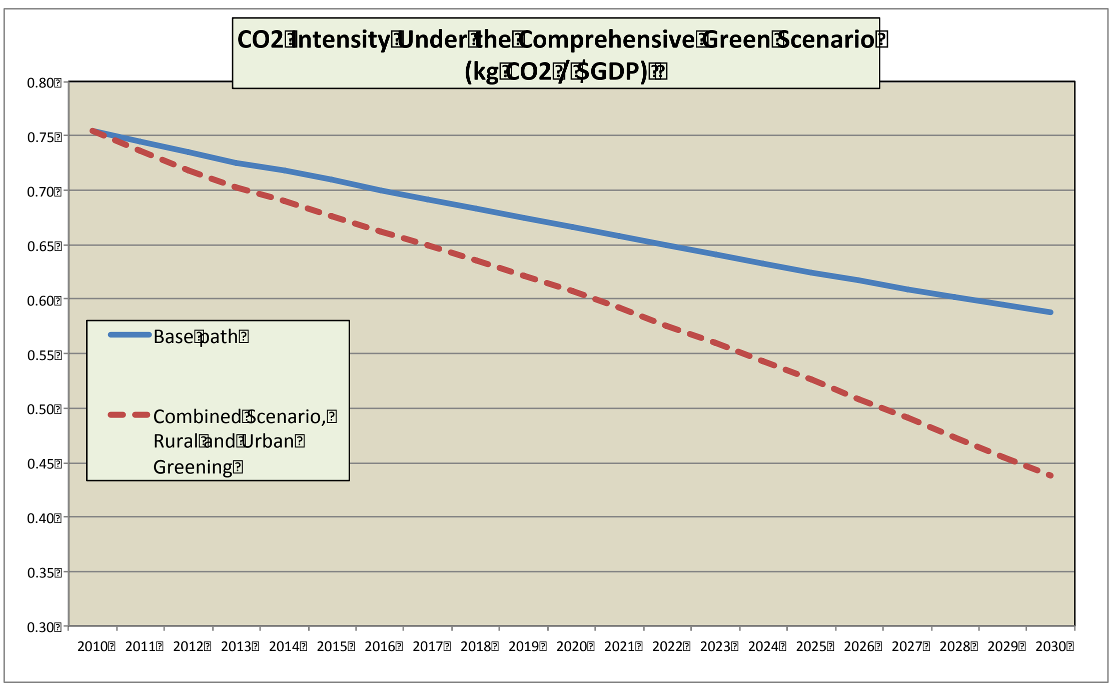

Table 6.7 Summary of CGE scenarios

Identifier	Scenario Description	% change wrt GDP-BAU in 2030
	Simulation 1: Greener Cities	
EXP1_fixedW	Taxing PM10 under fixed real urban wages	-0.3
EXP1_fixedW_HelathTFP	PM10 tax with fixed wages with added TFP gains from health effects due to PM10 abatement	4.8
EXP2_fixedW	Solid waste tax only, with fixed wages no green jobs	-12.1
EXP3_fixedW	Water waste tax only, with fixed wages no green jobs	-4.8
EXP4_fixedW	CO2 tax only, with fixed wages no green jobs	-7.4
EXP5_fixedW	All taxes together, with fixed wages with added TFP gains from health effects due to PM10 abatement No green jobs	-11.4
EXP5_GrnJobs_fixedW	All taxes together, with fixed wages with added TFP gains from health effects due to PM10 abatement plus earmarking green tax revenues for green jobs	-7.2
EXP5GrnJobs_TFP_fixedW	All taxes together, with fixed wages with added TFP gains from health effects due to PM10 abatement plus earmarking green tax revenues for green jobs plus TFP gains in strategic sectors (old EXP2)	2.4
EXP1_flexW	PM10 tax with flexible wages, no health productivity gains	0.8
Simulation 2: Greener Agriculture		
EXP3_Rural Greening	Greening through sustainable agriculture • Expand Conservation Agriculture/no-till • Improve pasture management • Improve water use efficiency	3.6
Simulation 3: Greener Turkey		
EXP4_Integrated Greening	Integrated scenario (urban, industrial & CO2 pollution mitigation + green jobs + innovation + sustainable agriculture	5.8

7. Conclusions and Recommendations

Overall, the results from this pilot analysis point to two broad messages and a set of initial general recommendations.

First message: Given the current structure of the Turkish economy and the rigidities of its labor market, ***green policies*** relying on environmental taxes alone, which in principle should improve welfare (through access to clean water supplies and sanitation) and economic efficiency (through reducing excessive pollution and improving the efficiency of water, land and energy resources), ***also have costs***. However, the magnitude of these costs depends on the flexibility of the economy and the availability of qualified human resources, as well as public policies that support "green jobs," induce innovation, and therefore reduce potential trade-offs between economic and environmental objectives.

The impacts would be felt by consumers and producers who will have to alter input mix decisions in response to changes in relative prices and the structure of demand. Switching to new more efficient and environmentally compliant technologies by the private sector will require up-front capital and an adjustment period during which efficiency may fall and jobs may be lost; this impact however will be felt differently by different sectors. The automotive, electronics and white goods, and to a certain extent, the iron & steel industry, would adjust faster because as exporters to the EU and other international markets, and to remain competitive, they have already adopted cleaner technologies. All three also have in place R&D programs focused on enhancing productivity and resource use efficiency (e.g., smart appliances to further reduce energy use; hybrid and electric vehicles, use of energy sources, and waste recycling).

Second message: Green polices that combine environmental taxes with earmarking tax revenues to stimulate innovation and green jobs can contribute to growth. This study illustrates one way of achieving such a scenario through assuming that tax revenues can be used to expand research and development capabilities and innovation as well as promote job creation in environmental sectors (e.g., recycling, waste water treatment, waste management, energy efficiency). These results are predicated on the fact that innovation-driven productivity gains are an indispensible complement to environmental policies aimed at reducing the intensity of resource use and improving environmental health.

However, it is important to note that other approaches to using tax revenue to stimulate innovation and green jobs are possible. In particular, when environmental taxes are used to reduce taxes on labor and income, the impact on GDP is likely to be neutral or positive (World Bank 2012c). As was noted earlier in the report, this was done for example in Germany where green taxes were used to stimulate employment through reducing the non wage cost of labor throughout the economy.

Moreover, there is still debate among researchers and practitioners regarding what constitute green jobs. The focus of this paper was mainly on employment created in environmental service sectors (waste management, energy efficiency, etc.), both public and private, and not on the broader employment consequences of introducing public policies to correct externalities. For example, the evidence suggests that green growth is likely to be more labor intensive than growth sustained by traditional fossil fuels. This is particularly true for renewable energy supply and energy efficiency improvements which appear to be more labor intensive, because the construction sector requires relatively unskilled labor. However, the implications of the current lower labor productivity of these activities for public finances, energy prices, and the profitability of private-sector activity, are issues that need to be carefully examined in an economy-wide context. Because of their importance for Turkey, these issues would need to be further investigated in work that follows-up the present study.

Some initial general recommendations: Turkey would benefit from a mix of policy instruments better targeted at its green innovation potential. This includes not only policies to spur access to technologies and capital, but a more focused set of both supply-side 'technology-push' policies (including matching grants for collaborative early-stage technology development) and demand-side 'market-pull' policies (including prices and regulations) – that should induce green innovations across many industries. Empirical evidence shows that well-designed environmental regulations, incentives, and standards stimulate significant innovation by firms. Firm surveys in Europe show that existing or future environmental regulation is the top driver for firms to introduce environmental innovation. Similarly, international sustainability standards can help local firms upgrade their environmental practices, a form of catch-up innovation.

Overall, Turkey has done a lot in terms of environmental sustainability and climate change mitigation (key components of GG/GE), but significant potential remains untapped. The analysis in this report reveals that:

- Internalizing the social cost of externalities through taxes and adhering to key EU Directives without additional measures would negatively impact overall growth, unless structural factors are addressed in order to explicitly promote innovation and green jobs;
- The manufacturing sector, with the six strategic industries up front, is leading the way in terms of technological adoption and R&D. With a over third of manufacturing production, a third of employment, and twice the R&D rate (61%), the six strategic sectors are already on a "green trajectory," and have the potential to be a source of additional green jobs; further, a combination of labor market reform, technological transfer, and internal innovation can spur significantly more skilled labor demand;
- Solid waste management can be an important source of green jobs at the local level (in support of Reduce-Reuse-Recycle goals) and lower the cost of collection and treatment; but, as this sector is characterized by a significant amount of informality, reforms of both sector institutions and of the current temporary employment regulations would help reduce informal activities and improve resource efficiency;
- Reducing air pollution is an important green policy because of the welfare impacts of improved health outcomes and worker productivity;
- Reducing GHG is an important part of any green policy package in Turkey. While on economic grounds alone, energy efficiency has significant potential economic benefits (e.g., in all the six strategic sectors as well as in agriculture; in the housing sector in particular, the incremental cost of applying adequate insulation and heating techniques would be dwarfed by the 30-45% saving potential and the employment benefits), it would also provide significant mitigation co-benefits, and the new government energy efficiency strategy is an important first step in this direction;
- Waste Water Management is key to achieving water quality standards and should have a significant long-term greening impact through welfare improvement (access to clear water sources and reduced

water-borne diseases), water allocation and use efficiency increase in the economic value of the resource, and adaptation to climate change; and

- As agriculture in Turkey continues its structural change, greening policies can produce significant *“climate-smart triple wins”:* mitigation through carbon sequestration, improved resilience to climate change, and higher competitiveness and employment.

An important issue (which is beyond the scope of the present analysis) is the role of structural change as a potential engine of green growth. This note and the model used to motivate its conclusions have focused on cost abatement and innovation in existing sectors. However, as the structure of the economy changes, new sectors may come into being in ICT and other services sectors that may not exist or may play only a minor role in today’s Turkish economy. Over the long term, it is likely that structural change will contribute significantly to mitigating the environmental impacts of economic growth. Even without such effects, this note has shown that with appropriate policies the growth – environment trade-off can be substantially mitigated.

Annex 1: Description of the Algebraic Structure of the CGE Model

This is an overview description of the properties of the computable general equilibrium (CGE) model to be utilized as a laboratory device to investigate various alternative scenarios of policy intervention and technical change as pertain to the medium-long term growth of the Turkish economy. The CGE approach, compared with other modeling techniques (such as linear programming or input-output analysis) for environmental policy evaluation proves more attractive with its ability to trace the relationship between production costs, their relevant technologies, consumer choices, and interaction of the green policy instruments with the fiscal and foreign trade policies throughout the economy in an internally consistent way.

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. "Dynamics" into the model is integrated via "sequentially" updating of the static model into a medium-run of twenty years from 2010 through 2030. Economic growth is the end result of (i) rural and urban labor population growth; (ii) investment behavior on the part of both private and public sectors; and (iii) total factor productivity (TFP) growth performance of the Turkish economy.

The supply-side of the economy is modeled as twelve aggregated sectors. In line with our focus on strategic industrial sectors and environmental policy evaluation, the disaggregation scheme develops into the energy sectors and critical sectors of GHG and Particular Matter (PM10) pollutions in detail. It thus aggregates a large number of other activities that, although being far more important contributors to total gross output, are not germane to the strategic growth and greening problem. The sectors that we specify are:

- Agricultural production (*AG*)
- Coal Mining (*CO*)
- Petroleum and Gas (*PG*)
- Refined Petroleum and chemicals (*RP*)
- Electricity Production (*EL*)
- Cement Production (*CE*)
- Iron and Steel Production (*IS*)
- Machinery and white goods (*MW*)
- Electronics (*ET*)
- Automotive (*AU*)
- Construction (*CN*)
- Other economy (OE)

Labor, capital and a composite of primary energy inputs, electricity, petroleum and gas and coal, together with intermediate inputs are the factors of production.

For modeling agricultural production activities, the model further accommodates rainfed and irrigated land as additional factors. Water and fertilizer use (nitrate and phosphorus) are explicitly recognized as part of land usage in rural production.

Basic Features of the Model

The model is in the tradition of applied general equilibrium paradigm where the production-income generation-consumption and saving-investment decisions of an economy are depicted within a market equilibrium setting. Optimizing economic agents are modeled as responding to various price signals as affected by a range of government's taxation/subsidy policies. The economy is modeled to operate in an internationally open environment where exchange rate and foreign capital inflows interact with exports and imports of the domestic sectors.

Emissions arising both from production activities and from consumption activities are modeled within the specification of the dynamics of the circular flow of the economy.

Sectoral 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*), intermediate inputs –excluding primary energy inputs (*ID*) and primary energy composite (*ENG*) as factors of production. In agriculture, in addition to these, the model accommodates *land aggregate* as an additional composite factor of production. Agricultural land aggregate is further decomposed as a constant elasticity of substitution (CES) function of *irrigated* and *rain-fed land*. This decomposition is responsive to rental rates of the type of the land respectively, which are solved endogenously by the model.   Water used in irrigated land is set as a Leontief coefficient. Fertilizer use is similarly modeled as a Leontief technology as a ratio of aggregate and used.

In algebraic terms, for the *non-agricultural* sectors the production technology is given as follows:

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

i = CO, PG, RP, EL, CE, IS, MW, ET, AU, CN, OE

where as in agriculture, production entails land aggregate as an additional factor of production:

$$XS_A = AX_A \left[K_A^{\lambda_{K,A}} L_A^{\lambda_{L,A}} N_A^{\lambda_{N,A}} \left(\prod_j ID^{\lambda_{ID,j,A}} \right) ENG_A^{\lambda_{E,A}} \right] \qquad (1\text{-ii})$$

In Equations 1-i and 1-ii, AX is the technology level parameter, $\lambda_{K,i}$, $\lambda_{L,i}$, $l_{N,i}$, $\lambda_{E,i}$ 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:

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

These relationships are further portrayed in Figure 6.1 (in main text –chart which summarizes flows of commodities, factors and emissions in the model).

At the lower stage of the production technology, 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 and electricity:

$$\frac{ID_{CO,i}}{ENG_i} = \left[\frac{\kappa_{CO,i} PEG_i}{AE_i^{-\rho x_i}(1 + CO_2taxN_{CO} + PM10taxN_{CO})PC_{CO}}\right]^{1/(1+\rho x_i)} \quad (4)$$

$$\frac{ID_{PG,i}}{ENG_i} = \left[\frac{\kappa_{PG,i} PEG_i}{AE_i^{-\rho x_i}(1 + CO_2taxN_{CO} + PM10taxN_{CO})PC_{PG}}\right]^{1/(1+\rho x_i)} \quad (5)$$

$$\frac{ID_{EL,i}}{ENG_i} = \left[\frac{\kappa_{EL,i} PEG_i}{AE_i^{-\rho x_i}(1 + CO_2taxN_{CO} + PM10taxN_{CO})PC_{EL}}\right]^{1/(1+\rho x_i)} \quad (6)$$

Where, PEG is the cost of energy input composite, and CO2taxNj and PM10taxNj are the pollutant's fees (carbon, and particular matter-10 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:

$$K_i = \lambda_{K,i}\left[\frac{(1 - t_{Prod,i} - CO_2taxP - PM10taxP)PX_i XS_i}{r}\right] \quad (7)$$

$$L_i^D = \lambda_{L,i}\left[\frac{(1 - t_{Prod,i} - CO_2taxP - PM10taxP)PX_i XS_i}{(1 + pyrltax)\overline{w}}\right] \quad (8)$$

$$ID_j = \lambda_{ID,j,i}\left[\frac{(1 - t_{Prod,i} - CO_2taxP - PM10taxP)PX_i XS_i}{(CO_2taxN_j + PM10taxN_j\ )PC_j}\right] \quad (9)$$

The equations above governing demand for both primary energy inputs and the other factors of production already provide some indication on the effects of alternative policies on the supply-side of the economy. A tax on the usage of coal for instance, (CO2taxNCO + PM10taxNCO) would shift the demand away from coal as a primary source of energy towards other sources, under the allowances of substitutability determined by the production technology.

In agriculture, the land aggregate is demanded in relation to its factor intensity as above:

$$N_A = \lambda_{N,A}\left[\frac{(1 - tax_A - CO_2taxP - PM10taxP)PX_AXS_A}{RN_A}\right] \quad (10)$$

where RN_A is the average land rental rate. This average is obtained from the weighted average of the rental rates on irrigated land and rain-fed land:

$$RN_A\ N_A = RNRF(1+taxF)NRF + RNIR(1+taxF+feeW)NIR \quad (11)$$

In equation (11) RNRF and RNIR refer to rental rates of the rain-fed land, NRF, and irrigated land, NIR, respectively. The fee rates are on fertilizer use (taxF) and on water usage (feeW).
At a lower level, land aggregate is a CES composite of the irrigated and rain-fed land types:

$$N_A = AN_A\left[\theta_{NRF,A}NRF_A^{-\rho_{NA}} + (1-\theta_{NRF,A})NIR_A^{-\rho_{NA}}\right]^{-1/\rho_{NA}} \quad (12)$$

The optimal choice of the farmer towards utilization of irrigated versus rain-fed land is given from the optimizing conditions and is subject to the taxation (fees) instruments:

$$\frac{NRF_A}{NIR_A} = \left[\frac{\theta_{NRF,A}RNIR}{(1-\theta_{NRF,A})RNRF}\right]^{1/(1+\rho_{NA})} \quad (13)$$

It is assumed that the amount of water usage in irrigation is given by a Leontieff coefficient on the irrigated land:

$$IRW^D = w\ NIR \quad (14)$$

Likewise, fertilizer usage is modeled as a fixed ratio of the aggregate land:

$$FRT^D = € (NIR + NRF) \quad (15)$$

The water and fertilizer usage are to be affected by fee/subsidy instruments (taxF and taxW) as introduced above.

In the land markets, the rental rates of the irrigated and rain-fed land types are determined by contrasting the land demand against the available supply.

$$NRF_A = NRF^{SUP} \quad (16)$$

$$NIR_A = NIR^{SUP} \quad (17)$$

The model specifies a dualistic structure in the labor markets where rural and urban labor forces 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 inter-temporal 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.

The amount of rural labor migrating to the urban labor market is found by:

$$LMIG = \mu \frac{(EWU - W_{AG})}{W_{AG}} LSUP_{AG} \quad (18)$$

where W_{AG} is the rural labor wage rate (flexible), and EWU is the expected urban wage rate. μ is an elasticity parameter used to control the responsiveness of the migration decision in response to the wage differentials. The expected urban wage rate is a weighted average of the (nominally fixed) urban wage rate and the sectoral employment levels in the urban sectors:

$$EWU = W_{URB} \sum_{i \in Non-Ag} \left(\frac{L_i^D}{LSUP_{URB}} \right) \quad (19)$$

Given the migrated labor and supplies of both types of labor, urban labor market is quantity adjusting via unemployment:

$$UNEMP = LSUP_{URB} - \sum_{i \in noAg} LD_i \quad (20)$$

$$UNEMP_G = LSUP_{URB} - \sum_{i \in noAg} LD_i - \sum_j L_{G,j} \quad (20\text{-i})$$

Rural labor market wages are flexible and agriculture sector is at full-employment:

$$LSUP_{AGR} = L_A^D \quad (21)$$

Likewise, given the aggregate physical capital stock supply in each period, the capital market equilibrium, $\sum_i K_i = \overline{K}^S$ implies an equilibrium interest rate *r* for the economy. Thus the physical capital is mobile across sectors. It is the difference in sectoral profit rates that leads to the sectoral allocation of aggregate investments in within-period dynamics of the model.

Environmental Pollution and Instruments of Abatement

We will distinguish two types of environmental pollution: gaseous emissions (in terms of CO2 equivalents and PM10) and waste generation.

Waste is thought to be in "solid" and "water" discharge form and is generated from

i. urban waste (to be formulated as a ratio of urban consumption);
ii. waste from industrial processes, and
iii. waste from water usage in agricultural production.

On the other hand, three basic sources of CO2 and PM10 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 and PM10 emission in the economy is the sum over from all these sources:

$$CO_2EM_i = \sum_j CO_2EM_{j,i}^{INM} + CO_2EM_{j,i}^{ENG} + CO_2EM_i^{IND} \quad (22)$$

Depending on the source of emission, we assume different allocation mechanisms of carbon dioxide. Following Gunther et al. (1992), the emissions from industrial processes is regarded to depend on the level of industrial activity, therefore is hypothesized proportional to gross output:

$$CO_2EM_i^{IND} = \bar{\delta}_i XS_i \quad (22\text{-}i)$$

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):

$$\text{TOTCO2ENG} = \sum_i \left[\sum_j \left(CO_2EM_{j,i}^{INM} + CO_2EM_{j,i}^{ENG} \right) \right] \quad (23)$$

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:

$$CO_2EM_{j,i}^{ENG} = \varpi_{j,i} \, ID_{j,i} \qquad j = CO, PG \quad (24)$$

$$CO_2EM_{j,i}^{INM} = \bar{\varepsilon}_{j,i} \, ID_{ji} \qquad j = RP \quad (25)$$

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

$$TOTCO_2HH = \sum_i \bar{\psi}_i CD_i \quad (26)$$

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

Pollutant tax/fee can serve as one of the instruments and is thought to be introduced at per tons of carbon dioxide emitted, on production, on intermediate input usage and on consumption respectively. The revenues are directly added to the revenue pool of the government budget.

$$TOTCO2TAX = \sum_i CO_2tP PX_i XS_i + \sum_i \sum_j CO_2tN_i PC_i ID_{i,j} + \sum_i CO_2tC_i PC_i CD_i \quad (27)$$

PM10 emissions are modeled in the same manner, with the corresponding fee/tax rate as:

$$TOTPM10TAX = \sum_{i} PM10\text{taxP} PX_i XS_i + \sum_{i}\sum_{j} PM10\text{taxN}_i PC_i ID_{i,j} + \sum_{i} PM10\text{taxC}_i PC_i CD_i \qquad (28)$$

Income Generation and Demand

Private sector is aggregated into one household. Household income comprises returns to labor input, net of social security taxes, and land rental income. Household income is further accentuated by remittances of profits from the enterprise sector. $W^*L_{G,J}$ corresponds to the transfers from the green wage fund (as defined in Box 6.2, Equation 1:

$$YHWnet = (1 - ss\,tax)\bar{w}\sum_{i} L_i^D + RNRF \cdot NRF + RNIR \cdot NIR \qquad (29)$$

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

$$EtrHH = (1 - t_{Corp})\sum_{i} r\,K_i - EERPtrROW - NFI^G + GtrEE - r^D DomDebt^G - r^F eForDebt^E + eForBOR^E \qquad (30)$$

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:

$$EERPtrROW = trrow \sum (1 - t_{Corp}) r K_i \qquad (31)$$

In Equation 31, 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:

$$YHH = YHWnet + EtrHH + GtrHH + SSItrHH + eROWtrHH \qquad (32)$$

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:

$$YHnet = (1 - t_{Inc}) YHH \qquad (33)$$

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:

$$CD_i = cles_i . \frac{PRIVCON}{PC_i} \tag{34}$$

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

$$GD_i = gles_i . \frac{GOVCON}{PC_i} \tag{35}$$

It is assumed that the aggregate public consumption is specified to be a constant fraction of aggregate public income:

$$GOVCON = gcrGREV \tag{36}$$

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:

$$GREV = \sum_i t_{Prod,i} PX_i XS_i + \sum_i t_{Sal,i} PC_i CC_i + \sum_i tm_i eP_i^w M_i + \sum_i te_i eP_i^w E_i + t_{Inc} YHH + t_{Corp} \sum_i rK_i + \sum_i NFI^G$$

$$+ \ TOTAL \ Environmental \ Taxes \tag{37}$$

The set of environmental tax/fee instruments are tabulated in Table 6.1 (see main text).

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.

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

$$PSBR = GREV - GCON - GINV - r_P^G e\, ForDebt^G - r^D DomDebt^G - GtrHH - GtrEE - GtrSSI \tag{38}$$

and is either financed by domestic borrowing, ΔDomDebtG or by foreign borrowing ΔeForDebtG.

General Equilibrium

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 i:

$$CC_i = CD_i + GD_i + IDP_i + IDG_i + INT_i \tag{39}$$

that is, the aggregate absorption (domestic supply minus 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:

$$PSAV + GSAV + e\ CAdef = PINV + GINV \qquad (40)$$

The CAdef in the equation above determines the current account balance in foreign exchange terms and equals to the export revenues, the remittances and private and public foreign borrowing 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:

$$\begin{aligned} CAdef &= \sum P_i^W E_i + ROWtrHH + ForBor^E + ForBor^G \\ &- \left[\sum P_i^W M_i + \left(trrow \sum (1 - t_{Corp}) rK_i\right)/e + r^F ForDebt^E + r^F ForDebt^G\right] \end{aligned} \qquad (41)$$

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.

Dynamics

The model updates the annual values of the exogenously specified variables and the policy variables in an attempt to characterize the 2010-2030 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 Hicks-neutral manner, and are introduced exogenously.[54] Urban nominal wage rate is updated by the price level index (PINDEX)[55] which is endogenous to the system.

Finally, at this stage we account for the evolution of debt stocks. First, government's foreign borrowing is taken as a ratio to aggregate PSBR:

$$e\ ForBor^G = (gfborrat)PSBR \qquad (42)$$

Thus, government domestic borrowing becomes:

$$DomBor = (1 - gfborrat)\ PSBR \qquad (43)$$

Having determined the equations for both foreign and domestic borrowing by the government, we establish the accumulation of the domestic and foreign debt stocks of the public sector:

[54] Under the policy scenarios below, productive rates are endogenized through abatement benefits.
[55] Price level index refers to consumer price index. For the reference year, the price level index is assumed as unity (fixed to 1) to calibrate the model based on the CGE literature.

$$DomDebt_{t+1} = DomDebt_t + DomBor_t \quad (44)$$

$$ForDebt^G_{t+1} = ForDebt^G_t + ForBor^G_t \quad (45)$$

Similarly, private foreign debt builds up as:

$$ForDebt^P_{t+1} = ForDebt^P_t + ForBor^E_t \quad (46)$$

TFP increase is one of the drivers of growth; various assumptions held in greening scenarios are detailed in Box 6.2 and 6.4. In the reference scenario, TFP growth is specified as:

$$AX^i_{t+1} = (1 + tfpGR_t)AX^i_t \quad (47)$$

Capital and labor growth follows standard specification as:

$$\overline{K}^S_{t+1} = (1 - dprt)K^S_t + \sum_i \left(IDP_i + IDG_i\right) \quad (48)$$

$$\overline{L}^S_{t+1} = (1 + popgr_t)\overline{L}^S_t \quad (49)$$

Definition of Model Variables and Parameters

ENDOGENOUS VARIABLES

INDICES

i	Commodity
j	Sectors (12)
G	Green activites
SS	Strategic sectors
T	Time
A	Agriculture sector
N	Land
ID	Intermediate input
E	Energy
Prod	Producer
P	Private
F	Foreign
D	Domestic
CO	Coal
PG	Natural gas
EL	Electricity

EXPONENTS

G	Government
M	Imported
E	Exported
S	Supply
D	Demand
INM	Non-energy inputs
ENG	Primary energy inputs
IND	Industry linked

PRICE BLOCK

P_i^m	Domestic Price of Imports
P_i^e	Domestic Price of Exports
e	Exchange Rate (nominal)
PC_i	Composite Price
PD_i	Domestic Price
PX_i	Gross Output Price
PEG_i	Price of Composite Energy Input
$PINDEX$	Price Index

OUTPUT AND FACTORS OF PRODUCTION BLOCK

XS_i	Gross Output Supply
ENG_i	Primary Energy Composite Input
K_i	Capital Demand

L_i	Labor Demand
$ID_{j,i}$	Intermediate Good Demands
NA	Deamnd Demand for aggregate land composite
NRF	Rainfed land
NIR	Irrigated land
LMIG	Labor migration from rural to urban labor market
EWU	Expected urban wage rate
UNEMP	Unemployment
r	Average interest rate
IRW	Irrigated land
FRT	Demand for fertilizer
RNIR	Rental rate of irrigated land
RNRF	Rental rate rain-fed land
$LSUP_{URB}$	*Labor supply urban*
$LSUP_A$	*Agricultural labor*
N_A	*Demand for land*

Specific tax variables are summarized in Table 6.1.

ENVIRONMENTAL POLLUTION AND CO2 TAXES

$CO2EM_i$	CO2 Emissions
$CO_2EM_{j,i}^{INM}$	CO2 Emissions caused by non-primary energy input usage
$CO_2EM_{j,i}^{ENG}$	CO2 Emissions caused by combustion of primary energy inputs
$CO_2EM_i^{IND}$	CO2 Emissions caused by industrial processes
TOTCO2ENG	Total CO2 Emissions from Primary and Non-primary Energy Input Usage
TOTCO2IND	Total CO2 Emissions from Industrial Processes
TOTCO2HH	Total CO2 Emissions from final private consumption by households
TOTCO2	Total CO2 Emissions
$CO2tN_j$	CO2 Tax Rate on Intermediate Input Use of j
CO2tP	CO2 Tax Rate on Sectoral Output
$CO2tC_j$	CO2 Tax Rate on Private Consumption good i
TOTCO2TAX	Total CO2 Emissions Tax

TRADE BLOCK

CC_i	Composite Tradable Good
DC_i	Domestically Produced Good
E_i	Exports
M_i	Imports

INCOME GENERATION AND DEMAND BLOCK

EtrHH	Enterprise Profit Transfers to Households
EERPtrROW	Profit Transfers Abroad
NFI^G	Net Factor Income from Enterprises to Government
YHWnet	Private Household Net Labor Income
YHnet	Net Private Income (Private Disposable Income)

YHH	Private Income

PUBLIC SECTOR BALANCES

GREV	Public Revenues
GPRMBAL	Primary Budget Balance
GTrans	Government Transfers
GCON	Public Consumption
GtrHH	Government Transfers to Households
GtrEE	Government Transfers to Enterprises
GtrSSI	Government Transfers to Social Security Institutions
revSSI	Revenues of Social Security Institutions
SSItrHH	Social Security Institution Transfers to Households

FINANCIAL ACCOUNTS

PSAV	Private Savings
GSAV	Government Savings
$ForDebt^G$	Government Foreign Debt Stock
$DomDebt^G$	Government Domestic Debt Stock
$ForBor^G$	Government Foreign Borrowing

SECTORAL DEMANDS

PRIVCON	Private Consumption
PINV	Private Investment
GINV	Public Investment
CD_i	Private Consumption
GD_i	Government Consumption
IDP_i	Private Investment Demand by Sector of Origin
IDG_i	Government Investment Demand in Sector (i)

MARKET CLEARING

INT_i	Intermediate Input Uses
CAdef	Current Account Deficit
GDP	Gross Domestic Product

EXOGENOUS VARIABLES AND PARAMETERS

PRICE BLOCK

PW_i^m	World Price of Imports
PW_i^e	World Price of Exports
$pwts_i$	Price Weights
t_i^m	Import Tariff
t_i^e	Export Tax Rate
$t_{Sal,i}$	Sales Tax Rate

OUTPUT AND FACTORS OF PRODUCTION BLOCK

$\overline{w}$ Nominal Wage Rate of Formal Labor

$\overline{L}^S$ Total Formal Labor Supply

$\overline{K}^S$ Total Formal Capital Supply

AX_i Production Function Shift Parameter

$\lambda_{K,i}$ Cobb-Douglas Production Function Capital Share Parameter

$\lambda_{L,i}$ Cobb-Douglas Production Function Formal Labor Share Parameter

$\lambda_{ID,j,i}$ Cobb-Douglas Production Function Intermediate Good Share Parameter

$\lambda_{E,i}$ Cobb-Douglas Production Function Energy Share Parameter

$t_{\mathrm{Prod},i}$ Production Tax Rate

AE_i Primary Energy Composite Production Function Shift Parameter

$\kappa_{j,i}$ Primary Energy Composite Production Function Coal Share Parameter ($j = CO, PG, EL$)

ρx_i Primary Energy Composite Production Function Exponent

ENVIRONMENTAL POLLUTION AND CO2 TAXES

$\overline{\varepsilon}_{j,i}$ Coefficient for emissions created by non-primary energy intermediate input usage

$\varpi_{j,i}$ Coefficient for emissions created by primary energy intermediate input usage

$\overline{\delta}_i$ Coefficient for emissions created by industrial processes

$\overline{\psi}_i$ Coefficient for emissions created by final private consumption

TRADE BLOCK

α_i CET Function Shift Parameter

β_i CET Function Share Parameter

ρt_i CET Function Exponent

φ_i Armington Function Shift Parameter

θ_i Armington Function Share Parameter

ρc_i Armington Function Exponent

t_i^m Import Tariff rate

t_i^e Export Tax rate

INCOME GENERATION AND DEMAND BLOCK

$trrow$ Profit Transfers abroad ratio

$shrg_i$ Government Profit ratio

t_{Corp} Corporate Tax rate

t_{Inc} Income Tax rate

$ROWtrHH$ Workers Remittances

Various pollution fees and taxes are summarized in Table 6.1 in Vol1.

PUBLIC SECTOR BALANCES

prbrat	Primary Balance Ratio (of GDP)
gcr	Government Consumption Ratio (of non-interest expenditures)
gtrs	Ratio of Government Total Transfers to Government Revenues
pyrltax	Payroll Tax Rate
sstax	Social Security Premium Paid by Formal Labor
rtgtrhh	Rate of Government Transfers to Households to Total Government Transfers
rtgtree	Rate of Government Transfers to Enterprises to Total Government Transfers

FINANCIAL ACCOUNTS

s^P	Marginal Propensity to Save
r^F	Foreign Interest Rate on Public Debt
r^D	Domestic Interest Rate on Public Debt
$ForBor^E$	Enterprise foreign borrowing
Gfborrat	Government Foreign Borrowing Rate

SECTORAL DEMANDS

s^P	Marginal Propensity to Save
$cles_i$	Sectoral Private Consumption Shares
$gles_i$	Sectoral Government Consumption Shares
$iples_i$	Private Investment Demand Shares
$igles_i$	Government Investment Demand Shares

Annex 2: Description of the CGE Model Calibration and Base Path (2011-2030)

Data

The model is built-around a multi-sectoral social accounting matrix (SAM) of the Turkish economy based on the Turkish Statistical Institute (TurkStat) 2002 Input Output (I/O) Data. The I/O data is re-arranged accordingly to give a structural portrayal of intermediate flows at the intersection of commodities row and activities column in the 12-sector 2010 macro-SAM. Table A2-1 provides the sectoral input-output flows of the macro SAM in correspondence with the TurkStat I/O data.

Table A2.1. Sectoral Aggregation over TURKSTAT 2002 I/O Data

	Sector Aggregation	NACE 1.1 (Code in I/O 2002 Table)
AG	***Agriculture***	01, Agriculture, hunting and related service activities
		02, Forestry, logging and related service activities
		03, Fishing, operating of fish hatcheries and fish farms; service activities incidental to fishing
CO	Coal	04, Mining of coal and lignite; extraction of peat
PG	Crude Oil and Natural Gas	05, Extraction of crude petroleum and natural gas; service activities incidental to oil and gas extraction excluding surveying
PE	Petroleum Products and Chemicals	17, Manufacture of coke, refined petroleum products and nuclear fuels
		18, Manufacture of chemicals and chemical products
		19, Manufacture of rubber and plastic products
CE	Cement	20, Manufacture of other non-metallic mineral products
IS	***Iron and Steel***	21, Manufacture of basic metals
MW	***Machinery and White Goods***	22, Manufacture of fabricated metal products, except machinery and equipment
		23, Manufacture of machinery and equipment n.e.c.
		24, Manufacture of office machinery and computers
ET	***Electronics***	25, Manufacture of electrical machinery and apparatus n.e.c.
		26, Manufacture of radio, television and communication equipment and apparatus
AU	***Auto Industry***	28, Manufacture of motor vehicles, trailers and semi-trailers
EL	Electricity Production	32, Electricity, gas, steam and hot water supply
CN	***Construction***	34, Construction
OE	Other Economy	Others

The Base Path 2011-2030

All alternative policy scenarios analyzed in this report are to be portrayed with respect to a base-path reference scenario. Having calibrated the parameter values, we construct a benchmark growth path for the Turkish economy for the period of 2011-2030, under the following assumptions:

- Constant technology (calibrated parameters in the production functions remain fixed)
- Exogenously determined foreign capital inflows
- Exogenous real interest rates
- Endogenous real exchange rate under the constraint of the current account balance
- Constant nominal wage rate for urban labor
- 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. As a result of reduced interest costs on public domestic debt then, it is gradually reduced to 0.0 by 2020 and is kept at that level over the rest of the base path.

- No specific introduction of environmental policy action/taxation/quota

Furthermore, population growth rate is set at 1% for rural labor until 2020, then to be decreased to 0.7% per annum. Urban labor force is assumed to increase by 0.5% per annum. Migration elasticity parameter, μ, is taken as 0.02 to match historical data on migration as reported in Dudu et.al (2008).

Hicks-neutral productivity growth is assumed at an exogenous rate of 0.5% for agriculture and 0.8% for the non-ag sectors. In some of the scenarios below, we have implemented submodels to create endogeneity of TFP growth in response to health and environmental benefits.

The total available irrigated a land is assumed to expand by 0.5% per annum. Rate of depreciation for physical capital stock is set at 0.20.

Figures A2.1 and A2.2 portray the simulated path of the real gross domestic product and its growth rate under business-as-usual conditions. As observed, the annual real GDP growth rate stays around 5% – 5.5% throughout the 2011-2030 period and the real GDP reaches to a value of 3012 billion TRY (in constant 2010 prices) by 2030.

Such a growth path is projected to generate an aggregate CO2 emission level of 983.7 mtons in 2030. In Figure A2.3 we illustrate the CO2 emissions from sources of energy (fuel combustion), industrial, and agricultural processes, and the household sector. This path follows the historical growth path of CO2 eq. emissions. This path is observed to follow the downward trend of aggregate CO2 eq. emissions per $GDP. Turkish emission intensity was estimated to be on the order of 0.89 kg/$GDP in 1990 to fall to 0.75 kg/$GDP in 2008. Under the base path trajectory, the CO2 eq. intensity is projected to fall to 0.55 kg/$GDP by 2030. This intensity metric in 2030 is observed to be still above the OECD averages (0.55 kg/$GDP in 1990; and 0.42 kg/$GDP in 2008).

Likewise, we can observe that with the projected economic growth, the sectoral emission values follow the growth trend throughout. To portray the evolution, Tables xx present the sectoral CO2 and PM10 emissions from energy combustion for selected years.

As the decomposition analysis of Lise (2006) documents, as in any other relatively fast growing economy, the biggest contributor to the rise in CO2 emissions in Turkey is the expansion of the economy (scale effect). Therefore the growth projections become crucial in the analysis of CO2 emissions. The recent projections of the OECD show that Turkey has an annual growth potential of above 7% (OECD, 2004). UNDP and the World Bank (2003) provide a projection of a six-fold increase in greenhouse gas emissions by 2025 with respect to 1990 level. The study foresees an annual increase of 5.9% in final energy consumption.

The reference base-run path also provides a number of other statistics, such as water waste in industry and the household sector, and industrial waste per output in emission-critical sectors. Figures A2-3 and A2-4 present base path trajectories for CO2 and PM10, and Tables A2-2 and Table A2-3present CO2 and PM10 sector distribution.

Figure A2-1 Base-run Real GDP (billion TL, fixed 2010 prices)

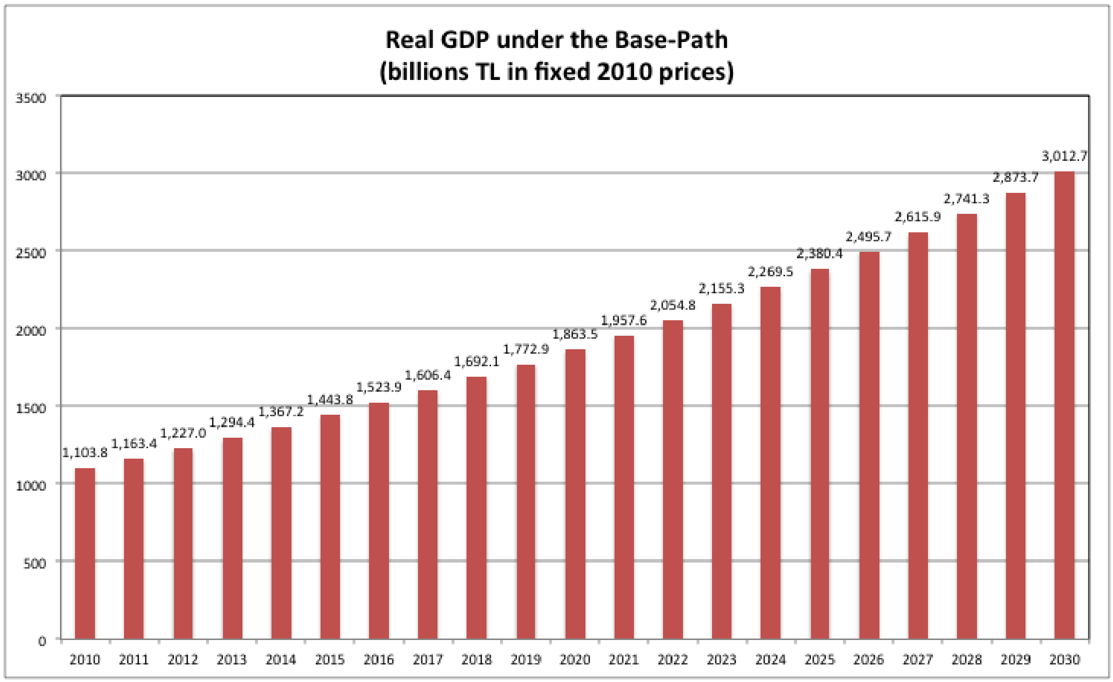

Figure A2-2 Base-Run Real GDP Growth Rate

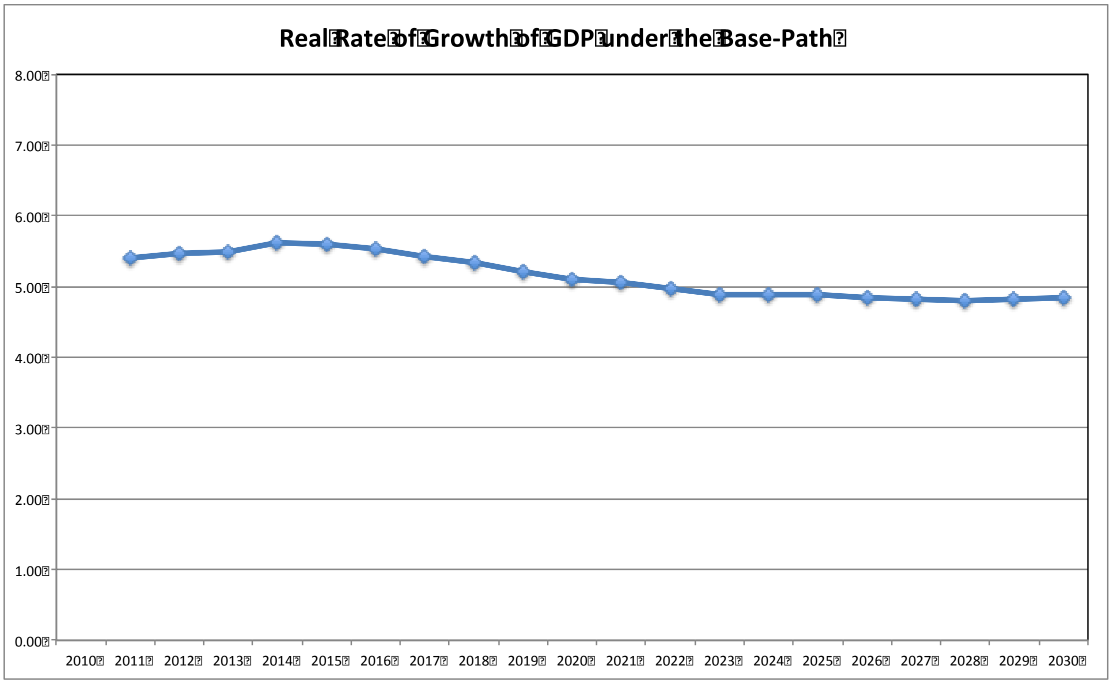

Figure A2-3 Base Run Total CO2 Emissions By Source (million tons) (Model Projections)

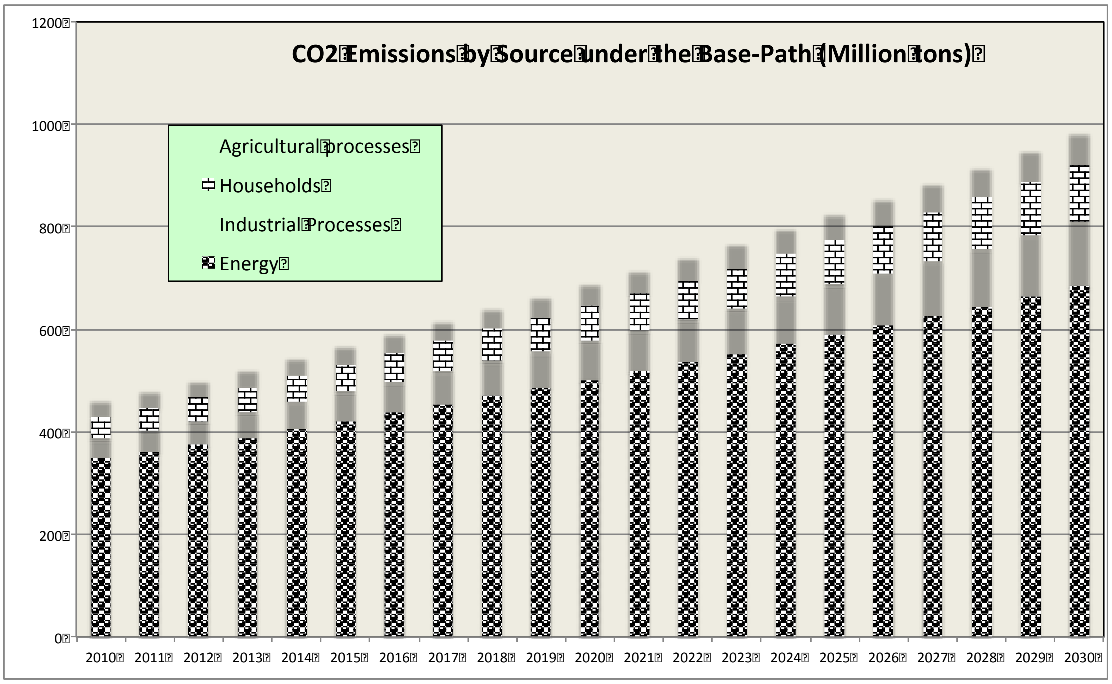

Figure A2-4 Base Run Total PM10 Emissions By Source (million tons)

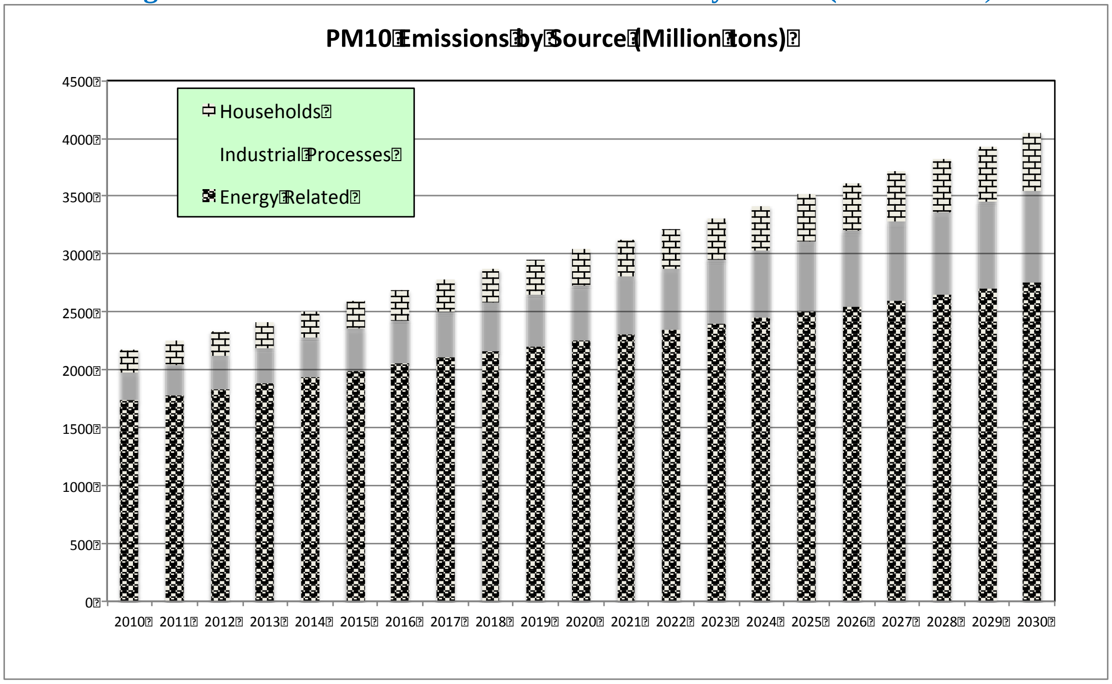

Figure A2-5 Total CO2 and PM10 Emissions as a Ratio to $ GDP (kg / US$, fixed 2010 prices))

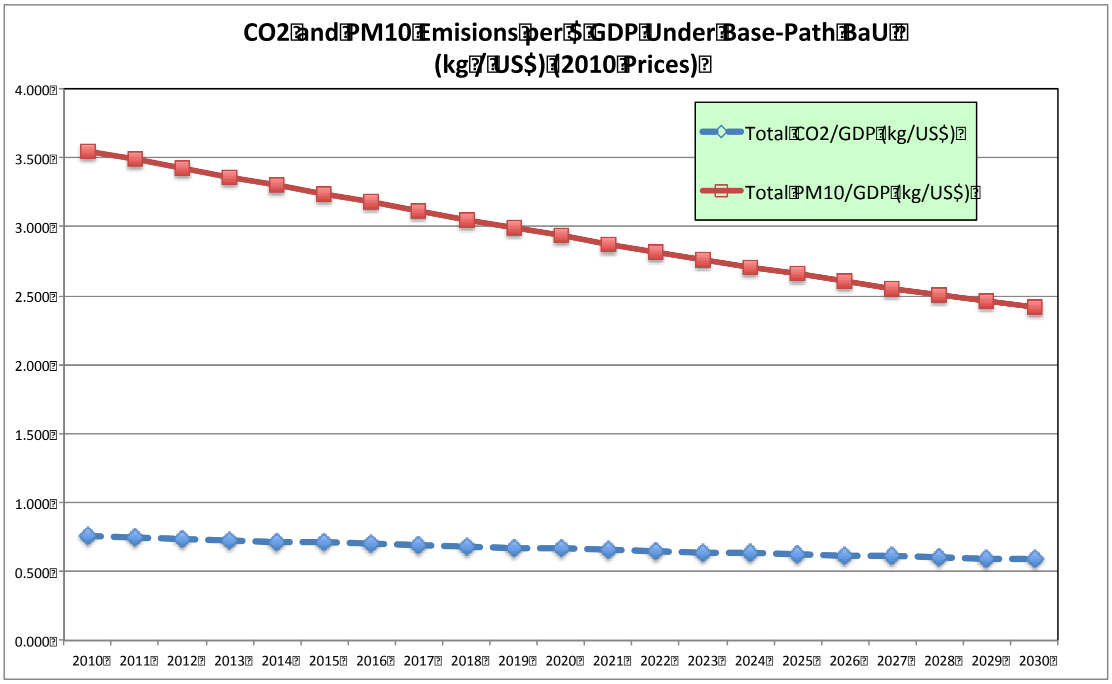

Table A2-2 Energy Related CO2 Emissions by Sectors under Base-Path (million tons)

Sectoral CO2 Emissions from Energy (Million tons CO2 eq.)	2010	2015	2020	2025	2030
Agriculture	21.1	23.1	25.8	28.6	31.6
Coal	10.1	12.7	16.6	21.0	26.3
Petroleum, Gas	9.7	11.7	13.7	15.5	17.2
Petroleum Products	7.0	8.3	9.7	11.3	13.1
Cement	73.0	91.3	105.5	119.2	132.5
Iron and Steel	13.9	21.3	29.7	40.1	53.5
Machinery White Goods	0.9	1.3	1.6	1.9	2.2
Electronics	0.5	0.7	0.9	1.1	1.4
Automotives	0.5	0.8	1.1	1.5	2.0
Electricity	120.7	141.3	169.0	199.7	235.3
Construction	5.7	7.4	8.6	9.7	10.8
Other Economy	85.5	102.0	120.4	139.4	158.9
TOTAL	**348.5**	**421.9**	**502.5**	**588.9**	**685.0**

Table A2-2 Energy Related PM10 Emissions by Sectors under Base-Path (million tons)

Sectoral PM10 Emissions from Energy (Million tons)	2010	2015	2020	2025	2030
Agriculture	97.624	101.706	107.493	113.454	119.079
Coal	46.664	55.774	69.215	83.15	98.896
Petroleum, Gas	44.861	51.56	56.981	61.427	64.883
Petroleum Products	32.578	36.374	40.6	44.89	49.385
Cement	456.585	542.668	595.351	638.452	673.992
Iron and Steel	64.288	93.598	123.907	158.881	201.422
Machinery White Goods	4.285	5.547	6.532	7.444	8.393
Electronics	2.305	3.071	3.761	4.467	5.228
Automotives	2.313	3.402	4.565	5.966	7.622
Electricity	558.63	621.248	705.458	791.452	885.432
Construction	26.291	32.388	35.741	38.287	40.791
Other Economy	395.962	448.593	502.778	552.365	598.065
TOTAL	**1732.4**	**1995.9**	**2252.4**	**2500.2**	**2753.2**

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