Economic Input-Output Life Cycle Sustainability Assessment of Electricity Generation in Turkey between 1995 and 2009

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ABSTRACT : The purpose of this paper is to present the sustainability assessment of the electricity sector by using economic input-output life cycle (EIO-LCA) in Turkey, taking into account the environmental, economic and social aspects for the period between 1995 and 2009. In order to evaluate the sustainability of electricity sector, we use some major economic, environmental, and social indicators as sustainability life cycle indicators. The policy scenario is a $1 million increase in output of electricity sector. Results indicates that decrease in emissions of carbon dioxide and air pollutants by almost half according to policy scenario. The main reason for this decline is the use of imported natural gas in the production of electric energy instead of lignite produced by Turkey in this period.

Jel code: Q56; Q53; Q54; D57
Keywords: Sustainability; Air pollution; Climate; Input–Output Tables and Analysis

1995-2009 YILLARI ARASINDA TÜRKİYE'DE ELEKTRİK ÜRETİMİNİN EKONOMİK GİRDİ-ÇIKTI YAŞAM DÖNGÜSÜ SÜRDÜRÜLEBİLİRLİK DEĞERLENDİRMESİ

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ÖZET: Bu çalışmanın amacı, 1995 ve 2009 yılları arasındaki dönemin çevresel, ekonomik ve sosyal yönlerini dikkate alarak, Türkiye'de ekonomik girdi-çıktı yaşam döngüsü (EIO-LCA) kullanarak elektrik sektörünün sürdürülebilirlik değerlendirmesini sunmaktır. Elektrik sektörünün sürdürülebilirliğini değerlendirmek için bazı önemli ekonomik, çevresel ve sosyal göstergeleri sürdürülebilirlik yaşam döngüsü göstergesi olarak kullanıyoruz. Politika senaryosu, elektrik sektörünün üretiminde 1 milyon dolarlık bir artış olarak tasarlanmıştır. Sonuçlar, politika senaryosuna göre karbon dioksit ve hava kirleticilerinin emiliminin neredeyse yarısı kadar azaldığını göstermektedir. Bu düşüşün temel nedeni, Türkiye'nin bu dönemde ürettiği linyit yerine elektrik enerjisi üretiminde ithal edilen doğalgaz kullanılması olarak gösterilebilir.

Jel kodu: Q56;Q53;Q54;D57
Anahtar Kelimeler; sürdürülebilirlik; hava kirliliği; Sera gazları; Girdi-Çıktı Tabloları ve analizi

1. Introduction

Turkish electricity generation is a rapidly growing sector due to strong economic growth, rapid population increase and urbanization, and extension of electrification to the whole country driven by rising per capita electricity demand. Over the past quarter century, the average annual growth rates of electricity generation and demand were both around 6.5% while generation capacity grew by about 6.1%. During the same period, per capita electricity demand grew annually by 6.1%. It is clear that Turkey's electricity is generated mainly from fossil fuels including natural gas, coal, and oil, which accounts for about 79% of total generation in 2014. The major fuel in electricity generation is natural gas (47.9%), followed by coal (30.3%), and at the lower end by fuel oil (0.9%). In Turkey the mix of electricity generation fluctuates each year due to the seasonal nature of the hydro resources and disabled or unavailable old lignite thermal power plants. The Turkey's electricity sector has also significant effects on environment, economy and society. Although it is of great importance to measure and analyze the effects of sustainability on electricity generation, it has not been studied sufficiently.

In this paper, electricity generation sector is evaluated by using a number of economic and environmental indicators such as carbon dioxide emissions, air pollution, water use, value added and employment. Sets of indicators are often used to measure the effects of sustainability. They are flexible, and sometimes some indicators can be added or removed if the set is insufficient. Although there are standard sets of indicators for industrial systems in the literature such as Global Reporting Initiative (2002), IChemE (2002a), Azapagic and Perdan (2000), they have not yet been accepted.

This paper also gives a sustainability assessment of power generation from Turkish fossil fuels, notably brown coal (lignite) and natural gas. Sustainability assessment has positive and negative effects that can predict the entire spectrum of effects. A simple and feasible definition of sustainability in this analysis is as follows: In order to increase sustainability, it is necessary to reduce the negative impacts on economy, environment and society and to develop positive effects. Therefore, measuring effectiveness and labeling them as positive and negative is the first measure of sustainability. Developments that lead to the reduction of adverse effects will increase sustainability. The indicators presented in this article will relate to electricity generation and electricity and gas transmission. The effects analysis of oil, natural gas and coal mining, coal transport, refining of petroleum products is excluded from the analysis.

Sustainability analysis in electricity generation is not only a vital issue for Turkey, but also a vital priority for many other countries in the world and even for all countries. EIO-LCA is

widely used as an important tool in assessing the impact of a sector on sustainable development (even with certain limitations), as it is widely accepted and perfectly adapted to assess environmental, economic and social sustainability (Atilgan and Azapagic;2016). Lin et al. (2012), Fang et al. (2011), Hsieh and Chen(2010), Wiedmann etal. (2010), Ma et al. (2009), Varun et al. (2008), Odeh and Cockerill (2008), Yang et al. (2007), Hondo (2005) are the some well-known examples of economic input-output life-cycle Sustainability Assessment of Electricity Generation.

2. Methodology and Data

Economic Input-Output Life-Cycle Assessment (EIO-LCA) modelling approach is employed to estimate the carbon dioxide emission, air pollution, energy and water use, value added and employment resulting from industrial production in Turkey. EIO-LCA is based on an environmental I/O modeling approach first proposed by Leontief (1941; 1966; 1970).

The EIO-LCA model divides the entire economy into different sectors. The model can be indicated as a set of large tables or matrices with 35 rows and 35 columns with one row and one column for each sector. Tables can represent the total amount of sales from one sector to another, purchases from one sector or the amount of purchases from a sector to generate a dollar from one sector. Figure-1 shows the extended input-output table including many monetary flows between sectors and final users.

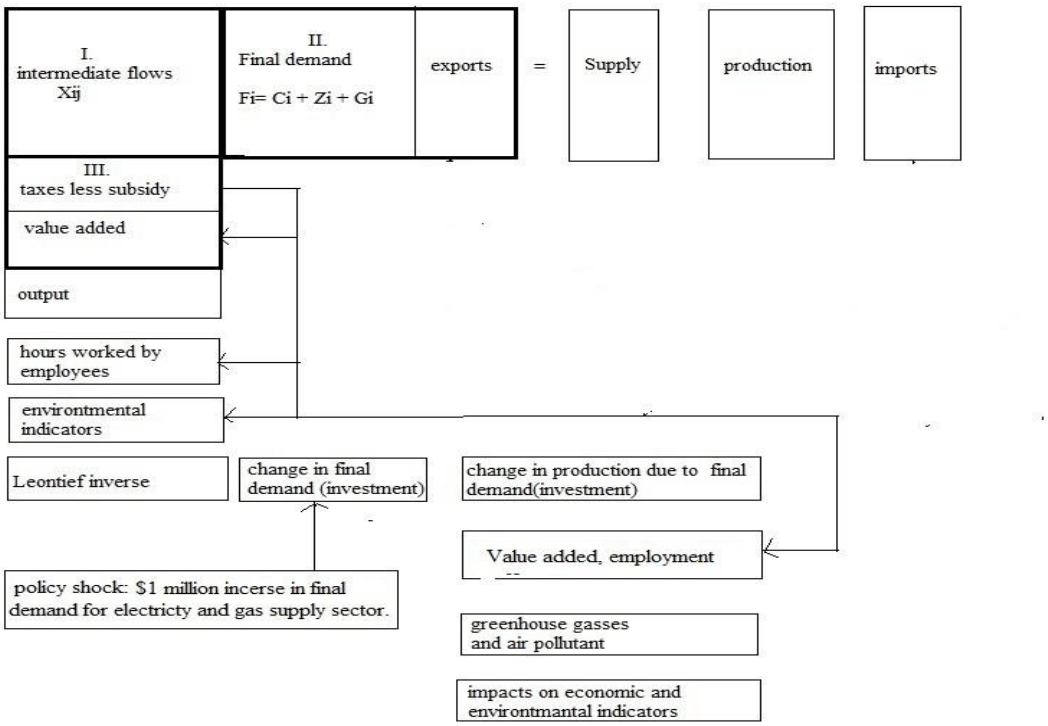


Figure -1: Schematic Overview of Extended Input-Output Analysis

The first flow is known as intermediate flows (X_{ij}). İt has two dimensional matrix describing the purchasing and the selling flows among the economic sectors in the first flow. Second flow has series of column showing the industry deliveries to the household consumption and public expenditure, investments, and exports. These are known as the final demand (Fj) of economy. The third flows are the matrix with the rows that represent the value added including labor and capital incomes associated with production subsidies and taxes.

Input-output tables that show the total supply and demand equilibrium in the economy are known as equilibrium tables, and therefore the rows and columns must be equal. Equation-1 shows this equilibrium.

$$X = (I - A)^{-1}F \qquad (1)$$

In this equation, X refers to the total output of sector, I refers to the unit matrix, A refers to the technology matrix, F represents the final demand. Leontief inverse matrix is represented by $(I - A)^{-1}$. F refers to the final demand including private and government consumption and fixed capital formation.

When we take the first difference of equilibrium equation (1) we obtained equation-2 to make comparative static analysis.

$$\Delta X = (I - A)^{-1}\Delta F \qquad (2)$$

The first difference of ΔX equal to X^f minus X^i. Here, X^f indicates the final value of equilibrium output, X^i indicates the initial value of equilibrium output. Similarly the first difference of ΔF equal to F^f minus F^i. F^f indicates the final value of equilibrium final demand and F^i indicates the initial value of equilibrium final demand. Difference of the inverse matrix is not change because we assume that the technology remains constant. When we added economic and environmental indicator vector of Bi into equation (2) we obtain equation-3 as follows.

$$B_i = R_i X = R_i (I - A)^{-1} F \qquad (3)$$

In this equation, Ri refers to to matrix that has diagonal elements representing the economic and environmental impacts per dollar of output for each process. Equation-4 is the first difference of equation (3) for each period.

$$\Delta B_{i,t} = R_{i,t}\Delta X = R_{i,t} (I - A)^{-1} \Delta F \qquad t=1995,2000,2005,2009 \qquad (4)$$

The policy simulation is employed to make the sustainability assessment of electricity and gas supply sectors in a period of between 1995 and 2009 by using equation-4. The policy simulation is the increase in production of electricity and gas supply sectors by $1 million (see figure-1).

We use World Input-Output Table (Timmer, et al., 2015) as database for this analysis. World Input-Output Database (WIOD) also provides the environmental accounts including CO2 emissions and emissions to air (Aurélien Genty, 2012). Table-1 shows the data sources of all periods.

Table 1: Economic and environmental indicators

	Economic indicators			Environmental indicators		
	Output	Value added	Employment	CO2	Air pollution	Water use
Units	US$, million	US$ Million	million	kilotons	tons	1000 m3
Explanation	Output at basic prices	Compensation of employees, other net taxes on production and gross operating surplus	Total hours worked by employees	Emissions of carbon dioxide	Emissions of methane	
Data source	WIOT, Inter country Input-Output Table for 1995,2000,2005,2009	WIOD Socio Economic Accounts, 1995,2000,2005,2009	WIOD Socio Economic Accounts, 1995,2000,2005,2009	WIOD database, 1995,2000,2005,2009	WIOD database, 1995,2000,2005,2009	WIOD Socio Economic Accounts1995,2000,2005,2009

3. Results

Carbon dioxide emission in Table-2 and air pollution in Table-3 in Appendix as an environmental impacts per unit of economic output have been calculated for the period of 1995 and 2009 by increasing in output for electricity and gas supply sector by $1 million policy. According to Table 2, an increase of 1 million dollars in the output of the electricity

generation sector causes 7,8 kg per dollar in 1995, 8 kg in 2000, 3.7 kg in 2005 and 4.3 kg in 2009 in this sector.
Increasing in carbon dioxide emissions per dollar for each period in the electricity generation sector and the increase in the output of this sector are shown in Figure-2.

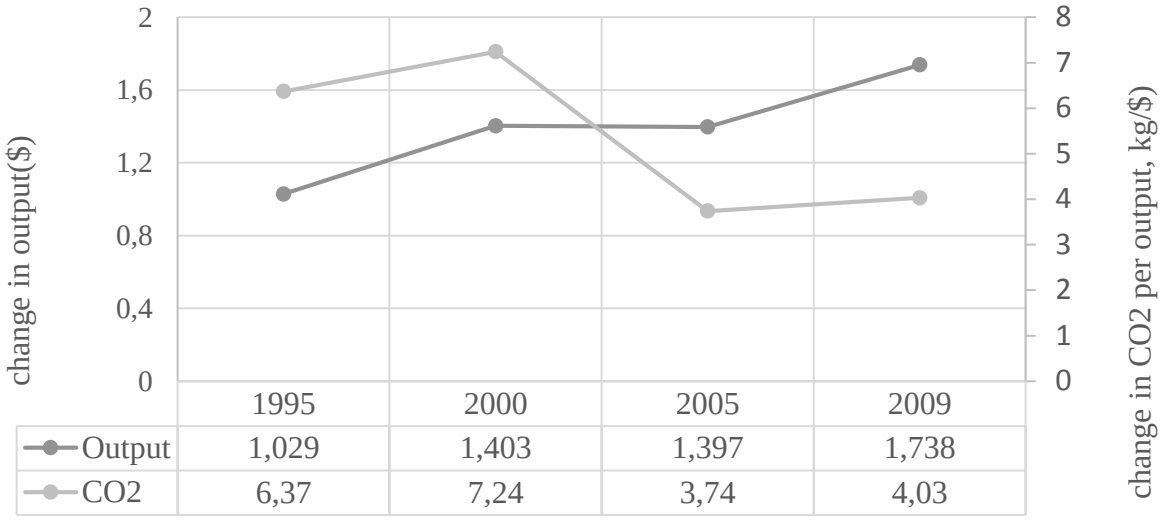
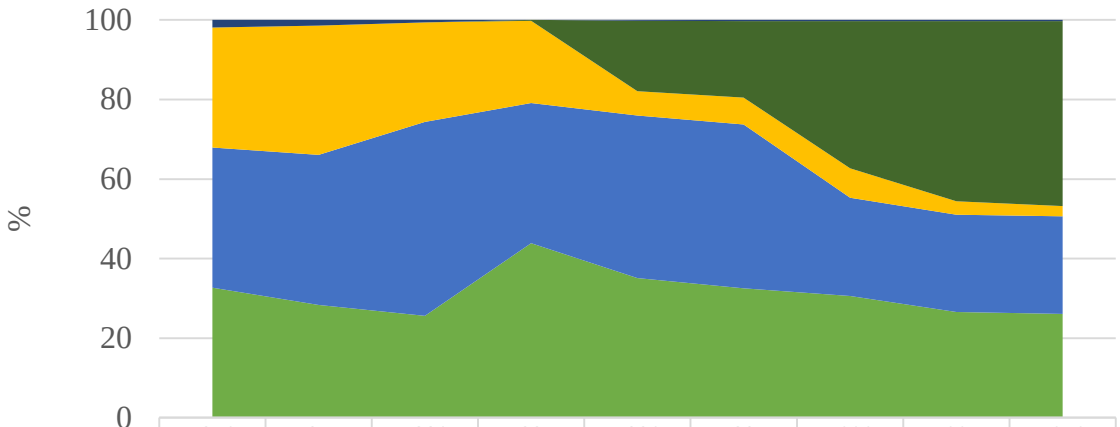


Figure-2: Change in CO2

To begin with in 1995, it is sufficient to look at Fgure-3 to explain how the amount of carbon dioxide per dollar of electricity production between 2000 and 2005 falls from 7 to 4 kilograms. In this period, we can say that the share of coal in the electricity production decreased from 30 percent to 26 percent, whereas the share of natural gas increased from 19 percent in 2000 to 37 percent in 2000 and to 45 percent in 2005.

It is known that coal burns more carbon dioxide emissions than natural gas. According to Intergovernmental Panel on Climate Change (IPCC), Fourth Assessment Report (AR4), carbon dioxide factor of lignite, which is mostly used by Turkey for electricity generation, is 97.8 kg CO2 per mmBtu, whereas the carbon dioxide factor of the natural gas used is 53.06 kg CO2 per per mmBtu.



	1970	1975	1980	1985	1990	1995	2000	2005	2010
Renewable	1,9	1,4	0,6	0	0,2	0,3	0,3	0,3	0,3
Natural Gas				0,2	17,7	19,2	37,00	45,3	46,5
Oil	30,2	32,5	25	20,7	6,1	6,8	7,4	3,4	2,6
Hydro	35,2	37,8	48,8	35,2	40,9	41,2	24,7	24,4	24,5
Coal	32,7	28,3	25,6	43,9	35,1	32,5	30,6	26,6	26,1

Figure-3: Development of Electricity generation by share of primary energy source

In this work, air pollution consists of energy related and non-energy related harmful gases. These gases have the environmental impact areas of global warming (CO2, N2O, CH4), acidification (SO2, NOX, NH3) and tropospheric ozone formation (CO NMVOC, CH4, NOx). The results of air emissions are given in Table A-3 in Appendix. While a $ 1 million increase in the electricity generation and gas distribution sector was 123 grams per dollar in this sector in 1995, this amount is seen in Figure-4, which fell to 22 grams in 2005 and 25 grams in 2009, as it is in carbon dioxide emissions.

	1995	2000	2005	2009
Output	1,029	1,403	1,397	1,738
Air pollution	123	126	22	25

Figure-4: Change in air pollution

The other environmental impact of increasing output of electricity generation and gas supply by $1 million can be estimated by use of water. Water use in power plants involves two components: withdrawal and consumption. Water withdrawal is the act of removing water from a local water source; it can be returned to the withdrawn water source or cannot be taken or made ready for use elsewhere. Water consumption is used in such a way that the water in a plant cannot be returned because it usually disappears with evaporation.

On the other hand, water withdrawal by power plants can become a major challenge when drought or other water stress is experienced, even if the water is not only available in the required volumes or at the required temperatures. Numerous cooling water can be caught and killed by insect larvae and other organisms, drawn by pump and piping systems.

A report from the US Department of Energy (2010) identified a total of 347 coal-fired power plants (from the analysis set of 580 plants) vulnerable to water demand and / or water supply concerns. For this reason, it is important to understand the water footprint of different electricity generation technologies.

Database of this analysis covers the use of water (measured in 1000 m3) distinguishing different types: First, blue water refers to consumption of surface and ground water, second, green water is the volume of rainwater consumed, mainly in crop production, and third, gray water is the volume of freshwater that is required to assimilate the load of pollutants based on existing ambient water quality standards.

The increase in water use in this sector is given when Table in Appendix shows an increase of $ 1 million in electricity generation and gas distribution sector production. Figure-5 shows that 1486 liters in 1995, 936 liters in 2000 and 568 liters of water in 2005 and 390 in 2009 are required.

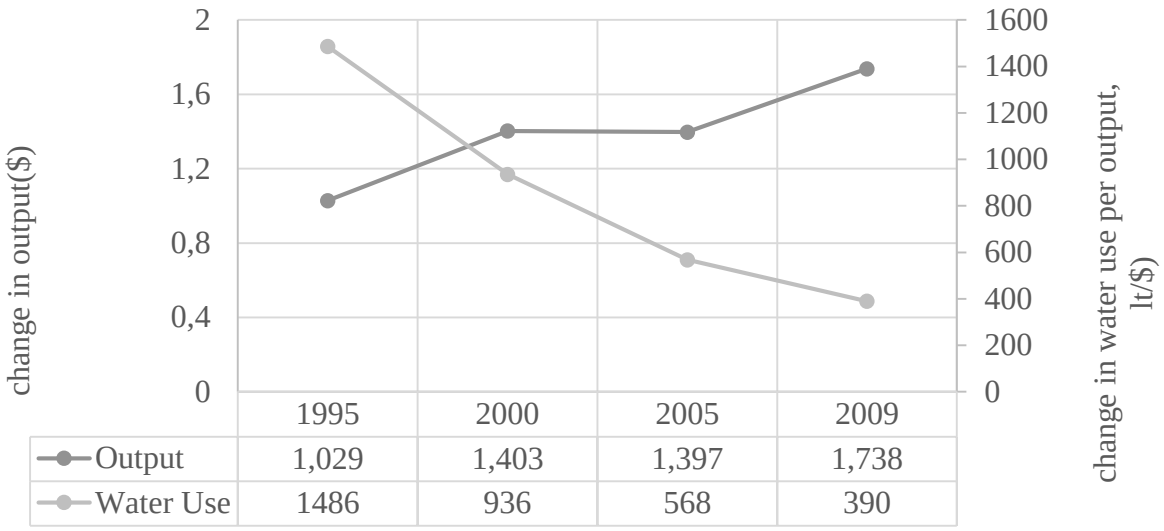


Figure-5: Change in water use

Energy use (TJ) in this work relates to energy emissions and relates to the use of gross energy but excludes energy use of energy commodities (eg, naphtha for plastic production, asphalt for road construction) and energy goods for conversion (eg coke and coke oven converted coal gas, to avoid double counting of emissions). Emissions-related energy use is a direct link between energy use and energy-related emissions. Table A-5 in appendix shows the energy use of the $ 1 million electricity generation and gas distribution sectors in the sectors. According to Figure-6, While 108 MJ is required for electricity generation per dollar in 1995, only 66 MJ in 2005 and 68 MJ in 2009 are required.

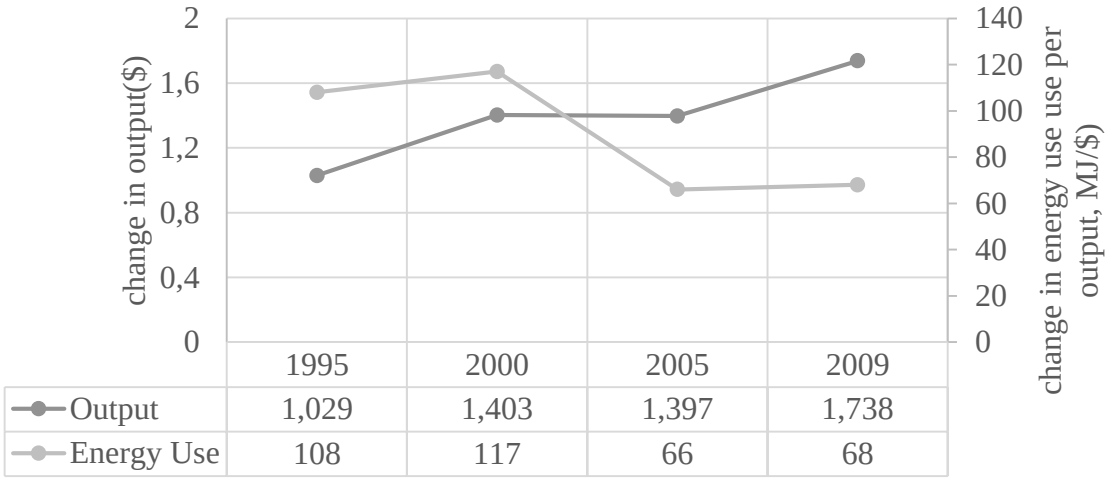


Figure-6: Change in energy use

The remaining two indicators relate to economic and socio economic sustainability. One of them is economic indicator represented by value added for sectors. As a policy scenario, an increase of $ 1 million on the output of the electricity generation sector has increased the value added in the economic sectors.(see Table A-6 in appendix) The value added are defined as the total of compensation of employees, other net taxes on production and gross operating surplus. According to the results of the value added analysis in Figure-7, electricity generation per dollar in 1995 produced an added value of 0,7 TL, this ratio decreased to 0,55 TL in the year 2000 and then 0,55 TL in 2005. In 2009, it increased again to 0,65 TL.

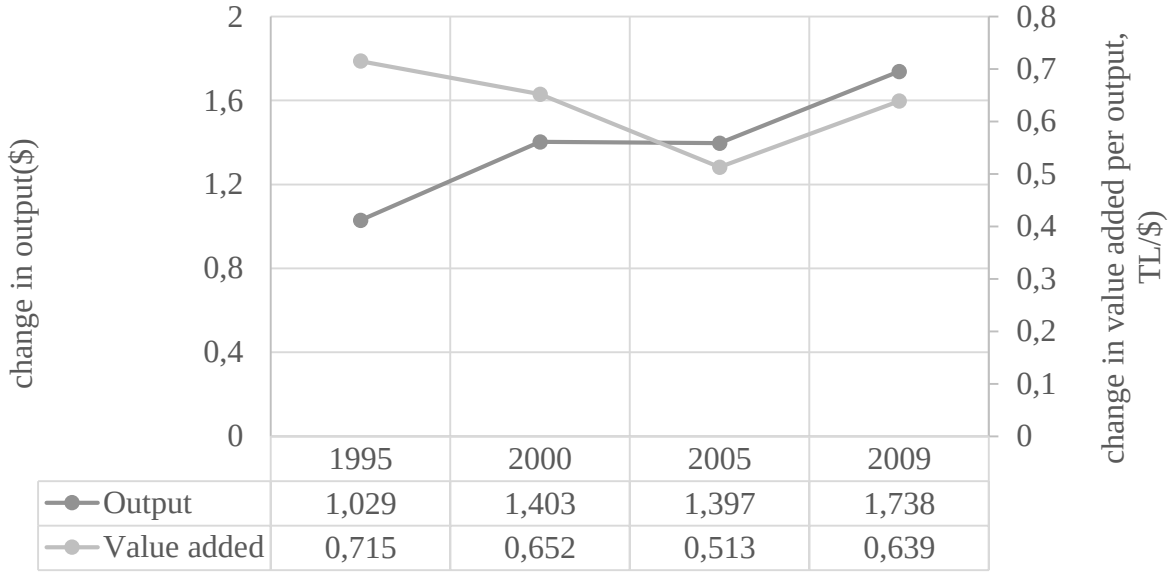


Figure-7: Change in value added

According to Figure-8, which is obtained from the results of the table, the employment values fall from 5 persons per 1000 dollars in 2005 to 20 persons per 1000 dollars in 1995. It continues unchanged from 2005 until 2009. Last indicator is related to socio economic indicator represented by employment measured by number of employees (thousands) for each sector. Table A-7 in appendix give the results of employment according to scenario of analysis.

The decline in employment is due to the start of the use of natural gas instead of carrots in electricity generation in this period. The coal calorie used in electricity generation in Turkey is low, moist and mostly dusty. Because it has rich lignite deposits, it increases employment when it produces it domestically. The substitution of lignite for natural gas has almost negatively impacted on employment as it imports almost all of it (95 per cent). We can say that besides employment, it also has an adverse effect on the current account deficit. However, this is not covered here because it is not covered by this study.

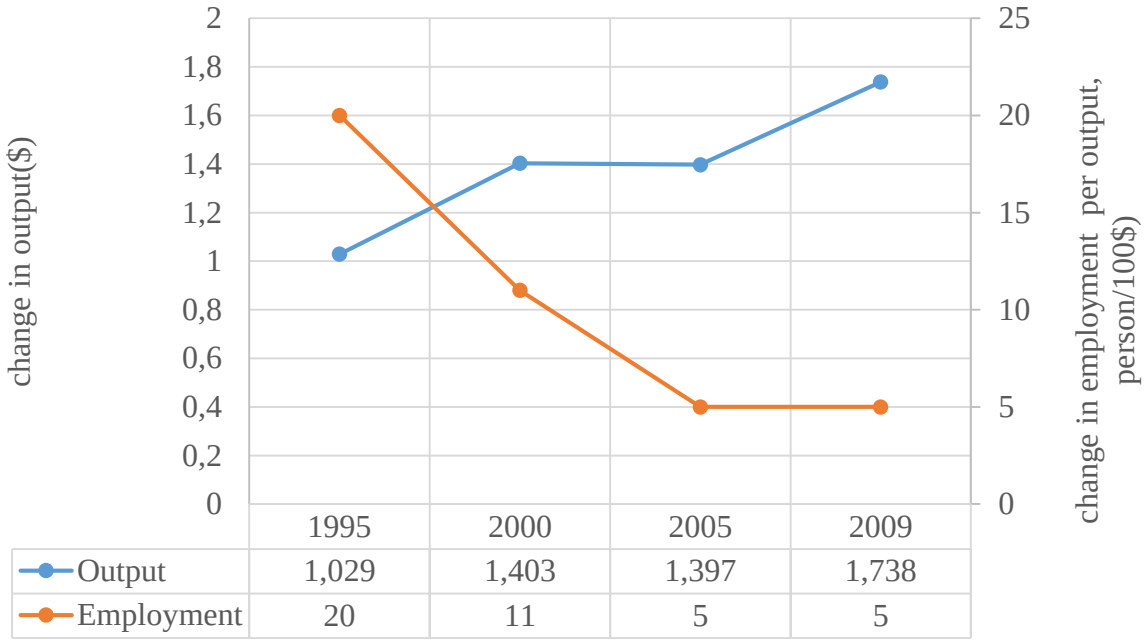


Figure-8: Change in employment

4. Conclusion

In this paper, we presented the development and some initial applications of a national economic input–output lifecycle assessment (EIO–LCA) model for Turkey's electricity generation and natural gas supply sectors for the period between 1995 and 2009. Some selected environmental, economic, and socio economic indicators are used for sustainability assessment.

It is seen that in the Turkish economy, there is a decrease in emissions of carbon dioxide and air pollutants by almost half when there is a $ 1 million increase in the policy scenario at the output of the electricity generation and gas distribution sector. The main reason for this decrease is the fact that Turkey uses imported natural gas instead of lignite produced domestically in electricity generation during this period. This change in the fuel choice in the sector reflects positively on environmental sustainability indicators but negatively on economic sustainability indicators (value added and employment). Policy makers seeking economic growth without environmental sustainability are faced with this trade-off.

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APPENDIX

Table A-2: Change in CO2 for $1 million output for electricity generation

	CO2 kg/$			
	1995	2000	2005	2009
Agriculture, Hunting, Forestry and Fishing	0,001	0,000	0,000	0,001
Mining and Quarrying	0,007	0,005	0,004	0,008
Food, Beverages and Tobacco	0,000	0,000	0,000	0,000
Textiles and Textile Products	0,000	0,000	0,000	0,001
Leather, Leather and Footwear	0,000	0,000	0,000	0,000
Wood and Products of Wood and Cork	0,000	0,002	0,001	0,000
Pulp, Paper, Paper , Printing and Publishing	0,001	0,001	0,000	0,000
Coke, Refined Petroleum and Nuclear Fuel	0,023	0,006	0,002	0,006
Chemicals and Chemical Products	0,002	0,003	0,002	0,001
Rubber and Plastics	0,000	0,002	0,001	0,001
Other Non-Metallic Mineral	0,003	0,011	0,003	0,007
Basic Metals and Fabricated Metal	0,004	0,009	0,003	0,003
Machinery, Nec	0,000	0,001	0,000	0,000
Electrical and Optical Equipment	0,000	0,001	0,000	0,000
Transport Equipment	0,000	0,000	0,000	0,000
Manufacturing, Nec; Recycling	0,000	0,000	0,000	0,000
Electricity, Gas and Water Supply	6,561	7,228	3,743	4,026
Construction	0,000	0,002	0,001	0,001
Sale ofMotor vehicle and Fuel	0,000	0,000	0,000	0,001
Wholesale Trade and Commission Trade	0,000	0,001	0,000	0,002
Retail Trade, Repair of Household Goods	0,000	0,001	0,000	0,002
Hotels and Restaurants	0,000	0,000	0,000	0,000
Inland Transport	0,007	0,004	0,002	0,005
Water Transport	0,006	0,006	0,004	0,008
Air Transport	0,001	0,002	0,001	0,001
Other Supporting and Auxiliary Transport Act.	0,000	0,000	0,000	0,000
Post and Telecommunications	0,000	0,000	0,000	0,000
Financial Intermediation	0,000	0,000	0,000	0,000
Real Estate Activities	0,000	0,000	0,000	0,000
Renting of M&Eq and Other Business Activities	0,000	0,000	0,000	0,000
Public Admin and Defence; Comp. Soc. Security	0,000	0,000	0,000	0,000
Education	0,000	0,000	0,000	0,000
Health and Social Work	0,000	0,000	0,000	0,000
Other Community, Social and Personal Services	0,000	0,000	0,000	0,000
Private Households with Employed Persons	0,000	0,000	0,000	0,000
	6,618	7,286	3,771	4,076

Table A-3: Change in air polltion for $1 million output for electricity generation

	Air pollution			
	1995	2000	2005	2009
Agriculture, Hunting, Forestry and Fishing	0,079	0,052	0,056	0,152
Mining and Quarrying	0,745	0,308	0,188	0,801
Food, Beverages and Tobacco	0,005	0,004	0,001	0,005
Textiles and Textile Products	0,010	0,009	0,005	0,015
Leather, Leather and Footwear	0,000	0,000	0,000	0,000
Wood and Products of Wood and Cork	0,007	0,025	0,010	0,004
Pulp, Paper, Paper , Printing and Publishing	0,037	0,017	0,004	0,006
Coke, Refined Petroleum and Nuclear Fuel	3,527	0,493	0,072	0,818
Chemicals and Chemical Products	0,029	0,054	0,023	0,030
Rubber and Plastics	0,003	0,029	0,014	0,020
Other Non-Metallic Mineral	0,014	0,073	0,009	0,034
Basic Metals and Fabricated Metal	0,120	0,178	0,038	0,065
Machinery, Nec	0,003	0,014	0,004	0,003
Electrical and Optical Equipment	0,003	0,018	0,006	0,008
Transport Equipment	0,001	0,004	0,001	0,001
Manufacturing, Nec; Recycling	0,002	0,001	0,000	0,001
Electricity, Gas and Water Supply	129,822	125,671	22,239	24,630
Construction	0,001	0,067	0,013	0,034
Sale of Motor vehicle and Fuel	0,005	0,006	0,005	0,014
Wholesale Trade and Commission Trade	0,014	0,013	0,008	0,027
Retail Trade, Repair of Household Goods	0,011	0,011	0,006	0,022
Hotels and Restaurants	0,001	0,002	0,001	0,005
Inland Transport	0,613	0,167	0,041	0,148
Water Transport	1,747	3,439	0,958	0,060
Air Transport	0,021	0,017	0,009	0,024
Other Supporting and Auxiliary Transport Act.	0,003	0,005	0,002	0,005
Post and Telecommunications	0,005	0,003	0,002	0,004
Financial Intermediation	0,007	0,008	0,002	0,006
Real Estate Activities	0,000	0,000	0,000	0,001
Renting of M&Eq and Other Business Activities	0,002	0,002	0,001	0,004
Public Admin and Defence; Comp. Social Security	0,000	0,000	0,000	0,000
Education	0,001	0,000	0,000	0,000
Health and Social Work	0,000	0,000	0,000	0,001
Other Community, Social and Personal Services	0,176	0,287	0,120	0,211
Private Households with Employed Persons	0,000	0,000	0,000	0,000
	137,016	130,976	23,839	27,159

Table A-4: Change in water use for $1 million output for electricity generation

	Water			
	1995	2000	2005	2009
Agriculture, Hunting, Forestry and Fishing	4,468	3,690	2,343	5,227
Mining and Quarrying	0,000	0,000	0,000	0,000
Food, Beverages and Tobacco	0,003	0,002	0,002	0,003
Textiles and Textile Products	0,010	0,018	0,025	0,088
Leather, Leather and Footwear	0,000	0,000	0,000	0,000
Wood and Products of Wood and Cork	0,000	0,000	0,000	0,000
Pulp, Paper, Paper , Printing and Publishing	0,056	0,116	0,097	0,176
Coke, Refined Petroleum and Nuclear Fuel	0,000	0,000	0,000	0,000
Chemicals and Chemical Products	0,011	0,023	0,025	0,055
Rubber and Plastics	0,000	0,000	0,000	0,000
Other Non-Metallic Mineral	0,140	0,621	0,281	0,511
Basic Metals and Fabricated Metal	0,108	0,360	0,165	0,150
Machinery, Nec	0,000	0,000	0,000	0,000
Electrical and Optical Equipment	0,000	0,000	0,000	0,000
Transport Equipment	0,000	0,000	0,000	0,000
Manufacturing, Nec; Recycling	0,000	0,000	0,000	0,000
Electricity, Gas and Water Supply	1486,378	936,147	568,079	390,902
Construction	0,000	0,000	0,000	0,000
Sale ofMotor vehicle and Fuel	0,000	0,000	0,000	0,000
Wholesale Trade and Commission Trade	0,000	0,000	0,000	0,000
Retail Trade, Repair of Household Goods	0,000	0,000	0,000	0,000
Hotels and Restaurants	0,000	0,000	0,000	0,000
Inland Transport	0,000	0,000	0,000	0,000
Water Transport	0,000	0,000	0,000	0,000
Air Transport	0,000	0,000	0,000	0,000
Other Supporting and Auxiliary Transport Activities	0,000	0,000	0,000	0,000
Post and Telecommunications	0,000	0,000	0,000	0,000
Financial Intermediation	0,000	0,000	0,000	0,000
Real Estate Activities	0,000	0,000	0,000	0,000
Renting of M&Eq and Other Business Activities	0,000	0,000	0,000	0,000
Public Admin and Defence; Comp. Social Security	0,000	0,000	0,000	0,000
Education	0,000	0,000	0,000	0,000
Health and Social Work	0,000	0,000	0,000	0,000
Other Community, Social and Personal Services	0,000	0,000	0,000	0,000
Private Households with Employed Persons	0,000	0,000	0,000	0,000
	1491,174	940,976	571,018	397,111

Table A-5 Change in energy for $1 million output for electricity generation

	Energy Use			
	1995	2000	2005	2009
Agriculture, Hunting, Forestry and Fishing	0,007	0,006	0,004	5,227
Mining and Quarrying	0,132	0,080	0,064	0,000
Food, Beverages and Tobacco	0,004	0,004	0,002	0,003
Textiles and Textile Products	0,007	0,010	0,007	0,088
Leather, Leather and Footwear	0,000	0,000	0,000	0,000
Wood and Products of Wood and Cork	0,006	0,023	0,012	0,000
Pulp, Paper, Paper , Printing and Publishing	0,023	0,018	0,007	0,176
Coke, Refined Petroleum and Nuclear Fuel	0,342	0,085	0,023	0,000
Chemicals and Chemical Products	0,018	0,044	0,033	0,055
Rubber and Plastics	0,003	0,031	0,020	0,000
Other Non-Metallic Mineral	0,008	0,052	0,009	0,511
Basic Metals and Fabricated Metal	0,082	0,173	0,064	0,150
Machinery, Nec	0,002	0,015	0,006	0,000
Electrical and Optical Equipment	0,002	0,019	0,009	0,000
Transport Equipment	0,001	0,004	0,001	0,000
Manufacturing, Nec; Recycling	0,002	0,001	0,001	0,000
Electricity, Gas and Water Supply	108,702	116,950	66,265	390,902
Construction	0,000	0,024	0,010	0,000
Sale ofMotor vehicle and Fuel	0,004	0,008	0,008	0,000
Wholesale Trade and Commission Trade	0,011	0,014	0,011	0,000
Retail Trade, Repair of Household Goods	0,011	0,011	0,007	0,000
Hotels and Restaurants	0,002	0,003	0,002	0,000
Inland Transport	0,101	0,056	0,025	0,000
Water Transport	0,083	0,078	0,053	0,000
Air Transport	0,007	0,022	0,013	0,000
Other Supporting and Auxiliary Transport Act.	0,002	0,005	0,002	0,000
Post and Telecommunications	0,003	0,004	0,003	0,000
Financial Intermediation	0,008	0,011	0,003	0,000
Real Estate Activities	0,000	0,001	0,000	0,000
Renting of M&Eq and Other Business Activities	0,002	0,003	0,002	0,000
Public Admin and Defence; Comp. Soc. Security	0,000	0,000	0,000	0,000
Education	0,000	0,000	0,000	0,000
Health and Social Work	0,000	0,000	0,000	0,000
Other Community, Social and Personal Services	0,001	0,002	0,001	0,000
Private Households with Employed Persons	0,000	0,000	0,000	0,000
	109,580	117,755	66,667	397,111

Table A-6: Change in value added for $1 million output for electricity generation

	Value Added (TL/$)			
	1995	2000	2005	2009
Agriculture, Hunting, Forestry and Fishing	0,001	0,001	0,001	0,002
Mining and Quarrying	0,022	0,008	0,011	0,065
Food, Beverages and Tobacco	0,001	0,000	0,000	0,001
Textiles and Textile Products	0,001	0,001	0,001	0,004
Leather, Leather and Footwear	0,000	0,000	0,000	0,000
Wood and Products of Wood and Cork	0,001	0,000	0,000	0,000
Pulp, Paper, Paper , Printing and Publishing	0,002	0,002	0,001	0,002
Coke, Refined Petroleum and Nuclear Fuel	0,034	0,005	0,001	0,001
Chemicals and Chemical Products	0,001	0,001	0,001	0,003
Rubber and Plastics	0,000	0,001	0,001	0,001
Other Non-Metallic Mineral	0,001	0,001	0,001	0,001
Basic Metals and Fabricated Metal	0,003	0,005	0,002	0,003
Machinery, Nec	0,001	0,003	0,002	0,002
Electrical and Optical Equipment	0,001	0,005	0,003	0,005
Transport Equipment	0,000	0,001	0,000	0,000
Manufacturing, Nec; Recycling	0,001	0,000	0,000	0,000
Electricity, Gas and Water Supply	0,715	0,652	0,513	0,639
Construction	0,000	0,002	0,002	0,003
Sale ofMotor vehicle and Fuel	0,006	0,005	0,004	0,009
Wholesale Trade and Commission Trade	0,015	0,014	0,010	0,024
Retail Trade, Repair of Household Goods	0,009	0,012	0,010	0,024
Hotels and Restaurants	0,001	0,001	0,001	0,002
Inland Transport	0,018	0,013	0,011	0,029
Water Transport	0,002	0,002	0,002	0,003
Air Transport	0,000	0,000	0,000	0,000
Other Supporting and Auxiliary Transport Act.	0,000	0,002	0,002	0,005
Post and Telecommunications	0,001	0,002	0,002	0,004
Financial Intermediation	0,011	0,020	0,006	0,017
Real Estate Activities	0,001	0,003	0,002	0,008
Renting of M&Eq and Other Business Activities	0,004	0,010	0,007	0,020
Public Admin and Defence; Comp. Soc. Security	0,000	0,000	0,000	0,000
Education	0,000	0,000	0,000	0,000
Health and Social Work	0,000	0,000	0,000	0,000
Other Community, Social and Personal Services	0,001	0,001	0,001	0,001
Private Households with Employed Persons	0,000	0,000	0,000	0,000
	0,854	0,774	0,597	0,883

Table A-7: Change in employment for $1 million output for electricity generation

	Employment (person per $1000)			
	1995	2000	2005	2009
Agriculture, Hunting, Forestry and Fishing	0,023	0,015	0,011	0,021
Mining and Quarrying	1,245	0,237	0,226	0,680
Food, Beverages and Tobacco	0,034	0,027	0,011	0,020
Textiles and Textile Products	0,081	0,076	0,067	0,176
Leather, Leather and Footwear	0,009	0,004	0,003	0,006
Wood and Products of Wood and Cork	0,043	0,034	0,011	0,011
Pulp, Paper, Paper , Printing and Publishing	0,085	0,077	0,041	0,062
Coke, Refined Petroleum and Nuclear Fuel	0,085	0,024	0,003	0,006
Chemicals and Chemical Products	0,032	0,048	0,027	0,041
Rubber and Plastics	0,023	0,065	0,034	0,062
Other Non-Metallic Mineral	0,025	0,080	0,026	0,046
Basic Metals and Fabricated Metal	0,171	0,372	0,115	0,115
Machinery, Nec	0,029	0,163	0,079	0,106
Electrical and Optical Equipment	0,040	0,359	0,128	0,194
Transport Equipment	0,011	0,038	0,012	0,020
Manufacturing, Nec; Recycling	0,036	0,015	0,008	0,013
Electricity, Gas and Water Supply	19,471	11,266	4,690	4,972
Construction	0,004	0,225	0,076	0,134
Sale ofMotor vehicle and Fuel	0,294	0,301	0,165	0,290
Wholesale Trade and Commission Trade	0,894	1,048	0,476	0,847
Retail Trade, Repair of Household Goods	0,381	0,567	0,313	0,497
Hotels and Restaurants	0,038	0,058	0,033	0,121
Inland Transport	0,416	0,212	0,086	0,174
Water Transport	0,066	0,049	0,024	0,041
Air Transport	0,001	0,008	0,003	0,005
Other Supporting and Auxiliary Transport Act.	0,005	0,045	0,031	0,057
Post and Telecommunications	0,049	0,065	0,027	0,051
Financial Intermediation	0,204	0,287	0,066	0,177
Real Estate Activities	0,005	0,016	0,014	0,054
Renting of M&Eq and Other Business Activities	0,064	0,121	0,070	0,188
Public Admin and Defence; Comp. Soc. Security	0,000	0,006	0,006	0,006
Education	0,036	0,014	0,013	0,017
Health and Social Work	0,011	0,009	0,011	0,017
Other Community, Social and Personal Services	0,056	0,048	0,020	0,075
Private Households with Employed Persons	0,000	0,000	0,000	0,000
	23,968	15,978	6,923	9,302