**Can Natural Gas Substitution in Transportation Sector Reduce Green House Gases (GHGs) Significantly: An Input-Output Analysis**

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**Abstract**

As Kyoto Protocol runs out in 2012, the wealthy nations have emphasized once again on the development of new climate protocol to address the reduction of GHGs emissions at various conferences of UNFCCC held at Denmark & Mexico. Global warming issue is gaining crucial place in the sustainable development policies of the economically developed countries specially and Turkey as being a developing country is struggling hard to contribute somehow to bring balance among economic, social & environmental goals reflected in her five year development plans.

Basing on the above, this study aims to offer an alternative to Turkey that she can reduce GHGs emissions without a great loss of economic & social goals. By using environmental input-output techniques, this study has simulated a policy scenario of estimating GHGs emissions for transportation sector with the existed pattern of fossil fuel consumption and with substitution of natural gas by 40 percent for each other fossil fuel type for the year 2012. The results show an overall reduction of three GHGs - CO2, N20 & CH4 emissions by 11.81, 8.95 & 19.05 percent and decline in transportation sector by 67.2, 72.31& 69.99 percent for CO2, N2O & CH4 respectively. This study strongly recommends for considering natural gas as an important policy tool for meeting the environmental goals.

Keywords: Transportation Sector, GHG Emissions, Natural Gas & Input-Output Model

**1. INTRODUCTION**

Over the last three decades, sustainable development has remained core debate for international organizations, governments, NGOs, political figures, academicians, researchers, and common public. Countries have responded to the emerging idea of sustainable development, as the overarching goal for environmental policy, by adopting diverse approaches. Different pathways to achieve sustainability depending on various factors, focusing on the interpretation of the concept, political structures, and political priorities were followed including institutional reform, green planning and social mobilization[[1]](#footnote-2) (Mazlum, 2004). Much ado has been done in last few decades like international treaties to address the issue of climate change with special focus on global warming and Kyoto Protocol is the prominent among all treaties. As the Kyoto Protocol runs out in 2012, there is need of a new climate protocol that can keep the countries on the track of sustainable development which was emphasized in the United Nations Climate Change Conference held in Canun, Mexico December 2010. This same issue was discussed one year before in the UNFCCC conference in Copenhagen, Denmark.

Turkey has never left behind in joining the hands with other countries in incorporating the sustainable development in her development plans and planning. Turkey’s economy is growing faster; its transportation sector is even growing faster to meet the demand of the country. Transportation sector plays very important role in the growth of the Turkish economy but this sector contributes too much in GHGs emissions than in the growth of the country. This conflict can be resolved partially by substituting natural gas for other fossil fuel types used in transportation sector

The aim of this study is manifold. Firstly to estimate the sole contribution of GHGs emissions from fossil fuel consumption by the year 2012 from transportation sector by using the input-output table. Secondly, to find out reduction in GHGs emissions after substituting natural gas by 40 percent in this sector for each fossil fuel type for the year 2012. Lastly, this study will give recommendation based on findings in lines with the sustainable development.

**2. SUSTAINABLE DEVELOPMENT & TURKEY**

The ninth development plan (2007-2013) corresponds to an era where globalization is pervasive in all areas and opportunities and risks for individuals, institutions, and nations increase. This Plan has the vision of “*Turkey, a country of information society, growing in stability, sharing more equitably, globally competitive and fully completed her coherence with the European Union”* as well as within the framework of the Long Term Strategy (2001-2023) (SPO, 2006). The goals articulated in Turkey's ninth development plan supported the government policies for long-term sustainable growth across the economy and in the energy sector in particular. The government program for energy security, energy efficiency, and clean energy first supported under the 2009 Programmatic Electricity Development Policy Loan (PEDPL). It is the main objective to supply the energy required for economic and social development in a continuous and secure manner at minimum cost. While meeting the energy demand; keeping environmental damages at the minimum level and using the energy in the most efficient and economical manner at all stages from generation to final consumption were the main aims articulated. In order to increase the supply security, a balanced resource diversification on the basis of primary energy resources and country of origin differentiation was ensured and the share of domestic and renewable energy resources in the production system was aimed to increase to the maximum extent. The other important dimension of “sustainability” was aimed in transportation and particularly in urban modes of transportation. A comprehensive national urban transportation strategy that is sustainable and consistent with energy, environment, economics, housing and land use policies was intended. This strategy was binding for the public sector and indicative for the private sector (SPO, 2006).

The evaluation of development plans reveals that despite the intentions, plans have little real effect in terms of integrating environmental considerations with other policy areas, and even less with regard to achieving environmental sustainability. The NEAP for instance, is actually an environmental strategy using sustainable development as the conceptual framework therefore, it does not attempt to define sustainable development and to set environmental quality targets; it is exclusively concerned with the institutional matters and it proposed measures and actions aimed at increasing institutional capacity (Mazlum, 2004).

Both the development plans and the NEAP deal with sustainability in terms of the environmental component of the concept and they are far from producing a comprehensive policy approach. Obviously, some new institutional and instrumental arrangements have been introduced into policy- making processes, but it is too early to suggest that they created fundamental changes in policy structures. There is an ongoing effort to adjust established policy patterns to meet the demands of sustainable development and Turkey has undertaken the task of promoting sustainability using different instruments; it has adjusted existing mechanisms and tried out new complementary ones. However, all these attempts remain disjointed because they are not implemented basing on a comprehensive policy strategy.

**2.1. Significance of Transportation Sector in Turkish Economy**

***The Economic Role***

Turkey's geographical location establishes links between the East and the West by making the transportation industry crucial for the economic development of the region. In addition, the Customs Union agreement between Turkey and the EU and potential EU membership are important opportunities encouraging new investments in this industry. The transportation industry covers both the transportation and logistics sector, broadly including airlines and airfreight, shipping, road and rail transport and the associated infrastructure and services. This industry generated US$ 3.4 trillion of revenue globally in 2007 and has grown about 6.2% between 2003 and 2007 (ISPA, 2010). By 2012, the global transportation industry is forecast to reach US$ 4.5 trillion growing with 5.4%.

Turkish logistic companies mainly serve the sectors in which most foreign trade is concentrated: these include textiles/garments, automotive, FMCG, retail and food, petrochemicals, machinery production and construction industry (The Consulate General of the Netherlands, 2004). As of 2009 1.1 people were employed in the transportation-communication and storage services in Turkey and the share of the transportation and logistics sector in Turkey’s GDP is estimated between 8-12%. The size of Turkish transportation & logistics industry is determined as US$ 59 billion, while the share of the logistics service supplier market (Third Party Logistics) is estimated as US$ 22 billion in (ISPA, 2010).

Road transport is the major mode of freight and passenger transportation in Turkey: at present 95% of passengers and 90% of goods are conveyed by highway transport. The network of highways has been developed significantly and the relative importance of highways has increased. The planned cost for modernization and construction of roads amounts to TL 37 billion (ISPA, 2010). In Turkey the length of railways is 8,697 km, operated by the General Directorate of Turkish State Railways (TCDD). Since most of the railways are old, the Turkish government aims to modernize the system through various projects. A budget of US$ 23.5 billion is allocated to railway development up to 2023. Turkey has 45 airports, 16 of which serve for international flights. The cost for airport modernization and construction is projected around TL 4 billion.

Turkish Airlines is the largest airline company in the country and the only one with a significant international network. Its shares are traded on the Istanbul Stock Exchange but it is mainly owned by the Turkish State. Turkish Airlines’ sales revenues increased by 26.0% in 2008 compared to 2007 and reached TL 6,123.2 , with 78.0% derived from international flights and 22.0% from domestic flights. The total number of passengers carried grew by 15.1% and reached 22.6 in 2008. In addition, cargo carriage increased by 8.0% to 203,000 tons. With deregulation and liberalization in the sector, several private airline companies have entered the market in recent years. Turkey has a competitive advantage in maritime transport since it is surrounded by seas on three sides and the length of Turkey’s coastal borders is 8,333 kilometers. By August 2008, the Turkish maritime fleet consisted of 1,631 ships and ranks 25th in the world according to the number of ships. Shipping is the most usual method of transportation for Turkey’s exports and imports, with respective shares of 46.0% and 59.1 %. Second to shipping for Turkey’s foreign trade is road transportation, with a share of 41.7 % for exports and 23.6 % for imports. Air transport comes third. In addition to the shipping of foreign trade, maritime transport of individuals is also significant.

***Energy Consumption***

Turkey’s cost of energy imports increased 9% in the first half of 2007 over the previous year to reach USD 14.75 billion. This amount (19% of Turkey’s total imports) caused mainly from natural gas purchases. During the same period, Turkey’s energy exports surged by 23 percent reaching to slightly over USD 2 billion. The imports of oil and oil-based products increased by USD 126 million to reach USD 7.95 billion in the given period and the cost of natural gas imports risen to USD 5.71 billion in the same period after an USD 863 million increase. The purchase of coal from abroad also climbed by USD 234 million to hit USD 1.1 billion. Turkey imported a relatively low amount of electricity in the first six months of the year at just USD 11.1 million. The total energy imports for last year were USD 28.6 billion, whereas the figure for 2005 was USD 21.3 billion. The figure for 2004 was, however, just USD 14.4 billion, and USD 11.6 billion in 2003. The main drive behind this sudden increase were surging oil prices, which climbed to highs of USD 70 per barrel from prior levels of around USD 30 per barrel in a very short time.

**Table: 1. Share of Main Energy Types in International Trade (000 USD)**



Source: TSI (2010).

The amount and share of crude petroleum and natural gas in total imports and exports are presented in Table 1 respectively for the years 2000, 2005 and 2010. Unfortunately it is observed that the share of main energy types in imports has not changed significantly in the last 10 years.

In Table 2, it is observed that, among the production activities in the economy, transportation is the third biggest one in consumption of energy after total industry and dwellings sectors. If the industry is further disaggregated into sub-industries apparently the significance of energy consumption in the transportation sector will be obvious.

**Table: 2. Energy Consumption by Sectors TOE: Tonne of oil equivalent**



Source: TSI (2010).

Table 2 presents the sources of energy used by various sectors including transportation. Various types of energy are given in terms their “oil equivalent”. It is observed that the total oil equivalent energy used by transportation sectors is about 14% of total final energy consumption and about 7% of total energy consumption in the economy. The majority of the energy used by the transportation is composed of diesel oil (about 55%) and it is followed by aviation gasoline and gasoline (less than 9% each).

**3. METHODOLOGY & DATA**

The I-O analysis simply measures the magnitudes of direct and indirect variation in total production caused by changes in the final demand. The solution procedure of the model is summarized through the equations 1 to 5. Given X as the vector of total production (equation 1), it is equal to sum of Ax and Y (final demand vector), where Ax represents the matrix of intermediate demand and A is the matrix of technical coefficients [*aij*] found as in equation 2. In equation 2,  is the sale of ith sector to sector j and  is the total outlay of sector j

 (1)

 (2)

Rearranging equation (1) and simplifying it results in equation 4, in which  is required to be a non-singular matrix in order to find a solution for X. Then by using the Leontief inverse, , total industrial output can be obtained by solving equation 5 with respect to exogenous changes in Y by calculating both direct and indirect effects in the chain of inter-industries linkages.

 (3)

 (4)

 (5)

The I-O model can be used to trace the environmental discharges in an economy, as firstly introduced and used in Leontief . As Leontief pointed out that pollution is the byproduct of economic activities and it has the linear relationship with production (Leontief, 1986). To incorporate environment into input-output analysis equation 8 is introduced.

 (6)

where EBi is the vector of environmental burden of sector i and ebi is the vector of environmental discharges of type iper monetary unit of sector’s output. In order to solve for EBi, simply X in equation 5 is substituted into equation 6. As a result, economic data can be linked with resource use (such as energy and ore consumption) and/or environmental impact categories (such as greenhouse gas emissions, toxic discharges, ozone depletion potential, hazardous or non-hazardous waste), as in equation 7.

 (7)

GHGs emissions have been estimated from fossil fuel consumptions as fossil fuel consumption is the most important source of emissions in the economic activities. This study has used the aggregated input-output table & aggregated environmental input-output table from Bhutto (2007); net calorific values and emissions factors of different fossil fuel are taken from IPCC (2006).

**4. POLICY ANALYSIS**

Transportation sector plays a vital role in Turkish economy for its contribution in growth and as well as in GHGs emissions in the country. This study has developed a policy scenario in which natural gas has been substituted for other fossil fuel types in transportation sector by 40 percent for the year 2012 by using environmental input-output model. Firstly, GHGs emissions will be estimated for the year 2012 for all fossil fuel types in transportation sector and then after GHGs emissions will be estimated by partially 40 percent of each fossil fuel type's equivalent natural gas substitution. This study aims to investigate would there be any significant change in GHGs emissions after the substitution. Real growth rates[[2]](#footnote-3) considering the 1998 as base year prices have been taken to estimate the final demand for the period of 2012.

This policy scenario has following assumptions:

1. All fossil fuel types are perfect substitutes of each other
2. There will be no crucial change in industry-wise production technology till 2012.

The guideline for the substitution of natural gas for other fossil fuel types taken from Bhutto & Cagatay (2008).

**6. RESULTS & DISCUSSIONS**

Table 3 uncovers that if there is no change in production and consumption pattern in Turkey till the period of 2012, then it will emit 307955.13, 3.11 &7.12 thousand tonnes of CO2, N2O & CH4 respectively in the atmosphere from fossil fuels consumption. The highest share comes from energy production and distribution sector that makes 45.15 in CO2, 52.52 in N2O & 34.84 in CH4 respectively. Transport sector takes the second position by contributing 54118.59 thousand tonne of CO2 , 0.39 thousand tonne of N2O & 1.94 thousand tonne of CH4 that make the share in total by 17.57, 12.28 & 27.21 respectively. However, manufacture of coke, refined petroleum prod, basic chemicals, rubber, plastics, glass, ceramic prod., non-metallic minerals, etc. is also very important sector in terms of its sectoral contribution in GHGs emissions i.e. 10.22 percent in CO2, 9.12 percent in N2O & 10.98 percent in CH4.

**Table: 3. GHGs Emissions in 1000 tonnes for 2012 From Fossil Fuel**

|  |  |  |  |
| --- | --- | --- | --- |
| Sectors | CO2 | N2O | CH4 |
| Growing of cereals and other crops n.e.c. | 5526.0042 | 0.0388 | 0.2019 |
| Wheat | 1090.4236 | 0.0077 | 0.0398 |
| Maize | 190.5103 | 0.0013 | 0.0070 |
| Sunflower | 240.2127 | 0.0017 | 0.0088 |
| Cotton | 148.5574 | 0.0010 | 0.0054 |
| Growing of vegetables, horticultural specialties and nursery products | 201.9875 | 0.0014 | 0.0074 |
| Growing of fruit, nuts, beverage and spice crops | 215.0560 | 0.0015 | 0.0079 |
| Farming of animals | 69.1652 | 0.0005 | 0.0025 |
| Agricultural and animal husbandry service activities, except veterinary activities | 18.9971 | 0.0001 | 0.0007 |
| Forestry, logging and related service activities | 288.8347 | 0.0031 | 0.0070 |
| Fishing | 609.5064 | 0.0045 | 0.0217 |
| Mining and quarrying [08-12] | 1603.5215 | 0.0114 | 0.0580 |
| Production, processing and preserving of meat and meat products | 123.1421 | 0.0012 | 0.0024 |
| Processing and preserving of fish and fish products | 13.1709 | 0.0000 | 0.0002 |
| Processing and preserving of fruit and vegetables | 237.5964 | 0.0018 | 0.0089 |
| Manufacture of vegetable and animal oils and fats | 535.7245 | 0.0056 | 0.0113 |
| Manufacture of dairy products | 95.0522 | 0.0008 | 0.0034 |
| Manufacture of grain mill products, starches and starch products | 8.6151 | 0.0001 | 0.0003 |
| Manufacture of prepared animal feeds | 8.6762 | 0.0001 | 0.0001 |
| Manufacture of bakery products | 142.5026 | 0.0006 | 0.0033 |
| Manufacture of sugar | 4038.0844 | 0.0521 | 0.0599 |
| Manufacture of cocoa, chocolate, sugar confert.& other food products n.e.c. | 1062.8675 | 0.0108 | 0.0254 |
| Manufacture of alcoholic, soft drinks and mineral waters[23-24] | 238.4550 | 0.0016 | 0.0082 |
| Manufacture of tobacco products | 69.1133 | 0.0004 | 0.0023 |
| Manufacture of textiles [26-32] | 3856.1542 | 0.0223 | 0.0964 |
| Wood, furniture, paper, publishing [33-37, 67] | 4244.4207 | 0.0317 | 0.1513 |
| Manufacture of fertilizers, pesticides, other agro-chemicals, paints, and varnishes [40-41] | 3306.3807 | 0.0137 | 0.0807 |
| Manufacture of coke, refined petroleum prod, basic chemicals, rubber, plastics, glass, ceramic prod., non-metallic minerals, etc. [38-39, 42-49] | 31472.0907 | 0.2839 | 0.7813 |
| Manufacture of ferrous, non-ferrous metals, various machinary, vehicles, etc. [50-66, 68] | 31355.8340 | 0.3802 | 0.5074 |
| Energy production and distribution [69-70] | 139030.4046 | 1.6359 | 2.4803 |
| Water and Construction [71-72] | 5213.7719 | 0.0348 | 0.1801 |
| Transport [73, 78-81] | 54118.5942 | 0.3856 | 1.9374 |
| Services [74-77, 82-97] | 18581.7000 | 0.1787 | 0.4104 |
| Total | 307955.1275 | 3.1148 | 7.1192 |

Source: Author's Calculations

**Chart 1. GHGs Emissions Sectoral Shares in % for 2012 From Fossil Fuel Consumption**

Source: Author's Calculations

After 40 percent substitution of natural gas for each fossil fuel type in transportation sector for the year 2012, the three GHGs i.e. CO2, N2O & CH4 decreases to 271580.83, 2.84 & 5.76 thousand tonnes respectively and that make overall reduction of 11.81, 8.95 & 19.05 percent from fossil fuel consumption without natural gas substitution. The reduction in GHGs emissions in transportation sector accounts for 67.2, 72.31& 69.99 percent for CO2, N2O & CH4 respectively. The results of GHGs emissions after the 40 percent of natural gas substitution are given in the table 4 given below.

**Table: 4. GHGs Emissions in 1000 tonnes for 2012 From 40 % Natural Gas Substitution in Transportation Sector**

|  |  |  |  |
| --- | --- | --- | --- |
| Sectors | CO2 | N2O | CH4 |
| Growing of cereals and other crops n.e.c. | 5526.00425 | 0.03883 | 0.20191 |
| Wheat | 1090.42355 | 0.00766 | 0.03984 |
| Maize | 190.51027 | 0.00134 | 0.00696 |
| Sunflower | 240.21267 | 0.00169 | 0.00878 |
| Cotton | 148.55744 | 0.00104 | 0.00543 |
| Growing of vegetables, horticultural specialties and nursery products | 201.98749 | 0.00142 | 0.00738 |
| Growing of fruit, nuts, beverage and spice crops | 215.05599 | 0.00151 | 0.00786 |
| Farming of animals | 69.16524 | 0.00049 | 0.00252 |
| Agricultural and animal husbandry service activities, except veterinary activities | 18.99705 | 0.00013 | 0.00069 |
| Forestry, logging and related service activities | 288.83467 | 0.00307 | 0.00702 |
| Fishing | 609.50643 | 0.00446 | 0.02166 |
| Mining and quarrying [08-12] | 1603.52147 | 0.01140 | 0.05802 |
| Production, processing and preserving of meat and meat products | 123.14207 | 0.00122 | 0.00240 |
| Processing and preserving of fish and fish products | 13.17086 | 0.00002 | 0.00022 |
| Processing and preserving of fruit and vegetables | 237.59638 | 0.00177 | 0.00894 |
| Manufacture of vegetable and animal oils and fats | 535.72451 | 0.00556 | 0.01130 |
| Manufacture of dairy products | 95.05217 | 0.00075 | 0.00339 |
| Manufacture of grain mill products, starches and starch products | 8.61514 | 0.00007 | 0.00033 |
| Manufacture of prepared animal feeds | 8.67623 | 0.00012 | 0.00012 |
| Manufacture of bakery products | 142.50263 | 0.00056 | 0.00331 |
| Manufacture of sugar | 4038.08443 | 0.05215 | 0.05994 |
| Manufacture of cocoa, chocolate, sugar confert.& other food products n.e.c. | 1062.86751 | 0.01080 | 0.02539 |
| Manufacture of alcoholic, soft drinks and mineral waters[23-24] | 238.45496 | 0.00161 | 0.00817 |
| Manufacture of tobacco products | 69.11326 | 0.00044 | 0.00227 |
| Manufacture of textiles [26-32] | 3856.15420 | 0.02229 | 0.09645 |
| Wood, furniture, paper, publishing [33-37, 67] | 4244.42071 | 0.03166 | 0.15130 |
| Manufacture of fertilizers, pesticides, other agro-chemicals, paints, and varnishes [40-41] | 3306.38068 | 0.01369 | 0.08067 |
| Manufacture of coke, refined petroleum prod, basic chemicals, rubber, plastics, glass, ceramic prod., non-metallic minerals, etc. [38-39, 42-49] | 31472.09072 | 0.28392 | 0.78134 |
| Manufacture of ferrous, non-ferrous metals, various machinary, vehicles, etc. [50-66, 68] | 31355.83398 | 0.38018 | 0.50738 |
| Energy production and distribution [69-70] | 139030.40457 | 1.63592 | 2.48034 |
| Water and Construction [71-72] | 5213.77186 | 0.03476 | 0.18006 |
| Transport [73, 78-81] | 17744.29186 | 0.10675 | 0.58142 |
| Services [74-77, 82-97] | 18581.69995 | 0.17872 | 0.41039 |
| Total | 271580.83 | 2.84 | 5.76 |

Source: Author's Calculations

Substituting natural gas in transportation sector by 40 percent for other fossil fuel types decreases its contribution and relative share in GHGs emissions to 6.53% in CO2, 3.76% in N2O & 10.09% in CH4. Before policy simulation, this sector was taking second position in all three GHGs emissions but it has taken 5th place in CO2 & N2O emissions and 3rd place in CH4 emissions. Manufacture of coke, refined petroleum prod, basic chemicals, rubber, plastics, glass, ceramic prod., non-metallic minerals, etc. sector has secured 2nd position in the emissions of CO2 & CH2 and 3rd in N2O whereas manufacture of ferrous, non-ferrous metals, various machinery, vehicles, etc. sector has taken 3rd place in CO2 & N2O and 4th place in CH4 emissions. The results are summarized in the chart 2 given below.

**Chart 2. GHGs Emissions Sectoral Shares in % for 2012 From 40 % Natural Gas Substitution in Transportation Sector**

Source: Author's Calculations

**7. CONCLUSION & RECOMMENDATIONS**

The overwhelming size of population has put much stress on the depletion of non-renewable resources of planet earth. Though, many developed countries have put their heads together to resolve how to lessen environmental damages, i.e. biodiversity loss, ozone layer depletion, deforestation, desertification & global warming. Per capita fossil fuel consumption has increased over the last few decades which shows red-signals to the sustainable development of this global village.

Technological revolutions have improved efficiencies for emitting less pollutions in the atmosphere in production activities but still many developing countries are deprived of it; Turkey is also one of them. In Turkey, per capita fossil fuel consumption has increased too over the last decade and if seen industry-wise sectoral share, transportation sector takes significant share. As this sector plays key role in the development and growth of the country and also in the GHGs emissions too.

This study has simulated a policy scenario of estimating GHGs emissions for transportation sector with the existed pattern of fossil fuel consumption and with substitution of natural gas by 40 percent for each other fossil fuel type for the year 2012 by using environmental input-output technique. Results show that total emissions of three GHGs - CO2, N2O & CH4 are 307955.13, 3.11 &7.12 thousand tonnes respectively with the consumption of fossil fuels. Energy production and distribution sector contributes highest share by 45.15 in CO2, 52.52 in N2O & 34.84 in CH4 respectively. The second position is taken by transport sector by contributing the share in CO2, N2O & CH4 by 17.57, 12.28 & 27.21 respectively.

As natural gas is substituted by 40 percent for each fossil fuel type in transportation sector, we find a total decline of emissions by 11.81, 8.95 & 19.05 percent in CO2, N2O & CH4 from fossil fuel consumption; whereas decline in GHGs emissions in transportation sector is 67.2, 72.31& 69.99 percent for CO2, N2O & CH4 respectively. Furthermore, its relative share & contribution in GHGs emissions has changed significantly; its sectoral share is 6.53% in CO2, 3.76% in N2O & 10.09% in CH4 emissions and it has been placed on 5th position in CO2 & N2O and 3rd in CH4 emissions.

Natural gas as a substitute for other fossil fuel types in transportation sector plays a crucial role in meeting the environmental goals specially reductions in GHGs emissions without compromising economic goals. In last few years, natural gas consumption in road transport sector increased drastically especially in Pakistan & India. If Turkey adopts such pattern that is relative increase in the consumption of natural gas in transport sector she will achieve her sustainable development goals.

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1. See Bührs and Aplin (1999) for more information. [↑](#footnote-ref-2)
2. from 1999 to 2010 real growth rates are taken from TSI and for the period of 2011 to 2012 projected real growth rates are taken from State Planning Office (SPO) [↑](#footnote-ref-3)