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An analysis on Environmental Kuznets Curve for CO_2 Emissions in Uzbekistan

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이 논문을 공학석사 학위 논문으로 제출함

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세르조드의 석사학위 논문을 인준함

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Abstract

This study examines the long-run relationship between CO_2 emissions and type of energy consumptions, economic growth and trade openness in the case of Uzbekistan by using time series data from 1990 to 2016. Generally, this research aims to test whether the concept of Environmental Kuznets Curve (EKC) exists in Uzbekistan. Considering the interval of time series, the autoregressive distributed lag (ARDL) approach was selected for empirical analysis. The results obtained from the study show that the EKC concept exists in Uzbekistan as the evidence from the long-run relationship among income per capita, square of income per capita and carbon emission levels.

The outcomes of this research point to the fact that, there is a significant positive effect of fossil fuel consumption on CO_2 emission while the negative impact of trade openness was also captured in long run. Renewable energy consumption is insignificant but, demonstrates the negative effect on CO_2 emission level.

Empirical analysis has sensible policy implications for decision-makers, to consider international trade in terms of liberalization, to develop appropriate measures towards the reduction of energy intensity by introduction high energy efficient technologies, and the increase of the share of renewable energy sources in the energy mix by implementing appropriate legislative base and mechanisms.

Keywords: Economic development, energy consumption, CO_2 emissions, ARDL, Environmental Kuznets Curve, trade openness.

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I. Introduction

When we start to discuss an environmental degradation and carbon emission issues, first of all, the energy consumption appears which as a major contributor to the CO_2 emission worldwide. Consequently, economic development is the next main factor which can influence to the environmental quality and welfare. Investigation of the relationship between economic growth and environmental degradation is comprehensively done on studies of previous scholars in international and country levels. Especially, the recent year's carbon emission issue became an actual topic which is discussed frequently in global summits, symposiums, and conferences which were dedicated to finding optimal ways and modern approaches of mitigating carbon emission in our planet by introducing new eco-friendly technologies in energy industries, advanced methods of using renewable energy sources and so on. Since the Earth Summit of Rio in 1992 (Quarrie, 1992), Kyoto Protocol in 1997 (Protocol, 1997), and Paris agreement in 2015 (Agreement, 2015) which are declared that environmental degradation and climate changes are associated with fossil energy consumption all over the world. There is a fact that major portion of emission greenhouse gas is coming from fossil fuel consumption in developed countries. In another hand, developed countries state that most developing countries should focus on introduction new energy efficiency and environmentally friendly technologies. Because aged technologies which have cheap fixed cost and mainly used in developing countries lead more pollution than new energy-efficient technologies. Many experts suggest that main driver of lowering the greenhouse gas emission world level is massively introducing the renewable energy sources (Bilgili, Koçak, & Bulut, 2016a; Jebli, Youssef, & Ozturk, 2016; López-Menéndez, Pérez, & Moreno, 2014). In the case of developing countries like Uzbekistan, the optimal solution to mitigate carbon emission is a technology transfer from developed countries into industrial sectors, modernization existing aged technologies by replacing step-by-step into eco-friendly technologies and ensuring the sustainable development of the country.

1.1 Background

Uzbekistan is one of the fast developing countries within Central Asia region and beyond of it. After acquiring sovereignty in 1991, the government restructured the economy to create the fundaments for ensuring sustainable development of the country. The main purpose of diversification of economy was to decrease agriculture share in GDP, especially decrease producing the cotton, which was supplied from the country into the entire former Soviet Union countries, and in the past annual production volumes of cotton was required from Moscow. Consequently, the goal of diversification of Uzbekistan's economy was to increase industrialization and production high value-added products. In this case, energy industry, particularly oil and gas industry was a locomotive which pulled-up the economy and provided an economic prosperity of the country and people. Uzbekistan is located in central part of Asia and one of the double landlocked countries (Alam & Banerji, 2000) in the world, this is one of the barriers to retard the economic development, export and import movements from the country. The size of the territory of Uzbekistan is 448,9 thousand square km. and located in the center of five neighbored countries, bordered with Kazakhstan on the north side, with the Kyrgyz Republic and Tajikistan in the east and southeast side, with Turkmenistan on the west side, and with Afghanistan in the south side (Figure 1).

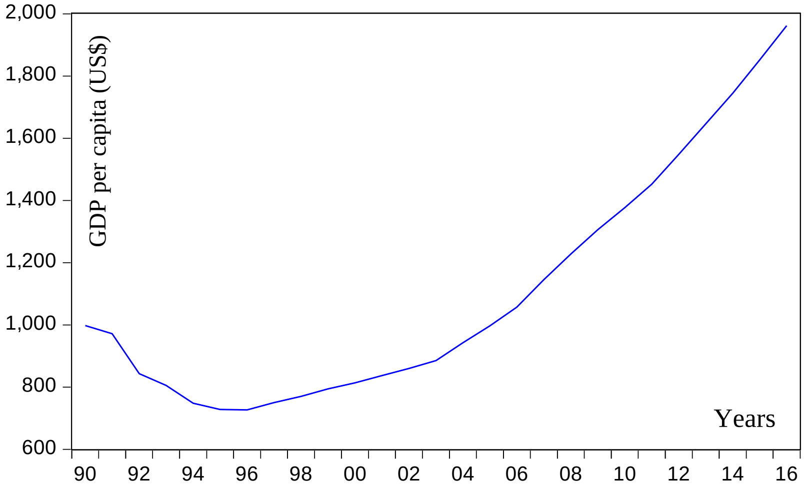
Figure 1: Uzbekistan Location Map[1]

The potential of Uzbekistan can be seen in many features, for instance, Uzbekistan has the highest number of population in the region. According to the statistics of World Bank, in 1990 total population of the country was 21 million people; in 2017 this number is achieved 32.5 million with an average growth rate of 1.7% annually.

With above-mentioned situations and facts (double landlocked, high populated), Uzbekistan's economy keeps developing with average yearly growth rate 6-7% (Figure 2) and the country is one of the most fast developing countries in the region as well as in the world.

[1] http://ontheworldmap.com/uzbekistan/

Figure 2: Plot of Per capita GDP growth (US$)[2]



Uzbekistan is one of the fossil fuel rich and self-sufficient countries of energy recourses in the region. The country has significant natural gas resources; also the country is one of the major energy and fuel exporters for neighbored countries as well as to the abroad. The main fossil fuel to domestic use by the population as well as for industry is natural gas, around 85% of energy consumption share based on blue flame gas. After 1991, the country significantly increased natural gas production by attracting foreign direct investment, and implementation and introduction of the modern technologies for exploration of new

[2] Drawn by author based on World Bank data - World Development Indicators

fossil fuel fields significantly increased the production of the energy resources. As mentioned above Uzbekistan is double landlocked country, so country exports the natural gas by the gas transmission pipelines, subsequently, Uzbekistan has to operate trades in global level by using intermediating countries land. These factors can affect to price as well as revenue of energy business. Although during the past years export of the natural gas significantly increased, but total energy consumption and energy consumption per capita fluctuated, time by time increased or decreased, in general view and in last five years energy consumption per capita slightly increased. Obviously, the country's the entire population has access to the electricity and around 85% of the population has access to the natural gas by pipelines. It means infrastructure for supply of the electricity and natural gas are well developed. From a review of the cases of developed countries and as well as developing countries, the energy consumption is one of the key drivers for providing economic growth and people welfare. But another hand, the environmental quality stands opposite side of energy consumption and economic development.

1.2 Purpose of Study

In Uzbekistan's case, the relationship between environmental degradation and economic growth is not studied with time series data by previous scholars. There were several panel data analyses with the short time period for Commonwealth of Independent States (CIS) including Uzbekistan (Apergis & Payne, 2010). Our research will be a "Pioneer" in terms of cointegration analysis of carbon emission level and economic growth with independent variables like energy consumptions and trade openness using time series.

In the scope of this study, we focus on to examine the impact of economic growth on environmental degradation in case of Uzbekistan by the empirical way. Other explanatory variables: energy consumptions (based on fossil fuel and renewable energy) and trade openness, also taken into consideration. Methodological approaches of this study go to dynamic cointegration framework and investigation existence of Environmental Kuznets Curve Theory (Grossman & Krueger, 1991; Panayotou, 1993). The annual time series data between 1990 to 2016 applying ARDL bounds approach (M Hashem Pesaran, Shin, & Smith, 2001) is used for analyses.

1.3 Research Questions

- The Environmental Kuznets Curve theory can be applied in Uzbekistan?
- Which factors are mainly responsible for the environmental degradation of Uzbekistan?

The outcomes of the study could be used for the reasonable current and future policy planning in the case of Uzbekistan, to determine the right strategy for the sustainable development and guide optimal energy policy and secure the environmental quality. Consequently, according to the results of this study, the suggestions could be provided for the policymakers in Uzbekistan to reduce environmental degradation which can lead towards sustainable development in the future perspective and the long-term industry planning.

1.4 Thesis Structure

The structure of thesis consists as follows; Chapter two reviews the Economic development and energy industry relationship in Uzbekistan by providing information about entire energy industry in the country, including natural gas, oil, electricity, and renewable energy facts, also the achievements of the country in term on CO_2 emission mitigation, and country's international trade actions and the current foreign trade policy are reviewed in this chapter. Chapter three is reviewed related previous studies, in the case of different country facts and results were explained briefly. Chapter four is about selected methodology ARDL approach and its features, also information about the stationary test; cointegration and error correction modeling approaches were reviewed. Chapter five consists of empirical analysis and results, also a discussion about the evidence of empirical outcomes, and the existing situations in the country and future opportunities in terms of carbon emission mitigation included in this chapter. Chapter 6 is the conclusions; it also presents policy implications based on overcoming form the empirical outcomes and discussion. The limitations and suggestions for future studies finalized the chapter 6.

II. Economic Development and Energy Industry

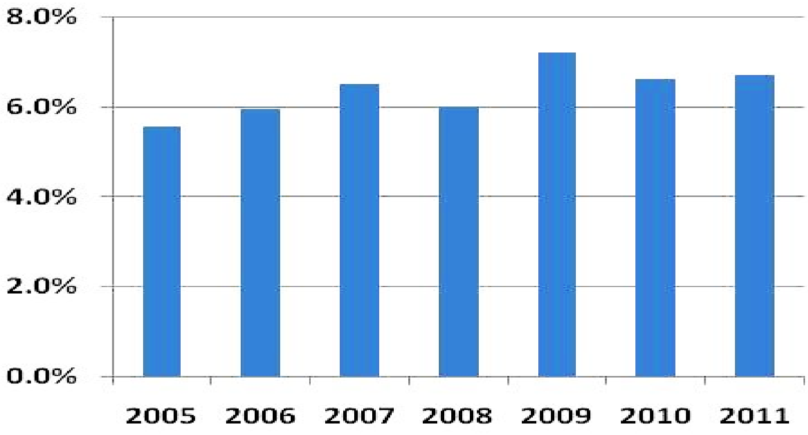
The energy industry is a major key to ensure Uzbekistan's growth rate in the past, as well as in the long-term perspective plans. Particularly, in the short and long-term plans countries trade policy is pursuing an enhancing energy industry and increase the share of refinery and processing of fossil fuels like natural gas and gas condensate to achieve export-led growth strategy.

According to long-term perspective, Uzbekistan aspires to achieve an industrialization middle-income state with per capita earnings of US$ 6,500 by 2021 and US$8,500 by 2030. During 2009 to 2015 according to "Industrial Modernization and Infrastructure Development Program" country spent upon US$ 43 billion.

Consequently, the share of energy industry was around US$33.7 billion or almost 72 % of the total expenditure asset. In the result, with implementing around 500 investment projects share of industry in GDP increased from 24% proximately 30% at the end of 2015.

Obviously, to achieve these indicators, the energy industry was a key supporter with a huge amount of export profit source to ensure growth rate (Kochnakyan et al., 2013). Past decades share of the energy sector in GDP significantly increased (Figure 3).

Figure 3: Energy sector share in GDP



Source: (Kochnakyan et al., 2013)

Country's energy industry is one of the main pillars of income growth and the large share of export value of income comes from it. According to World Bank analytic report in 2010, Uzbekistan's energy industry estimated more than 6.7 % of income and 27.7 % of industrial productions (more than 3.0 billion USD). Also export of energy resources, especially export of natural gas, which is major exported good, calculated more than 25 % of sum merchandise exports (more than 3.2 billion USD).

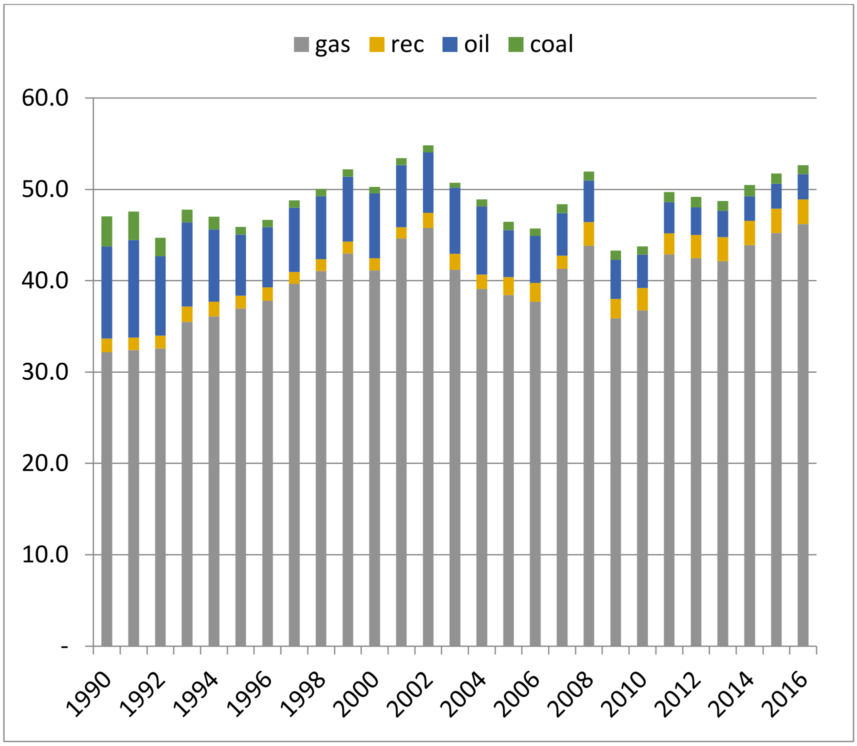
Consequently, to support the growth of production and export energy resources huge amount of capital investment spent into the energy industry, and the amount calculated more than 1.7 billion USD at 2010, which is 49.5% of the annual capital investment (Kochnakyan et al., 2013).

2.1. Country Energy Profile

Uzbekistan is one of the fossil fuel rich and self-sufficient countries in terms of energy recourses. After independence, effective energy policy allowed an increase in the natural gas share of total energy consumption from 64% 1991 to 88% 2016, replacing oil and coal, also share of hydro increased (Figure 4). In 2016, share type of energy resources in total primary energy consumption, natural gas is 88%, oil 5%, coal is 2 % and renewables 5% respectively[3].

[3] BP Statistical Review of world energy, 2017

Figure 4: Primary energy consumption by fuel (Mtoe)[4]



For the leaders of Uzbekistan, it was clear that to ensure comprehensive development of the newly independent country, the oil and gas industry is a main pillar of the economy, and after became the sovereign state the energy industry immediately restructured. The leaders of the nation clearly determined the exact perspective plan to the wide-ranging expansion of the energy industry.

[4] Drawn by author based on date of BP Statistical Review of world energy, 2017

The steps strategic plans to transform from command-administrative methods into a market economy were clearly defined by the government policymakers. The strategic plan had covered the solution of the next main organizational measures that were launched earlier in 1992 and consisted of next:

- A provision increasing volumes of fossil fuels, natural gas, oil, and gas-condensate, increase the output of petroleum products to ensure energy independence;
- Transform from raw products production into deep-processing natural gas and oil, increase the type of petrochemical products with international standards and quality in order to enter the global market;
- Exploration and open new hydrocarbon reserves and build-up those, to ensure short term and long term a reliable fossil fuel base and deposits for the sustainable providing oil and gas industry of Uzbekistan.

The subsoil of Uzbekistan has large reserves of hydrocarbon raw materials. About 60% of the territory of the republic is potential for oil and gas, especially for natural gas. Generally, the territory of the country divided into 5 regions for oil and gas exploration and production, and In five oil and gas regions, 211 hydrocarbon deposits have been discovered. Of these, 108 are gas and gas condensate, 103 are oil and gas, oil and gas condensate, and oil. More than 50% of the fields are in development, 35% are ready for development, the remaining exploration work continues[5]. Consequently, according to BP-statistical-review-of-world-energy-2017 proved natural gas reserves estimated more than 1.1 trillion cubic meters in the end of 2016[6].

After the independence of the country, National Holding Company (NHC) "Uzbekneftegaz" is a united company which is responsible for oil and gas mining, refinery and supply activities. The main objective of "Uzbekneftegaz" is expansion of existing prospects to support significant growth of hydrocarbon mining, ensure supply-demand equilibrium of fossil fuels for provide them to the internal market, introduction and spreading the new technologies for natural and oil processing fields for the purpose to enhance production of high value-added products, and entree to the export markets with diversified goods, and ensure attraction of foreign direct investments by providing

[5] http://www.uzneftegaz.uz

[6] BP Statistical Review of world energy, 2017

positive environments to invest in the gas and oil industries. Thanks for right government policy and support of oil and gas industry, production of hydrocarbon in recent years achieved more than 55.0 million oil equivalent, and obviously major share of total production is natural gas and gas condensate.

The adopted law "On Subsoil" is a legislative constitution of the NHC “Uzbekneftegaz”, for the purpose to increase foreign investments there were adopted next legislations which are base for protection of right of foreign investors and named "On Production Sharing Agreements", and second one named "On Measures to Attract Foreign Direct Investments in Exploration and Production of Oil and Gas" and a number of other legislative documents were have been approved which are confidently promote the oil and gas industry.

Restructured and named “Uzbekneftegaz” NHC gave first positive results from the initial years of independence and new deposits of natural gas and oil such as “Kokdumalak”, “Alan”, “Urga”, “Southern Tandyrchi”, and others were discovered and successfully started operating which are significantly increased annual production of hydrocarbons. “Uzbekneftegaz” NHC obtained perfect experience by the cooperation with global oil and gas companies. Effective conducting appropriate geological exploration works outcomes ensured the growth of deposits, at the same time reliability of raw material base for the long-term perspective ensured too. Next stage and the next main task were to increase petrochemical ready products and ensure the growth of high value-added products by enhancing the variety of products. For this purpose, “Uzbekneftegaz” NHC stated to extensively applying modern technologies to increase a type and variety ready products with international standards.

The efforts to increase the proved reserves were very productive and exploration activities which were carried out in recent years confirmed of the existing huge amount of hydrocarbons in the regions of the country like Bukhara, “Surkhandarya” region and near “Karakalpakstan” region.

Huge amount of deposits were explored in the northern part of the country (“Ustyurt”), significantly huge natural gas deposits “Surgil”, “East Berdakh”, “Uchsay” were discovered there. More than 50 investment projects which are included into government investment short-term perspectives for the period 2017-2021, and "Uzbekneftegaz" NHC working on the successful implementation of this projects. Almost all above-mentioned investment projects have been implementing by attracting foreign direct investments. Especially foreign companies like Korea National Oil Corporation, Korea Gas Corporation (KOGAS), SASOL (South Africa) “Gazprom” and “Lukoil” (Russia), CNPC (PRC), Petro Vietnam (Vietnam), are already became trusted partners of "Uzbekneftegaz" NHC.[7]

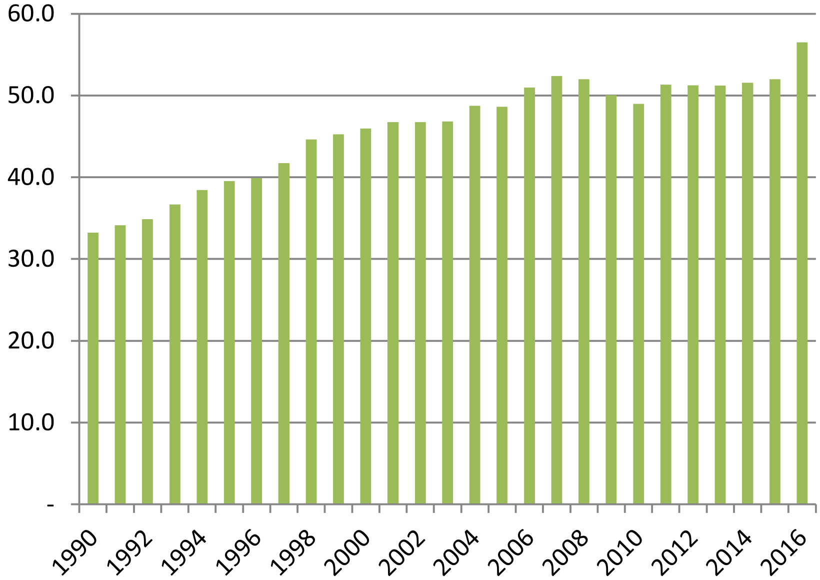
[7] http://www.uzneftegaz.uz

2.1.1 Natural Gas Policy

Initially produced natural gas was very clean and contents low level of sulfur and other ingredients, which are found in 1953 at the "Saman-Tepe" field in the red-sand desert at Bukhara region. But at that time the Uzbek people were far from to use natural gas because the former soviet union decision makers pushed to construct natural gas transportation transcontinental gas pipelines named "Bukhara-Ural" and "Central Asia-Center" in order to send Uzbek gas to the industrial plants located at Ural area of Russia. Uzbekistan kept full government proprietorship over its own oil and gas reserves and excluded the direct participation of global players in developing them. The Soviet Union's collapse in 1991 provides an exceptional chance to statement this gap in the works. This remarkable incident created not only numerous anew independent countries but also a new set of key oil and gas producers: Uzbekistan, the Russian Federation, Turkmenistan, Azerbaijan, and Kazakhstan. Composed of Iran, these five energy-rich former Soviet Union countries make up the Caspian Basin, which is valued to hold the biggest gas and oil deposits in the world outdoor the Persian Gulf. These countries particularly suitable cases through which to explore these bigger hypothetical questions since they had nearly undistinguishable preliminary arguments when they discovered the prospective marketplace value of their oil and gas reserves and supposed manage over them. Outstanding to their joint capability under Soviet regulation, these countries hold in public numerous social, political, and economic legacies, such as a nascent civil society, central strategy assembly and economic development, and a county-wide based administrative-territorial structure. Furthermore, for the reason that all natural assets were owned and managed by the former Soviet state, the leaders of all five afresh independent countries kept natural resources management with similar political and organized configuration for the managing of their energy deposits. Even with the above-mentioned relationships, for the initial several years of self-governing statehood, they followed particularly different approaches on the way to develop their energy industries. At one end of the scale, Uzbekistan had full state proprietorship over their particular gas and oil deposits and excluded the direct involving of global actors in developing them. The efforts and aimed activities had given productive results by significant growth of natural gas production (Figure 5).

Energy industry advance approaches not only have a significant effect on political and economic conditions but also have a direct influence on the long-term obtainability and usage of income from gas and oil productions. Privatization, for example, may offer state leaders large sums of money in the short run, yet it significantly reduces state reception of and control over oil and gas profits in the long run.

Figure 5: Natural gas production (Mtoe)[8]



[8]Drawn by author based on date of BP Statistical Review of world energy, 2017

Public proprietorship, in contrast, frequently stays financial pay-offs since country should borrow the necessary capital from global sources to develop their resources, but it also allows bigger government regulator over the distribution and supply of upcoming oil and gas earnings[9].

2.1.1.1 Natural Gas Transportation Network

Russia has been providing natural gas to Europe and itself, also natural gas was delivered from Uzbekistan and Turkmenistan to Russia through an elaborate pipeline system largely created in the 1960s, 1970s, and early 1980s (Figure. 6). Based on the finding of huge, manageable reserves in western Siberia, the Ministry of Gas Industry, now Gazprom, industrialized an extensive network of national pipelines linking those sources with the main manufacturing centers of the former Soviet Union. The Figure 6 describes this network which also drew the former existing natural gas sources, all managed by the Ministry, in the Caucasus and Central Asian regions including

[9] http://www.uzneftegaz.uz

Uzbekistan of the Soviet Union into the joined system of gas transport and supply (Luong & Weinthal, 2001).

Figure 6: Russian Gazprom existing gas transportation pipelines

Source: (Luong & Weinthal, 2001).

Uzbekistan has huge natural gas reserves yet all of these double-landlocked republics face challenges in getting those gas and oil products into the global market. Then, independence from the former Soviet Union, local natural gas manufacture has been categorized by modest yearly rises from Uzbekistan. Russian company Gazprom annoyed, though, to controlling and transportation most gas exports from the region. Moreover, through feasibility studies, Gazprom carried out on projects to increase natural gas exports from the region to the European Union through pipelines under its proprietorship or control. Nevertheless, in recent years Uzbekistan achieved to export the gas east to China. Uzbekistan also signed, in April 2007, an agreement with China for a 530 km, 30 billion cubic meter capacity, gas pipeline to China which is shown on the Figure 7 (Economides & Wood, 2009).

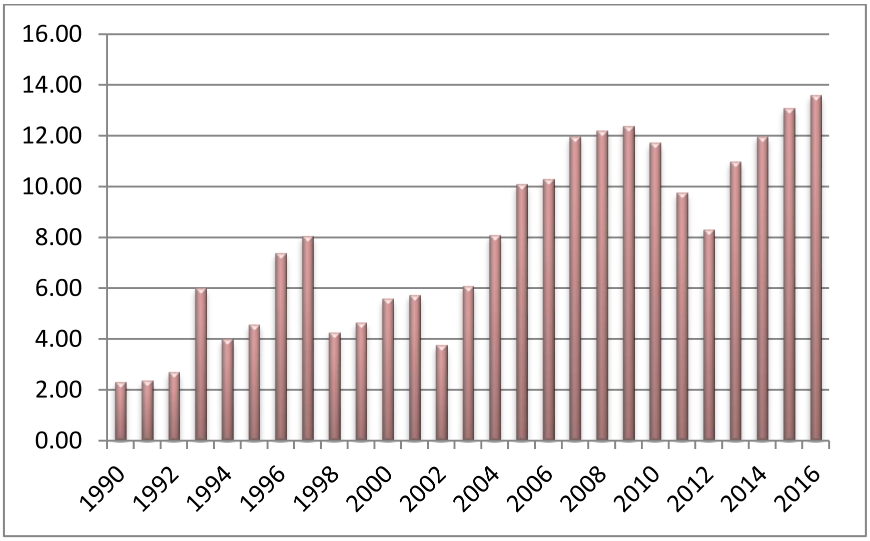
Figure 7: Natural gas pipeline network of Uzbekistan

Source: (Luong & Weinthal, 2001).

The country owns significant major energy sources, mainly hydrocarbons, and liquid fuels. The confirmed deposits are assessed at more than 1.8 trillion cubic meters of natural gas, oil is more than 0.6

billion barrels, and coal deposits estimated more than 1.9 billion ton. Greatest reserves are located in the South-Western parts of the country which are based on natural gas and oil. At present manufacture degrees, the confirmed reserves are predictable to last 31, 22 and 95 years correspondingly. The entire undiscovered resources are projected to be considerably greater (Kochnakyan et al., 2013). Natural gas export is a national wealth of the country which particularly supports income growth. Country appropriate policy ensured the growth of export volume hydrocarbons and in recent year's natural gas exports achieved more than 13 million ton oil equivalent annually (Figure 8).

Figure 8: Annual natural gas exports from Uzbekistan (Mtoe)[10]



[10] Drawn by author based on date of International Energy Agency statistics 2017

2.1.1.2 Natural Gas Refinery

Initially, in Uzbekistan, gas processing plant was constructed in the "Kashkadarya" region in 1972 which is named "Mubarak gas processing plant". At that time this gas processing plant was one of the biggest gas processing and manufacturing company in the world. After start mining natural gas from "Shurtan" deposit, there was a necessity to build another gas processing plant. "Shurtan" gas processing plant start to operate from 1980Uzbekistan always aspired to the diversification of fossil fuel based products which required to investment modern gas manufacturing technologies. First deep gas processing plant "Shurtan" Gas Chemical Complex (GCC) constructed under the signed contract between "Uzbekneftegaz" National Holding Company and conglomerate led by "ABB Lummus Global" (USA), including Japanese companies Toyo Engineering, Nissho Iwai, Mitsui and Italian company "ABB Soimi". "Shurtan" GCC started to operate from 2001 by producing several types of gas-chemical products like ethylene, and polyethylene. Quality and standards of produced products by "Shurtan" GCC are matching with international level and more than 60% of the production is active exports to the European countries like Hungary, Latvia, Poland, Turkey, and Lithuania, also products are found consumers in Asian countries markets like China, Pakistan, Iran, as well CIS countries like Azerbaijan, Kazakhstan, Ukraine, Russia are permanent customers. After successful implementation of first gas refinery plant, the country has taken a course in enhancing the industries by introduction depth processing technology of fossil fuels. Next biggest achievement in the depth processing of natural gas and gas condensates implemented with the Consortium of Korean Companies, this gas processing plant became one of the largest gas-chemical complexes in Central Asia, which is located at "Ustyurt Plateau" and consume to process a natural gas from deposit "Surgil". Annual production of the clean natural gas is more than 4 billion cubic meters which are export by pipelines, and chemical complex produces of 362 thousand tons of polyethylene and 83 thousand tons of polypropylene for supplying domestic market as well as export. One of the important and latest technological investment projects is a manufacturing synthetic liquid fuel, we can say with other words like gas-to-liquid (GTL) technology which is based on cleaned methane of "Shurtan" GCC. The total investment cost of GTL technology is around 4.0 billion USD. After implementation GTL plant's proposed to produce around 900.0 thousand tons of diesel fuel, around 300.0 thousand tons of kerosene, around 400.0 thousand tons of naphtha and around 11.0 thousand tons of liquefied gas products. The implementation of the project is held jointly with global companies like "Sasol" and "Petronas". After successfully implementing the project it is expected to become one of the largest natural gas processing plants which will convert natural gas into liquid fuel.

2.1.1.3 Natural Gas Domestic Consumption

Responsibility and tasks for the reliable supply of natural gas to consumers of the Republic of Uzbekistan, as well as transportation, transit, also export, for both domestically and abroad, are vested in the Joint Stock Company "Uztransgaz", which is a part of the NHC "Uzbekneftegaz". Natural gas is the national wealth of the country. Since the first days of independence of the Republic of Uzbekistan, much attention has been paid to ensuring the pace of economic growth of the republic and developing the competitiveness of enterprises, which in turn increases the need for fuel and energy resources. Considering the increasing volumes of gas consumption, both inside the country and beyond, continuous development and improvement of the gas transport and gas distribution systems, and their reliability increase are necessary.

In accordance with the Decree of the President of the Republic of Uzbekistan numbered PP-438 from August 8, 2006 "On measures to improve the organization of activities of the joint-stock company "Uztransgaz" the company, in addition to the transportation of natural gas, directly engaged in gas supply to domestic consumers, which is an important step in the creation of a unified technological system transportation and sale of natural gas.

These days, the natural gas distribution system of Joint-Stock Company (JSC) "Uztransgaz" consists of more than 127.7 thousand km of gas distribution networks and 96.3 thousand units. Gas distribution points of high and medium pressure. During the years of independence of the Republic of Uzbekistan, the Joint-Stock Company has achieved a significant increase in the level of gasification, both in urban areas and in rural areas, by increasing construction and commissioning of new gas trunk lines and gas distribution pipelines. As a result of increased investment in the industry since 1991, the length of the main gas pipelines has increased by 1.4 times; length of gas distribution networks 3 times, and gasification level 2 times - from 44.1 to 85.3 percent. With an investment of exploration and increasing amount of natural gas production at the same time, the gasification policy of regions was held parallel, and this day gasification level achieved 89 and 80 percent, respectively in urban and rural areas. Consequently, natural gas consumption of economic sectors and householder's consumption are increased. In accordance with the State Program for Regional Development, as well as to improve consumers' access to natural gas and improve the quality of living conditions of the population, especially in rural areas, the Joint-stock company has been implementing a set of targeted measures for gasification of remote regions in recent years. These days, in accordance with the assigned tasks, the Company provides a reliable supply of the following consumers of natural gas:

- 4,519,806 houses and apartments, where more than 20.5 million people live;
- 80,912 wholesale consumers, including 4,964 industrial enterprises, 17,833 household and socially significant facilities and 58,115 individual entrepreneurs.

In addition, the company supplies more than 1.6 million liquefied gas to consumers located in rural areas remote from gas networks. For this purpose, about 330,000 revolving gas cylinders, 206 warehouses and service centers for servicing gas cylinders and 283 special vehicles for their delivery are used[11].

2.1.2 Oil Policy

Responsibility and tasks for processing of processing of hydrocarbon raw materials (oil and gas condensate) are vested in the Joint-Stock Company "Uznefteprodukt", which is a part of the NHC "Uzbekneftegaz". The main tasks and lines of activity of the “Uznefteprodukt” are:

- Processing of hydrocarbon raw materials (oil and gas condensate), production of petroleum products and liquefied gas in the appropriate volumes and assortments necessary for the uninterrupted supply of the national economic complex and the population of the Republic of Uzbekistan;

[11] http://uztransgaz.uz/

- Make a contract for the supply of petroleum products and liquefied gas, including transit in accordance with the distribution plan in accordance with the established procedure, monitoring their conclusion and execution;
- With the involvement of foreign investors - the organization and development of joint ventures and industries in the territory of the Republic of Uzbekistan and abroad;
- Implementation of progressive, scientific and technical and investment policies aimed at solving priority problems in the development of the system for the application of new equipment and technologies in the production, transportation, storage and distribution of petroleum products and gas, ensuring the quantitative and qualitative safety of oil products and gas, fire and technical safety requirements, ecology, creation of automated control systems.

2.1.2.1 Oil Refineries

Government-guided suitable policy for ensuring oil product reliable supply for consumers and economic sectors, two major oil refinery plants allocated in a different part of the country. Bukhara oil Refinery plant located in northwestern part of the country and Fergana Oil refinery plant is located in eastern part of the country, Bukhara Oil Processing plant is the result of one of the important strategic and optimal energy policy decision of government which was assembled in 1997. For the construction new energy efficient technology was introduced by attracting French company TECHNIP to produce several types of petroleum products. This day's varieties of production are 10 kinds of petroleum products with annual manufacture 2.5 million tons oil yearly. The major products of manufacture are aviation fuel, diesel fuel, and others[12]. Fergana oil refinery plant is a major refinery in Uzbekistan also in central Asia Region, It started operation in 1958. To achieve improved environmental quality and mitigate toxic emission like sulfur, in the refinery plant implemented investment projects with the Japanese companies Mitsui and Toyo Engineering. After reconstruction, in 2000 Fergana oil refinery plant start to operate with desulfurization units for diesel fuels, which supports environmental safety satisfying of finished products. The capacity of Fergana oil refinery plant is 7 million tons oil annually.

[12] http://bnpz.uz/en/history

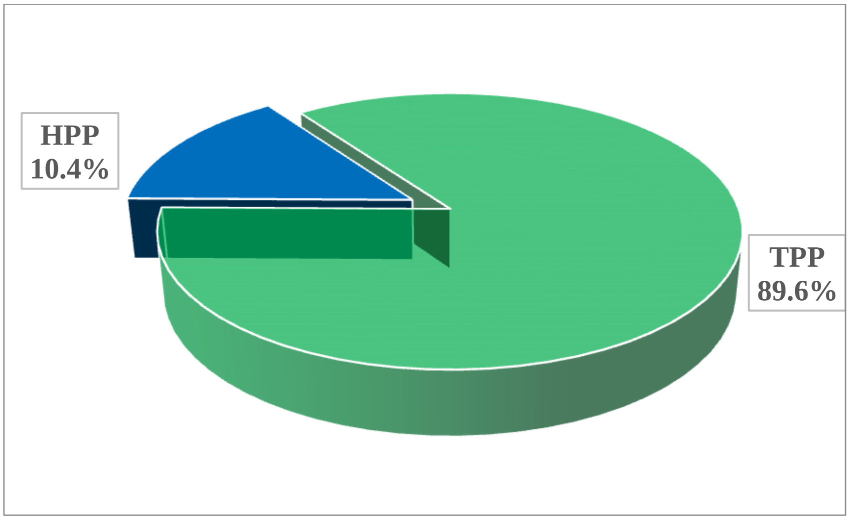
2.1.3 Electricity

In Uzbekistan, electricity production is dependent on natural fossil fuel resources, especially from natural gas. The thermal power stations which supply the major generation capacity comprises a fuel mix to supply energy from natural gas of more than 87%, oil 5%, and 8% coal for an installed total capacity of 13.5 GW in 2016.

Uzbekistan has a goal-oriented arrangement to modernize and increase power generation capacity, at present; it holds more than 50% of the whole Central Asia connected grid capacity with the annual electricity generation about 57 TWh.

The total installed capacity of power plants is 13.5 GW which is consist of 12.1 GW thermal power plants and 1.4 GW hydropower plants. Share of thermal power plants in total installed capacity is 89.6% and share of hydropower plants is 10.4% (Figure 9).

Figure 9: Share of installed capacity of power plants by type



Source: Ministry of Economy of the Republic of Uzbekistan (2015)

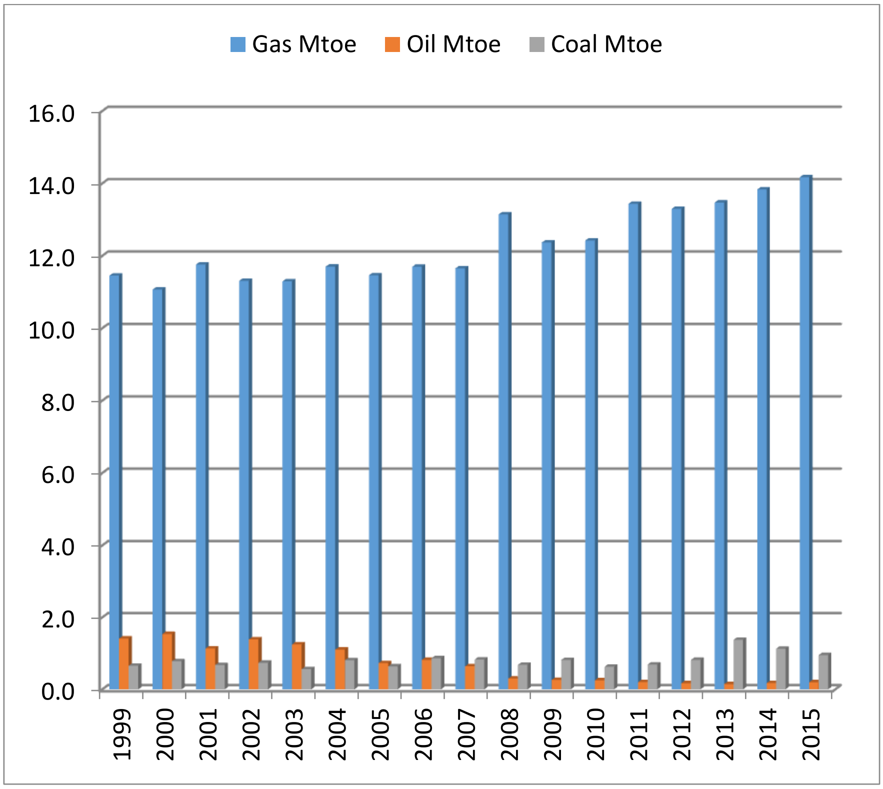
2.1.3.1 Thermal Power Plants

As one of the major fossil fuel exporter in the region, Uzbekistan's power industry causes economic losses related to the decreasing of export potential due to high domestic energy use. The reason for this economic loss is determined to be caused by utilization low-efficiency technologies and the extensive dependence on thermal power plants which also major contributors of CO_2 emission levels. The power system of Uzbekistan includes 10 thermal power plants, which are main electricity and heat producers for the entire economy. The first of these thermal power plants were put into operation in 1955 and the last one is "Talimardjan" thermal power plant started to generate electricity earlier in 2004 with capacity 800 MW. The power plant has one unit which includes one generator with maximal available active power output 800 MW. It is totally based on Russian technology and equipped with facilities produced by power engineering company named "Power Machines". This Russian enterprise majority is manufacture and provider of facility collections for boiler and steam turbine based thermal power plants, nuclear and hydropower plants, also company offers turn-key opportunity in power plant construction field[13].

In spite of "Talimardjan Thermal Power Plant" is one of the newest power plants, its efficiency fluctuated around 30-35% according to seasons weather. Also, other thermal power plants equipped with similar steam turbine based technology and an average efficiency of thermal power plants around 30%. As a natural gas is main energy resource, at 2015 in electricity production, the natural gas share was about 92 percent, and coal share is 6% and oil share is only 2%.

[13] http://www.power-m.ru/en/company

Figure 10: Share of fuels by types consumed in TPP[14]



According to the Figure 10 in past decade shares of natural gas, which consumed by thermal power plants significantly increased but the share of oil consumption decreased. The consumption of coal fluctuated.

Low-efficiency thermal power plants not only contributor to the high cost of electricity but they also the main contributor of CO_2 emission in the country.

[14] https://data.gov.uz/uz/datasets/

2.1.4 Renewable Energy

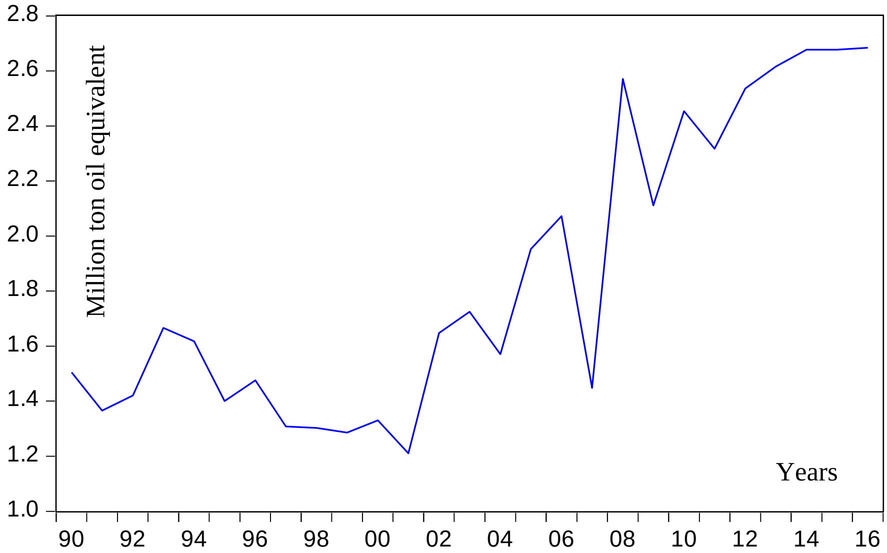
In Uzbekistan renewable energy consumption based on hydropower plants (HPP). The first HPP was built in 1926 on the “Bozsu” channel; there were installed 4 units with 1 MW installed capacity each. These days there are 32 HPP with various installed capacities and total power is 1400.0 MW. The average annual output of the HPP is 6.3 billion kWh.

“Charvak” HPP is one of the largest hydroelectric power plants in Central Asia with capacity 650 MW. The “Charvak” reservoir provides seasonal flow regulation in accordance with irrigation needs, keeping summer and flood waters for use in periods of low water availability, plays an exceptional role in generating peak power and regulating frequency in the national power system of the Republic.

Past decades there was built several medium and small HPP's in water reservoirs and flow of rivers which increased the share of renewable energy consumption (Figure 11). The total gross theoretical hydropower potential of the river flow in Uzbekistan is estimated at 88.5 billion kWh per year.

The technical hydropower potential (which is exploitable) of the Republic is estimated at 27.4 billion kWh per year, of which 6.27 billion kWh per year is currently in recent years.

Figure 11: Dynamics of renewable energy consumption (Mtoe)[15]



In Uzbekistan, the capability of some renewable energy sources is adequately high, yet it requires expanded mindfulness and the improvement of a motivator driven renewable energy spread approach for a quick and successful extension of the renewable energy source use (Bahtiyor, STULTJES, ESHCHANOV, & SALAEV, 2011). Like the

[15] Drawn by author based on BP Statistical Review of world energy, 2017

majority of the Asian nations, sunlight based power is considered as a standout amongst the most encouraging renewable energy source in Uzbekistan. The number of sunny days is high with more than 300 sunny days a year everywhere throughout the nation (Komilov, 2002). Roughly 75% of the nation comprises of deserts, which is good for sunlight based PV and sun oriented power usage. However, its use is yet not composed in spite of this high potential. A review by (Abdullaev & Isaev, 2005) uncovered that among the renewable sources sun oriented photovoltaic (PV) control era may be the most proper private energy source from a specialized perspective with gross sun based radiation capability of 50793 million ton oil equivalent (Mtoe), of which 176.8 Mtoe is actually exploitable (Bahtiyor et al., 2011). The utilization of renewable energy sources (RES's) is an important issue for the Republic of Uzbekistan and stems from the need to ensure the nation's energy security, and in addition to enhancing the living and social states of its populace. The primary sorts of RES's utilized as a part of the nation are sunlight-based energy (SE), hydropower, wind, geothermal, and other energy. The nation's aggregate innovative potential with respect to the accessible RES's is 179.4 million tons of oil equal (TOE), which is three circumstances more than the yearly national primary energy consumption. The region of Uzbekistan is 447400 km, and 70% of the land is involved in deserts. The energy capability of SE is 98.5% of the total RES's, and it is in this manner thought to be a key variable that decides the degree of utilizing renewable energy sources as a part of the general national energy balance (Avezov, Avezova, Matchanov, Suleimanov, & Abdukadirova, 2012).

2.2 CO_2 Emissions Mitigation Policy

In the case of fossil-fuel rich countries, increasing hydrocarbons exploration and production brings impacts to the environment with a huge amount of CO_2 emission with gas flaring (Ismail & Umukoro, 2012). Earlier in 2005, Uzbekistan launched the first phase of the project, putting it into operation on the field "Kukdumalak", depending on the level of utilization of associated gas, which allows utilization of associated gas in the amount of 1.3 billion cubic meters per year. The first stage of the project cost the joint venture $ 30.9 million. Within the second stage of the project, technological equipment was put into operation that allows utilization of associated gas in the volume of more than 3 billion cubic meters per year, and its implementation allows extinguish associated gas flares in the field, improving the environmental quality in the country. One of the largest in the Republic is the “Kukdumalak” deposit was discovered in 1986. Its huge reserves amount to 55 million tons oil, 67 million tons of gas condensate and 145 billion cubic meters of natural gas. Next step to mitigation carbon emission is by utilizing flared gases, the investment project which involves the utilization of low-pressure gases from the “South Kemachi”, “Kuruk”, “West Kruk”, “North Urtabulak” and “Umid” fields. The second project concerns the modernization of the Northern “Shurtan” field. By 2030, the country has a confident roadmap to completely abandon the practice of burning associated gases on flare rigs and decrease CO_2 emission level.

The national holding company "Uzbekneftegaz" in 2016 completed two major projects on the utilization of associated gases in the developed fields. The total cost of the two projects exceeds $ 267 million. As a result, Uzbekistan will annually be able to receive more than 1.2 billion cubic meters of gas. One of the largest projects in this direction is the utilization of low-pressure gases from the South “Kemachi”, Kruk, West Kruk, North “Urtabulak” and “Umid” fields. Its implementation will make it possible to reduce the amount of polluting emissions into the atmosphere, the emission of greenhouse gases and improve the environmental quality. An economic effect is also important - the losses of such valuable raw materials as gas, which is now flared at flare facilities, will be reduced.

The second project is being implemented in the northern “Shurtan” field. After its completion, the company will have an opportunity to annually dispose and send to consumers about 430 million cubic meters of flared associated gas at the flare of the northern “Shurtan” field and the degassing gases of the “Shurtan” head facility.

At the end of last year, "Uzbekneftegaz" has already put into operation the first phase of utilization of "blue fuel" in the field with a capacity of 170 million cubic meters per year. In April 2015, Uzbekistan joined the initiative of a number of oil-producing countries to halt by 2030 the practice of flaring gas in oilfields.

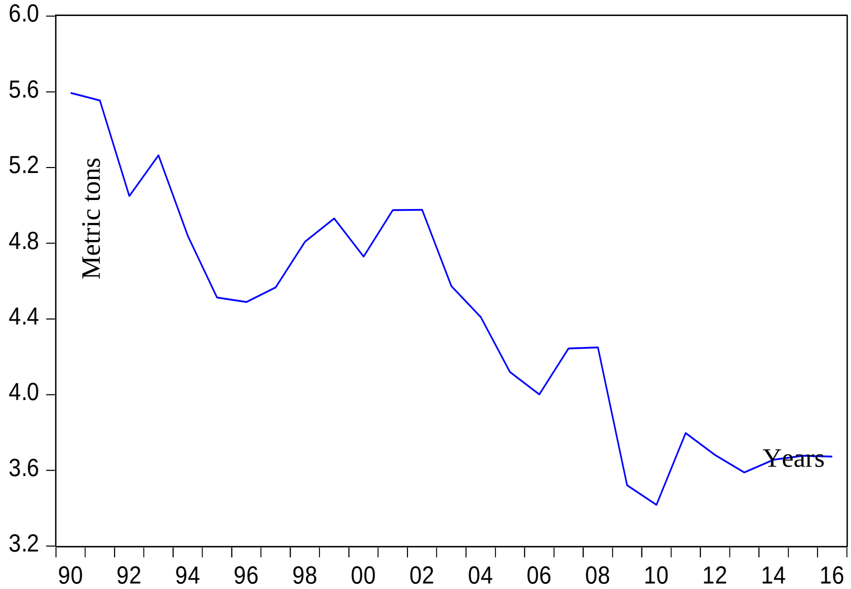
Today we can confidently say that Uzbekistan's strategy made a significant step in the process of energy "greening" the country by connecting the potential of Clean Development Mechanisms (CDM). It should be reminded that the CDM is one of three practical mechanisms allowing a number of countries (included in Annex 1) to fulfill their obligations under the Kyoto Protocol, to buy quotas for greenhouse gas emissions in other countries or to implement joint projects with them. The action to convert emission reductions into commodities takes place according to well-defined rules prescribed in the decisions of the Conference of the Parties to the UNFCCC/Meeting of the Parties to the Kyoto Protocol and the Executive Board on the CDM.

This mechanism brings real benefits to both partners involved in the implementation of a certain project, but by the procedure of reconciliation and registration, it is rather difficult and laborious. The contribution of the country to the process of reducing greenhouse gas emissions and the introduction of energy-saving technologies is expressed in the implementation of many relevant and ambitious projects in terms of their scope implemented under the Clean Development Mechanism:

- "Modernization of the Tashkent Thermal Power Plant;
- Construction of combined cycle gas turbine plant (CCGT) with a capacity of 370 MW "and" Expansion of “Talimardjan” TPP with two 450 MW CCGT units".

This technical re-equipment has many advantages and benefits. For example, at power plants with obsolete equipment, the efficiency is about 33%, and on modern gas-vapor systems, which are being built around the world at a fast pace, the efficiency with one ton of fuel is almost 60%. Increasing the efficiency in 30% obtained during the technical re-equipment means a significant reduction in carbon emissions in the production of the same amount of energy, which is then converted into electricity. Such large projects on combined-cycle plants are the largest not only in Uzbekistan but throughout Central Asia. In the near future, it is worthwhile to connect two combined-cycle plants at 450 megawatts at the “Talimardjan” power plant and commissioning a 370 MW combined-cycle plant at the Tashkent Thermal Power Plant. In the future, country long-term perspective plan to connect the Paris agreement 2015 component to other investment projects aimed at reducing greenhouse gas emissions and opening the way to obtaining carbon investments through their implementation. All efforts to the improvement of environmental quality are giving results by decreasing CO_2 per capita level (Figure 12). At a certain stage of the development of project documentation and the passage of all stages of harmonization under greenhouse gas emission mitigation projects, it was necessary to secure the support of a reliable partner.

Figure 12: Dynamics of per capita CO_2 emissions level (metric tons)[16]



Therefore, the help of the leading company Like Samsung, Hyundai, POSCO-Daewoo, which are already implementing a number of investment projects, is very important not only at the moment but also for the future. Uzbekistan energy policy carried out a serious selection

[16] Drawn by author based on BP Statistical Review of world energy, 2017

procedure due to the fact that the projects themselves are large-scale with significant investments and financial costs. At the stage of selection of the partner company, it became very serious that the partner takes certain risks.

2.3 International Trade

Uzbekistan is one of the countries which are not a member of world trade organization (WTO). First steps to processes and activities started earlier in 1994 (Muradova & Khusainova, 2003). In 1998 first version of the memorandum on becoming the member of WTO was represented to WTO main office. This memorandum included information on viewpoints of the economy and effective trade duty of Uzbekistan.

To become a member of the WTO can bring several problems for the country; particularly it might be the appearance of the issue for the local manufacturers due to diminishing state aid – restrictions of implicated instruments of government adjusting of economic subsidies and conversions. Moreover, revenue amount which is based on customs duties can be significantly decreased because of requirements of WTO for the fruitful foreign trade, and this can negatively affect to budget of the state (Muradova & Khusainova, 2003).

This day Uzbekistan is restarting work on accession to the World Trade Organization (WTO). It was stated by President of Republic of Uzbekistan Shavkat Mirziyoyev at the business forum in Seoul when president cake to Korea with an official visit. During the official visit, the President of the Republic of Uzbekistan mentioned: "We again resumed work on joining the World Trade Organization”[17]. He also noted that Uzbekistan and Korea are planning to adopt a joint "Road Map" on cooperation in the issues of the accession of Uzbekistan to the World Trade Organization (WTO).

During high-level meetings and productive business forums, the President of Uzbekistan gave his speech as "Korea is the first state with which we sign such a document. In addition, opportunities are being explored with Korean partners to improve the conditions for the growth of mutual trade"[18]. Early in the course of the visit, a Memorandum and a Roadmap for assisting the Republic of Korea to Uzbekistan's accession to the WTO were signed between the governments of the two

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[17] https://www.uzdaily.com/articles-id-41713.htm

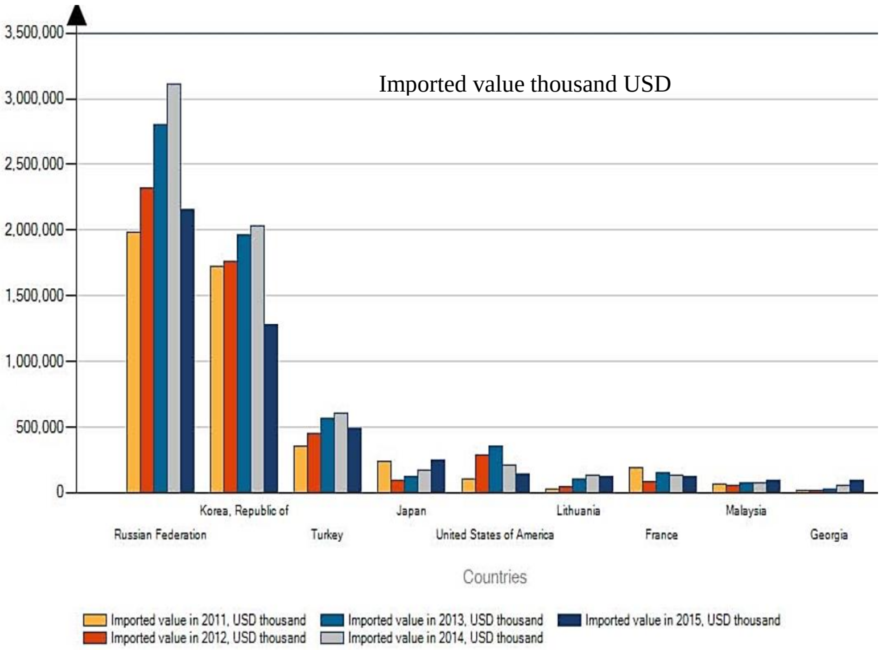
[18] https://www.uzdaily.com/articles-id-41707.htm

countries, including by assessing the consequences of joining the organization, examining national legislation in accordance with the requirements of WTO agreements, as well as technical, consultative and expert support to interested ministries and departments.

In addition, representatives of the ministries discussed the possibility of creating a free trade area and reached an agreement in principle on the need to ensure preferential access to the markets of the two countries. In this connection, the heads of the ministries decided to hold the first meeting of the Joint Working Group on the preparation of the bilateral Agreement on preferential trade between the Republic of Uzbekistan and the Republic of Korea before the end of this year.

Uzbek and Korean nationality have very a close culture, in Uzbekistan, this day lives more than 200 thousand Korean people and they are very close to Uzbek people and working at high-level positions. Consequently, even the distance is very far between two countries, the Republic of Korea is one of the strategic and main partners of Uzbekistan in terms of international trade especially to import of technology.

Figure 13: Uzbekistan's import volume by countries[19]



Earlier from first days of independence of Uzbekistan, the economical, strategically and cultural relationships between two countries started to develop with fast level, and these days, Korea is the second state with the huge market share in Uzbek imports, which is supply import merchandises and services to the Uzbek market. In 2014 total amount of exported merchandises and services from Korea into Uzbekistan were more than 2.0 billion USD[20] which demonstrated in the Figure 13.

[19] http://www.dedc.gov.ae/StudiesAndResearchDocument/MTR004022016UZBEKISTAN.pdf

[20] http://www.dedc.gov.ae/StudiesAndResearchDocument/MTR004022016UZBEKISTAN.pdf

Recently, Uzbekistan has increase import of technologies to energy industry particularly, natural gas and oil refinery, the Republic of Korea is number one investment partner in the energy industry of Uzbekistan. Last decade, Korean investments achieved more than 10 billion USD particularly invested in the energy industry. Recent period Uzbekistan confidently holds cooperation in the implementation of the several of big scaled investment projects on energy sectors which are bilateral beneficial for both sides. Most significant energy resource refinery project "Ustyurt gas-chemical complex" investment was more than 4.0 billion USD which was the outcome of cooperation of Uzbek and Korean nation. The existence of enormous of potentials for increasing Korean investments and enhance the synergy between two nations at the mining fields, gas and oil, chemical-petrochemical, manufacturing and construction, automobile-manufacturing and light industries with Korean energy efficient technologies are on the consideration of Uzbek side at short-term as well as at the long-term perspectives. [21]

[21] http://www.uzbekistan.or.kr/en/bilateral-relations/

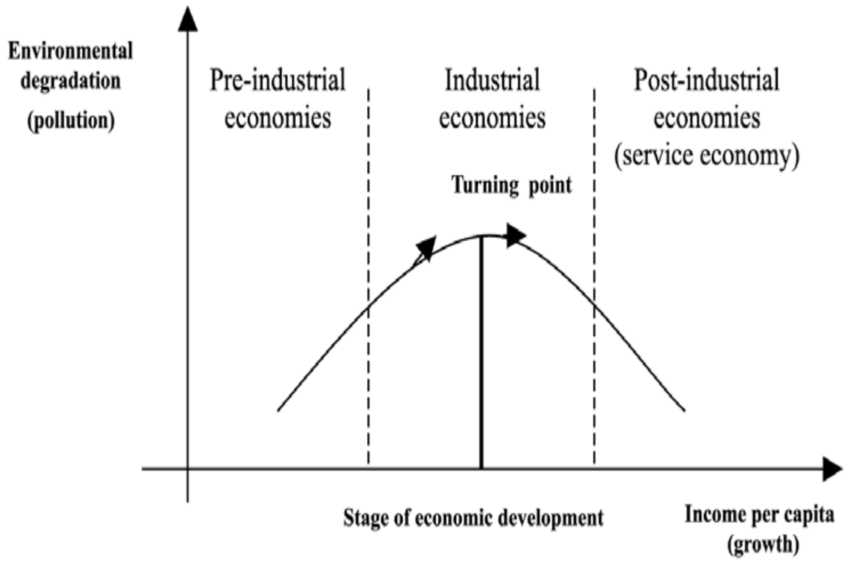
III. Literature Review

After an initial investigation and evidence of an inverted U-shaped relationship between income level and several types of pollutions like carbon dioxide and sulfur dioxide (Grossman & Krueger, 1991), it was the start-up of a new field of the academic research area in energy and environment economics. Until today, many researchers worked out to investigate the relationship between environmental degradation, economic development, and energy usage in the case of developed countries and as well as in the case of developing countries too.

Most of the studies proved the existence of the inverted U shape relationship (Figure 14) among economic development and environmental declining in the countries. Consequently, while carbon emission is the dependent function, a lot of different kind of investigations of the hypothesis has generated dissimilar outcomes. The relationship between economic growth and environmental quality has been examined by numerous authors whose works will be reviewed in the next.

Earlier, Grossman and Kruger (1991), Panayotou (1993), Selden and Song (1994), Panayotou (1997) proved an inverted-U shape relationship between air pollutants and income levels to suggest that the environment at first decline but improve when a nation achieves enough level of wealth.

Figure 14: Environmental Kuznets Curve



Source: Panayotou (1993)

Some academic papers prove existent Environmental Kuznets Curve Hypothesis some of the research reject in different countries context. In the most rejected existence of EKC hypothesis in the case of developing countries. According to academic literature, most developing states are at the left side of turning points of inverted U-shape, carbon emissions continue to increase until income level achievement its significant level which will start to improve environmental quality.

In addition, the environmental degradation caused by the GDP growth in developed nations might bring unalterably, and all measures to mitigation of carbon emissions and return initial environmental quality might be useless (Fodha & Zaghdoud, 2010).

Considering earliest researchers (Stern, Common, & Barbier, 1996) opinion about environmental Kuznets curve theory exploration approach, to get clear and productive results by the investigation of the association among income growth and environmental degradations most appropriate approach is using econometric analysis with historical time series data of individual states would be better.

Inexistence of the EKC for some countries cases demonstrates the necessity to conduct empirical studies on particular states and discover solutions for developing nations to regarding existence energy policy, environmental regulations and development plan to ensure sustainable development (Stern et al., 1996). Review of literature starts with academic papers which published recent years, with evidence of the existence of EKC.

In the United Arab Emirates (UAE) case, the validity of EKC was studied by utilizing factors like economic expansion, electricity usage, urbanization and as well as carbon emission was a dependent function like a proxy of environmental degradation, and all variables with quarterly series 1975–2011 period (Shahbaz, Sbia, Hamdi, & Ozturk, 2014). The outcomes from the empirical study based on the ARDL approach examinations. From the review of the backgrounds of UAE, countries active aspiration of economic development and fruitful business opportunities for investors, foreign direct investment, and achievement in recent years were the contribution of evidence EKC in the country case. It means researchers were determined from empirical results that, UAE's income's square level is associated with the negative index when income is influenced by a positive index into the ecological situation in the country. As a proxy for energy consumption, electricity usage is significantly influenced air quality by declining greenhouse gas emissions levels. This evidence of the country's appropriate energy efficiencies policy which is well organized and support's environmental quality. It is clear that UAE is the energy resource exporter country and its export value improves the air quality by decreasing greenhouse gas emissions. Past decades Countries significantly invested in construction and expansion of urbanization and empirical analysis showed that urbanization affected positively to carbon emissions level. From this researchers concluded that UAE should consider ensuring environmental quality, planning of enhancing of cities (Shahbaz et al., 2014).

In Tunisia case association among CO_2 emissions, income, energy usage, and trade were examined by bounds test technics to cointegration and the ARDL approach was utilized with time series data 1971–2008 (Farhani, Chaibi, & Rault, 2014). Like proxy of environmental degradation, CO_2 emissions were employed a dependent variable and its long-term associations with explanatory variables were examined. The foundation of the validity of EKC has evidence with income coefficient 6.66 and negative value of income square coefficient –3.44. Obviously, trade and energy usage slope parameters are determined carbon emission level which means both explanatory variables affected by the environmental degradation (Farhani et al., 2014).

By utilizing Bounds tests, the associations among carbon emissions, energy use, GDP growth and business openness for the case of Pakistan was studied, in data interval of 1971-2009 (Muhammad, Lean, &

Muhammad, 2011). Findings from research proved the existence of the Environmental Kuznets Curve and long-run associations between the variables. The Considerable being of EKCs proves that Pakistan government attempt to the improvement of environmental quality and specifies a sensible progress of ruling environmental quality in the country. One of the important findings of researchers is that relationship between trade openness and carbon emission is negative in the long run, which determines trade openness of country supports carbon emission mitigation in Pakistan (Muhammad et al., 2011).

To investigation Environmental Kuznets Curve Hypothesis this research employed various explanatory variables based on literature review. Shahbaz, Mutascu, and Azim (2013) employed like explanatory variable GDP per capita and energy consumption per capita with time series properties in 1980-2010 and tested the existence of EKC by ARDL Bounds test in case of Rumania. To examine the existence of a parabolic relationship between economic growth and carbon emission, researchers utilized GDP per capita square value. Main findings of this study proved the existence of inverted U-shape EKC in the country.

Baek (2015) studied being of the EKC exploiting time series properties at separate nation’s degree. As other researchers author utilized explanatory variables like GDP per capita and energy usage per capita in the case of Arctic states. In methodology part, ARDL modeling approach to co-integration is utilized with yearly data in 1960–2010. The unique side of this paper is that author utilized two models quadratic and cubic log formulas to the cheek of the shape of associations among economic development and environmental quality. Main findings provided small sensible of the being of the EKC hypothesis for examined states. Consequently, the author found that GDP growth has a positive influence on the improved environmental quality not for all Arctic states. Also, like in all academic papers case, there is evidence of energy usage significantly influences environmental quality for all learned states.

Jalil and Mahmud (2009) worked to test the long-term association among greenhouse gas pollutant and energy usage, GDP, and trade openness (trade openness is a percentage of the whole value of exports and imports as a share of GDP) in for world faster developing China case through exploiting time series properties. As above mentioned researchers, in this analysis also ARDL approach was used for study whether EKC correlation between greenhouse gas productions and per capita real income footings in the long term or nor. The signal of the existence of EKC is demonstrated by a square association amongst earnings and carbon emission was proved for the chosen epoch. Income and energy usage strong influences into environmental quality were found by this study in the elongated course one more time. But in the case of China, explanatory variable - trade openness even it statistically unimportantly influences on carbon emission.

In the case of developed countries like Korea Baek and Kim (2013) examined the existence of EKC. For empirical research authors generated two models, first model consist of CO_2 per capita, income per capita, energy consumption and electricity generation from traditional fossil fuels like coal, oil, and natural gas for the selected period 1971-2007, and in second model only electricity production from fossil fuels was replaced in to electricity generation from nuclear sources. Both models included a square value of GDP per capita to observe an inverted-U-shaped relationship between economic growth and environmental quality. Obviously, this paper published in 2013, researchers employed ARDL approach for testing cointegration long-term relationship among dependent and explanatory variables. The empirical outcomes of this research proved of the being EKC for Korea case, in the first stage of development of Korea carbon emission was increased and then after achievement certain high income per capita level which was turning point for carbon emission) environmental quality started to increase and last passed decades supplied positive influence on the environmental quality. Consequently, the evidence is that electricity generated by traditional fossil fuels and energy usage has a negative influence on environmental quality in the same sort and long term. But, for nuclear energy case researchers proved opposite effect than fossil fuel, which means after implementing nuclear power plants starting from 1978, it influenced into carbon emission negatively by reducing CO_2 emission significantly in both the short and long-term (Baek & Kim, 2013).

Next literature which dedicated to the investigation of the validity EKC in Portugal case, researchers Shahbaz, Dube, Ozturk, and Jalil (2015) studied and they proved the existence of theory in Portugal. Besides GDP and GDP^2, researchers used as explanatory variables like trade openness and urbanization and of course, the CO_2 emission is the dependent variable. The study confirmed the existence of EKC hypothesis in long-term, as well as in short term. Selected explanatory variables keep the supposed characters which are proved the existence of EKC hypothesis. A country imports major portion of consumption energy resources which is a reason for the positive effect of trade openness (international trade) into carbon emission.

Another unique two models utilized to cheek existence of EKC in developing Vietnam case (Al-Mulali, Saboori, & Ozturk, 2015). Authors created two models; the first model includes electricity consumption based on fossil fuel, and in the second model researchers replaced electricity consumption based on fossil fuel with electricity consumption from renewable energy sources. But because of collinearity or multicollinearity issues among GDP and GDP square, the author's dropped an explanatory variable square of GDP for using a different method which was suggested by Narayan & Narayan (2010) to test whether developing states have the positive or negative effect to CO_2 emission during the period with the rising in their economic development. Main suggestion of different method is that short-run and long-run elasticities should be compared. It means whether long-term earnings elasticity is less significant than short-run earnings, at that point conclusions is that, over time, earnings (GDP) leads to a lesser amount of CO_2 emission (Narayan & Narayan, 2010). Because of Vietnam is developing the country, there is no evidence of EKC hypothesis, even long or short run outcomes and in both models, income is significantly influenced to increase carbon emission. When, from the first model electricity consumption based on fossil fuel significantly influence to increase CO_2 emission, from the second model renewable energy-based electricity is influencing to decrease CO_2 emission, then again it is furthermore not significant which point out the share of renewables is minor and country have to focus on increased share of renewables to significantly decrease CO_2 emission (Al-Mulali et al., 2015).

Based on aforementioned scholars work and including the annual data availability, our research methodology based on ARDL model.

IV. Methodology

4.1 ARDL Bounds Approach

Examining the long run relationship between the chosen dependent variable and explanatory variables in this study, the ARDL Bounds testing approach, which was established by Mohammad Hashem Pesaran and Pesaran (1997), M Hashem Pesaran, Shin, and Smith (2000), M Hashem Pesaran et al. (2001) was used. The investigation of long-term relationship among carbon emissions, fossil fuel/renewable consumption, economic development, and trade openness with short sample size data set less than 30 years like in the case of Uzbekistan, ARDL Bounds test technique make available superior outcomes than before developed technique to co-integration like Engle and Granger (1987), Johansen and Juselius (1990), this advantages of our selected ARDL Bounds test approach was mentioned by Haug (2002). The Pluses of utilization of ARDL bounds approach was highly appreciated by Laurenceson and Chai (2003), they mentioned that unrestricted error correction model (ECM) takes abundant elasticity to provide somewhere to stay lags that grabs the statistics producing procedure in an over-all to the particular context of the condition.

This research followed the empirical frameworks from Jalil and Mahmud (2009), Muhammad et al. (2011), Shahbaz et al. (2013), Baek and Kim (2013), Baek (2015), Al-Mulali et al. (2015), (Shahbaz et al., 2015) and we merged ideas and models from above-mentioned papers, in the result modified model created to investigate EKC in the case of Uzbekistan. As we mentioned many times Uzbekistan is developing the country, which is exporting natural resources and importing technology for the energy industry, besides of energy consumption and income, we include trade openness. Suggested linear specification of model is demonstrated in Equation (1), which includes CO_2 emission per capita (CO_2) in Uzbekistan dependent on income per capita (GDPC), square of income per capita ($GDPC^2$), fossil fuel consumption per capita (FFCP), renewable energy consumption per capita (RECPC), and trade openness (TO), (TO = (Export + Import)/GDP)).

$$CO_2 = f(GDP, GDP^2, FFC, REC, TO) \qquad (1)$$

According to reviewed literature, in order to provide adequate and better results above demonstrated linear specification of formula turned into natural-logarithmic equation (Cameron, 1994; Ehrlich, 1973, 1996).

Additionally, a natural logarithmic formula of variables contributes straight resilience for explanations. Consequently, the initial model is as follows:

$$ln(CO_2)_t = a_0 + a_1(ln(GDPC))_t + a_2(ln(GDPC))_t^2 + a_3(ln(FFCPC))_t +$$

$$+ a_4(ln(RECPC))_t + a_5(ln(TO))_t + \varepsilon_i \quad (2)$$

From equations (2) ε is represented by mistake term. As above reviewed literature, in this investigation, we assume that economic development of the state is certainly motivated by a rise up in energy usage, and consequently, energy usage effects on environmental quality bringing more pollution of greenhouse gases. From this, for the case of equation (2), we can follow the guideline that, the coefficient of fossil fuel consumption is $\boldsymbol{\alpha_3 > 0}$. The existence of the EKC hypothesis submit that, from equation (2) the coefficient of income per capita is positive $\boldsymbol{\alpha_1 > 0}$ and at the same time, GDP square coefficient is negative $\boldsymbol{\alpha_2 < 0}$. Obviously, renewable energy consumption is the main driver to mitigate carbon emission and we believe that coefficient of renewable energy consumption will be negative $\boldsymbol{\alpha_4 < 0}$. The coefficient of trade openness **α5<0** if industries and manufacturers introduced new eco-friendly and high-efficiency technology to reduce carbon emission, according to the government strategy to environmental security rules and importing such energy efficiency technologies from the developed countries with international standards. For this reason, in case of Uzbekistan, which imports mostly technology for the energy industry, we hypnotized that, the trade openness coefficient is negative, **$\alpha 5<0$.**

As we mentioned above Uzbekistan is one of the technology importer countries, especially, a major share of investment including foreign direct investment is spending to energy industry by introducing technology from developed countries like the Republic of Korea. In this case, many researchers proved that for developing countries imported technology positively affect an environmental quality. Frankel and Rose (2005) maintain that investors from outside of country arrive with leading technology and innovational directorial capability from their motherland state for the privilege of receiving nations. It is the only way for developing countries for guiding and leads the energy efficient advances which expand prosperity.

Additionally, for developing counties case, Eskeland and Harrison (2003) finding out that, in few cases, foreign direct investment locates in industries with significant high air pollution. Also, authors investigated whether foreign investments contaminate lesser than their peers. In this case, researchers discover such foreign factory and technologies are higher energy efficiency and utilize cleaner forms of energy. In the end of research, authors mentioned that trade openness significantly cause environmental and air quality and less carbon emission products as trade openness offering a kit of accessible diversity to users. With opposite opinion, Grossman and Krueger (1995) and Halicioglu (2009) debated such feature of trading openness is staid if unclean manufactures of developing states are concerned to make a heavy proportion of carbon emission with the manufactures.

More appropriate and suitable approach ARDL bounds is employed for investigation long-term relationships among dependent and independent variables (M Hashem Pesaran et al., 2001).

4.2 Error-Correction Model (ECM)

The major goal of this investigation is to examine the short-term and long-term influence of GDP per capita, fossil fuel, and renewable energy consumptions, and international trade on environmental degradation in Uzbekistan. In order to achieve these goals, offered equation (2) have to be converted in an error-correction modeling (ECM) form.

$$\Delta \ln(CO_2)_t = \beta_0 + \sum_{k=1}^{n} \beta_1' \Delta \ln(CO_2)_{t-k} + \sum_{k=0}^{n} \beta_2' \Delta \ln(GDPC)_{t-k}$$
$$+ \sum_{k=0}^{n} \beta_3' \Delta (\ln GDPC_{t-k})^2 + \sum_{k=0}^{n} \beta_4' \Delta \ln FFPC_{t-k} +$$
$$+ \sum_{k=0}^{n} \beta_5' \Delta \ln RECPC_{t-k} + \sum_{k=0}^{n} \beta_6' \Delta \ln TO_{t-k} +$$
$$+\beta_1 ln(CO_2)_{t-1} + \beta_2 lnGDPC_{t-1} + \beta_3 (lnGDPC_{t-1})^2 +$$
$$+\beta_4 lnFFPC_{t-1} + \beta_5 lnRECPC_{t-1} + \beta_6 lnTO_{t-1} + \omega_t \qquad (3)$$

Accordingly to Pesaran et al. (2001), in the converted ECM forms equations (3) **Δ** is characterize the 1-difference manipulator; and "***n***" is a lag interval, also the coefficients β_1, β_2, β_3, β_4, β_5, β_6 stands for the long-run (cointegration) relationship, while the attendants of the summing symbol [∑] matches to the short-run relationship among carbon emission and explanatory variables.

4.3 Test of Stationarity

Initially, for time series and for our chosen approach, all variables should be cheek to unit root test, and to apply ARDL approach chosen variables should be stationary at the level I(0) or first difference I(1) otherwise our selected approach cannot be applied (Ouattara, 2004). In order to cheek unit root test, Dickey-Fuller generalized least square (DF-GLS) examination (Elliott, Rothenberg, & Stock, 1992) is employed in EViews 9.5 software, to be a sure that selected variables are I(0) or I(1), if any of them I(2) series, we cannot use ARDL approach (Ouattara, 2004). There are both, Akaike information criterion (AIC) and Schwarz information criterion (SIC) cases employed to cheek unit root test.

4.4 Lag Length Selection

Next step to start applying the ARDL bounds test modeling there is a necessity to find out lag length (m) in equations (3) through the AIC and SIC. ARDL bounds approach has a manipulation by two stages and requests corresponding lag interval in variables to eliminate the probability of the appearance of any serial correlations issues

(M Hashem Pesaran et al., 2001). The optimal lag selection will be chosen by least rating of AIC and SIC. Many researchers proved that accounting of ARDL bounds f-statistics has a sensitivity to the options of lag orders in formulas. To achieve unbiased and secured outcomes, selecting an appropriate lag order is very important.

4.5 Serial Correlation Test

After selection optimal lag by AIC and SIC, we should test the null hypothesis of no serial correlation, in contrast, to lag length by Lagrange multiplier (LM) statistics. In "EViews 9.5" software we run the Breusch-Godfrey Serial correlation LM test. LM test was presented and obtained for a number of unique type approaches, and as it was noted, it is reduced to some prominent diagnostics verify for serial correlation. Overall conceptual advantages of LM test look three-fold: usually, this requires the least squares; it is rarely difficult to calculate, and its precise distribution of small samples can be found in some specific cases (Breusch & Pagan, 1980).

4.6 Cointegration Test

Cointegration analysis of the concerning restrictive hypothesis that the variables, participating the finding of the dependent variable of interest of function are all integrated. M Hashem Pesaran et al. (2001) demonstrated that the issue of testing for the being of a level bonds among function and explanatory variables is irregular even if all the variables matching with I0, since according to the null hypothesis of neither level association among function and independent variables, the method characterizes the function act is I(1), independent of what the variables are fair I(0), purely I(1) or jointly cointegrated. M Hashem Pesaran et al. (2001) provided the asymptotical theory which demonstrates a common univariate structure for verifying the validity of a sole level association among function and explanatory variables when it is not familiar with confidence if the variables are truly I(0), truly I(1) or jointly cointegrated. Besides, it is needless that the commission of integration of the basic variables is set before the testing the validity of a level associations among function and explanatory variables.

V. Empirical Analysis and Results

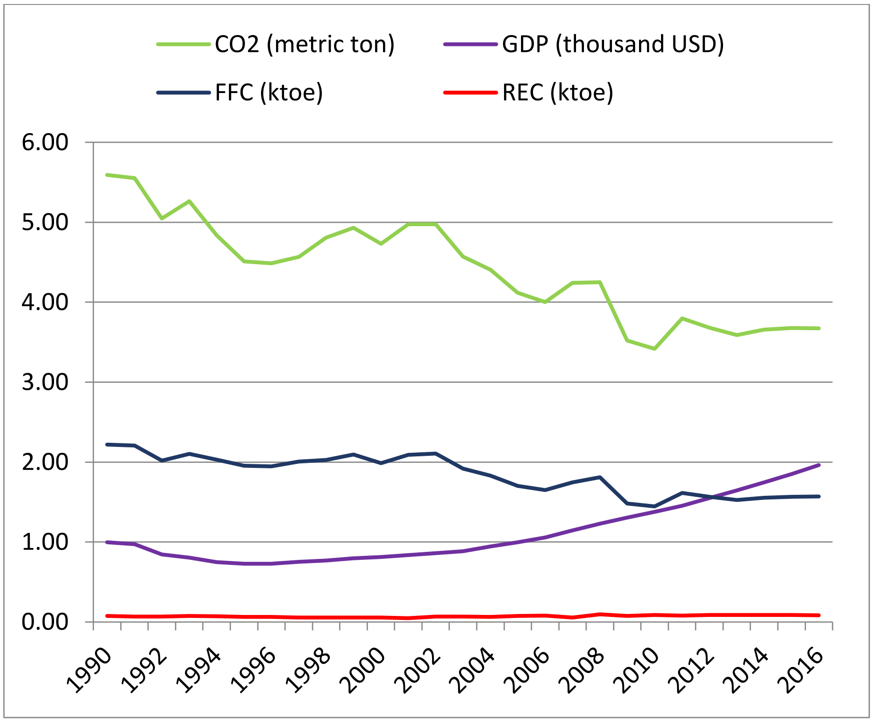
5.1 Data

For this research, time series data collected from, International Energy Agency statistical data, World bank data - Word Development Indicators, Statistical Review of World Energy 2017 published by British Petroleum (BP). As we mentioned much time above, Uzbekistan became independent from the Soviet Union earlier 1991, which is the main reason of data limitation with only 27 years. Time series data from 1990 to 2016 was utilized for our investigation. CO_2 emission per capita is utilized as a proxy for environmental quality.

- GDPC - GDP per capita (US$);
- FFPC - Fossil fuel consumption per capita (kilo ton oil equivalent per capita);
- RECPC - Renewable energy consumption per capita (kilo ton oil equivalent per capita)
- CO_2 - CO_2 emission per capita (metric ton per capita)
- Trade openness (TO) is defined as a percentage of the whole value of exports and imports as a share of GDP

From the chart demonstrated in the figure 15, we can see, after independence country achieved CO_2 mitigation and keeping growth rate. Also, renewable energy increased but not too much. Because of high energy efficiency technology deployment especially Korean technology in the energy and refinery sectors, energy consumption decreased.

Figure 15: Dynamics of CO_2 emission per capita[22], GDP per capita[23], fossil and renewable energy consumption per capita



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[22] Drawn by author based on BP Statistical Review of World Energy 2017

[23] Drawn by author based on World bank data - Word Development Indicators

5.2 Unit Root Test

Fortunately, from the results of unit root test in both criterions (AIC and SIC) we confidently say that all variables are I (1) and suitable to apply ARDL approach, there are no I (2) variables. More detailed results of DF-GLS unit root test demonstrated in the table 1.

Table 1: Results of Dickey-Fuller generalized least squares (DF-GLS) Unit root test

Unit Root Test Results					**Decision**
VARIABLES	levels		First difference		
	p-values	t - statistic	p-values	t – statistic	
$\ln(CO_2)$	0.8917	-0.1378	0.0000	-5.4331*	I(1)
ln(GDPC)	0.6472	-0.4637	0.0052	-3.0725*	I(1)
$\ln(GDPC^2)$	0.6700	-0.4316	0.0039	-3.1913*	I(1)
ln(FFPC)	0.9522	-0.0607	0.0000	-5.9906*	I(1)
ln(TO)	0.1280	-1.5791	0.0000	-6.0239*	I(1)
ln(RECPC)	0.2179	-1.2794	0.0000	-5.9414*	I(1)

* Denotes significance at better than 1%

5.3 Lag Selection

From the table 2 we can select the lag, which is demonstrated the values with mark “*” right upper side of value, and we can see the optimal lag, which is lag 1.

Table 2: Lag length selection criteria

VAR lag order selection criteria						
Lag	LogL	LR	FPE	AIC	SIC	HQ
0	143.934	NA	9.94e-13	-10.610	-10.319	-10.526
1	317.892	254.247*	2.65e-17*	-21.222*	-19.190*	-20.637*

5.4 Correlation Test

From the table 3 the value of Prob. Chi-Square (1) is equal to 0.0875 which is bigger than 0.05, which indicates residual term is distributed normally and we can say there is no serial correlation in our developed model. Based on the result, the error term of our model - there is no exists a serial correlation between among variables - where CO2 is specified as a function of all the independent variables, does not suffer from serial correlation based on the F-test (Wooldridge, 2015), but it does suffer from serial correlation based on Chi-Square test. The serial correlation can be rejected at the 10% level based on the Chi-Square (because of the p-value =0.08).

Table 3: Serial correlation LM test result

Breusch-Godfrey Serial Correlation LM test			
F-statistic	2.0235	Prob. F (1.16)	0.1174
Obs* R-squared	2.919	Prob. Chi-Square (1)	0.0875

Another hand, to test the Null Hypothesis H_0 ($H_0 = \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$) is required initially, if there are no levels relationship among all variables in the long run (not cointegrated), than, against alternative Hypothesis H_1 ($H_1 \neq \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$) where there is cointegration among variables from equation (3) (Wooldridge, 2015). From bond test result, by comparison, calculated F-statistics with lower and upper critical bound values we can reject or except null hypothesis.

If the f-statistic value is a bigger than upper critical bound there is evidence of cointegration between variables (M Hashem Pesaran et al., 2001).

Table 4: Bound Test results

F-Bounds Test Result	Value	Significance level	Lower critical Bound (I(0))	Upper Critical Bound (I(1))
F- statistic	3.69	10%	2.49	3.38
		5%	2.81	3.76
		2.5%	3.11	4.13
		1%	3.5	4.63

Our result showed cointegration between variables. Calculated F statistics is equal 3.69 which is bigger than upper critical Bound at 10 % significance and there is cointegration relationship between variables. According showed results in the Table 4 we can confidently reject the Null Hypothesis (H0) (M Hashem Pesaran et al., 2001; Wooldridge, 2015).

5.5 Short Run Relationship Estimates

In the short-run estimates, from the table 5 we can see, variable fossil fuel consumption per capita (FFPC) is statistically significant, other explanatory variables not significant and they dropped, the most important factor, error-correction term (CointEq (-1)) – is negative and highly significant, which confirming the existence of cointegration relationship among the variables. We can confidently proceed our estimation with long-run tests (Wooldridge, 2015).

Table 5: Short run estimation results

Variable	**Coefficient**	**Std. Error**	**T-statistic**	**p-value**
C	-7.269	1.227	-5.920	0.0000
D(FFPC)	0.948	0.035	26.612	0.0000
CointEq (-1)	-0.691	0.116	-5.917	0.0000

5.6 Long Run Relationship Estimates

The environmental consequence of growth is a long-run phenomenon. From the table 6, outcomes from long-run estimates proved the existence of EKC. Both the coefficients of GDP and GDP square per capita shows the existence of inverted-U shape relationship between economic development and CO_2 emission. The coefficients of income per capita and the square of income per capita are 3.0803 and - 0.2072 respectively and highly significant. These two coefficients indicate that a 1% rise in per capita income will increase CO_2 level by 3.0803% while the negative coefficient of squared term confirms the reduction of CO_2 emission levels. Our result is the same as previous studies findings. An increment of fossil fuel consumption (FFPC) positively affects to

CO_2 emission level which means, if fossil fuel usage will grow by 1 %; it will increase carbon emission levels by 0.9256%.

Consequently, a very important explanatory variable - trade openness demonstrated the negative influence on greenhouse gases emissions in the country. The negative and statistically significant coefficient (-0.0515) of trade openness (TO) indicates that, if country's international trade will grow 1%, it will decrease carbon emissions level 0.0515%.

Table 6: Long run cointegration Bound Test results

Dependent variable: $LnCO_2$			
Intercept	β_0= -7.264		
independent variables	slope parameters	p-value	t-statistics
lnGDPC	β_7 = 3.0803	0.0004	18.880
$(lnGDPC)^2$	β_8= - 0.2072	0.0006	-16.740
lnFFPC	β_9= 0.9256	0.0000	48.580
lnRECPC	β_{10}= - 0.0237	0.3987	-0.8657
lnTO	β_{11}= - 0.0515	0.0232	-2.494
Observations	26		

As we mentioned in above chapters several times, Uzbekistan is a raw material rich country and the export volume is based on finished and semi-finished merchandise particularly fossil fuels and chemical and petrochemical products and consequently, the imported volume based on technology transfer from developed countries, especially Korean technologies which are successfully deployed and continuing deployment at the raw materials manufacturing sectors.

From the long run estimates, the coefficient of renewable energy consumption (RECPC) is negative and equal to 0.0237, but it is not significant because the calculated p-value is equal to 0.3987.

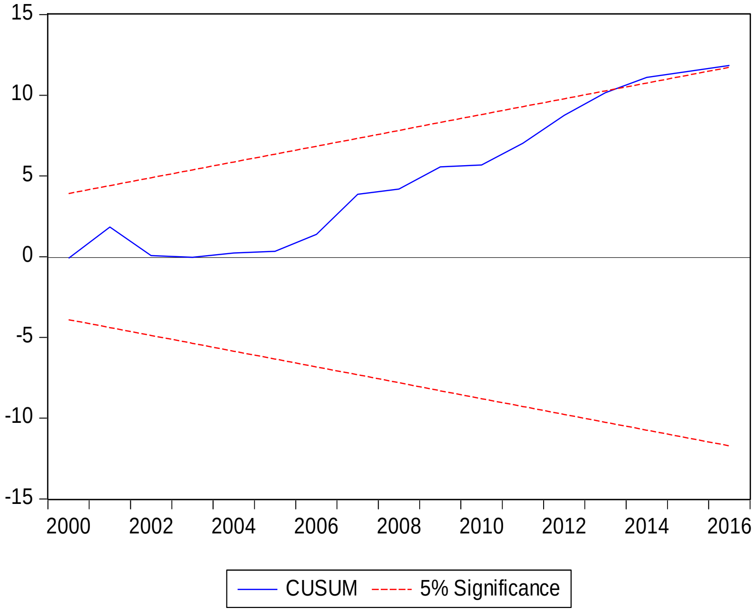
For countries like Turkey, Greece, Portugal and, Austria and Belgium, CO_2 emission mitigation was achieved based on renewable energy usage. (Bilgili, Koçak, & Bulut, 2016b). In Uzbekistan's case, consumption of renewable energy is still minor.

5.7 Stability Tests

The last stage of ARDL approach is to check the stability of the model. By cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMSQ) test, we investigate the stability of short-run and long-run parameters.

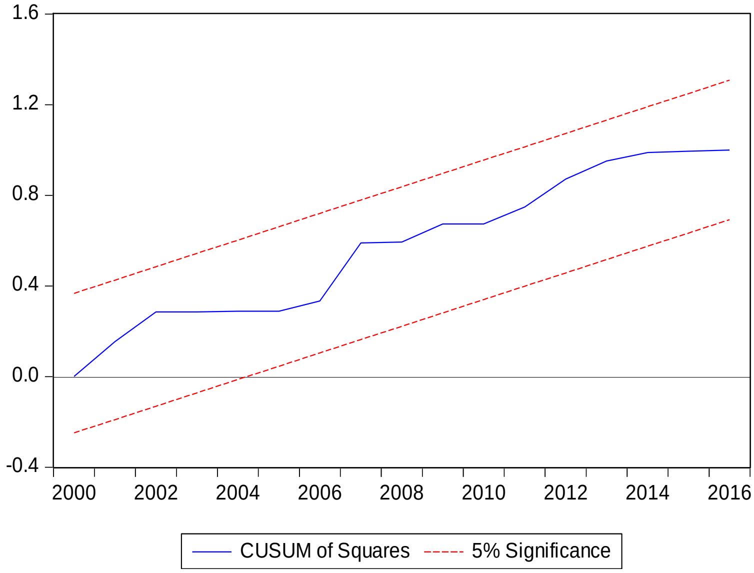
The Figures 16 and 17 plots of CUSUM and CUSUMSQ statistics are well within the critical bounds, implying that all coefficients are stable. And we are happy about our model.

Figure 16: Plot of cumulative sum of recursive residuals[24]



[24] Drawn by author based software “Eviews 9.5” outcomes

Figure 17: Plot of cumulative sum of squares of recursive residuals[25]



5.8 Discussion and Implications

In the scope of this study, we try to find out if there is a relationship between economic growth and environmental degradation in the case of Uzbekistan. Particularly we focused on the existence of EKC. GDP per capita was used in our analyses to capture the level of economic prosperity. Environmental degradation is represented by CO_2 emissions per capita measured in a metric ton. All data variables are obtained from statistics of World Bank and Statistical of British Petroleum (BP)

[25] Drawn by author based on software "Eviews 9.5" outcomes

for 1990-2016 years. Time series analyses by using ARDL model was chosen for this study after reviewing previous studies and considering specific features of data.

The outcomes of long-run estimates which came out by applying ARDL bound tests showed that there a relationship between economic growth and environmental degradation in case of Uzbekistan.

Also, following the strategy of the previous scholar's studies, like sub investigation, we examined existence EKC by replacing fossil fuel consumption per capita (FFCPC) to total energy consumption per capita (TECPC). According to ARDL approach first of all new variable tested to stationary and results showed the natural logarithmic value of total energy consumption per capita (ln(TECPC)) is I(1) (Table 7).

Table 7: Results of DF-GLS Unit root test for total energy consumption per capita

Unit Root Test Results					**Decision**
VARIABLES	Levels		First difference		
	p-values	t - statistic	p-values	t – statistic	
ln(TECPC)	0.3010	-1.0561	0.0000	-6.0157*	I(1)

Afterward the appropriate results of the unit root test, we proceed same estimation process by ARDL approach with using an explanatory variable (ln(TECPC)).

The outcomes from bond test results indicated that F statistics is equal 5.22 which is confidently significant at 1 % significance level by being higher than upper critical bound (Table 8), which proves existence cointegration relationship among variables. Also, we can confidently reject the Null Hypothesis (H0). Because of fossil fuel consumption is composed almost 95 % of total energy consumption the results of long-run estimates is similar with our developed model case and calculated F-statistic is obtained a more confident value which is the statistically significant even at 1%.

Table 8**:** F- Bound test result for the case with variable total energy consumption per capita

F-Bounds Test Result	Value	Significance level	Lower critical Bound (I(0))	Upper Critical Bound (I(1))
F- statistic	5.22	10%	2.49	3.38
		5%	2.81	3.76
		2.5%	3.11	4.13
		1%	3.5	4.63

Consequently, the short run estimation outcomes proved the existence of the cointegration relationship among the dependent and independent variables, because of the coefficient of error correction term (CointEq) is negative and highly significant (Table 9).

Table 9: Short run estimation results for the case with variable total energy consumption per capita

Variable	**Coefficient**	**Std. Error**	**T-statistic**	**p-value**
C	-7.015	0.996	-7.037	0.0000
D(FFPC)	0.959	0.037	25.680	0.0000
CointEq (-1)	-0.653	0.092	-7.033	0.0000

Long run relationship examination outcomes are similar with the results of our main developed model, which demonstrates the reality of EKC concept in Uzbekistan case, and the appeared slope parameters of the independent variables which are almost similar value and at the same significance level. The comparison of the results of the main model and sub-model (with variable total energy consumption per capita) outcomes demonstrated in the table 10.

Table 10: The comparison of the results of main model and sub-model

Dependent variable: LnCO2				
Name	Main model		Sub-model	
Intercept	β0= -7.264		β0= -7.0104	
Independent Variables	Slope Parameters	p-Value	Slope Parameters	p-Value
GDP per capita	β2 = 3.0803	0.0004	β2 = 3.0758	0.0008
square of GDP per capita	β3= - 0.2072	0.0006	β3= - 0.2058	0.0011
Fossil fuel cons. per capita	β4= 0.9256	0.0000		
Total Energy cons. per capita			β4= 0.9226	0.0000
Renewable energy cons. per. cap.	β5= - 0.0237	0.3987	β5= - 0.0952	0.1148
Trade Openness	β6= - 0.0515	0.0232	β6= - 0.0539	0.0025
Observations	26		26	

From the table 10, by matching the slope parameters and the p-value of each variable we became confident about the stability and correctness of our created model (2). Subsequently, when we exploited like independent variable - total energy consumption instead fossil fuel consumption Sub-model became more stable which is proves the rightness of our models and empirical results.

From empirical results, the coefficient of GDP per capita is positive while the coefficient of the square of income per capita has a negative relationship. This proved the existence of EKC. At the initial stage, GPD per capita lead to increased CO_2 emission level and then, by achieving a higher level of economic growth, there is an improvement in environmental quality as a result of a reduction in carbon emission levels. Other explanatory variables also play significant roles in the drawing final outcome of environmental quality. For example:

The trade openness is the factor which decreases the level of CO_2 emission at sample period in the case of Uzbekistan. This result confirms the finding Zambrano-Monserrate, Carvajal-Lara, and Urgiles-Sanchez (2016) and also contradicts the findings of Jalil and Mahmud (2009); (Shahbaz et al., 2015). This contradiction can be explained by several factors. First of all, every country has a specific situation in case of trade. Uzbekistan's level of trade openness is relatively different from liberalized international trades of other countries. The effect of trade openness in reducing CO_2 emission levels might be drastically changed after obtaining membership of World Trade Organization. Uzbekistan's main purpose is to transform from an agriculture country into an industrialized country, and all policies and measures focused towards the increase of production of high value-added products and to also increase the share of export final products instead to exporting raw materials. In order to achieve goals, Uzbekistan is attracting foreign investment by importing new, modern, and high-efficiency technology for production of oil and gas, chemical, petrochemical, gas processing, textile, and power energy sectors. As Frankel and Rose (2005) mentioned in their research paper, foreign investments flow brings advanced technology and innovative solutions which leads energy efficiency approach. Consequently, Eskeland and Harrison (2003) concluded in their academic paper that, trade openness increases environment quality and allows the production of cleaner products.

If we look at the background of Uzbekistan's economy and its features in the period of before 1990, environmental issues and energy efficiency had worst scenario. The energy intensity of economies the former the Soviet Union, central and eastern Europe traditionally have been extremely high (Cornillie & Fankhauser, 2004). A huge amount of CO_2 emissions were footprints from high energy intensity industries. During the Soviet Union period, all countries including Uzbekistan followed the centrally planned economy, starting from the production of consumer goods into high value-added products, simultaneously not cared about environmental quality and carbon emission. Covering a huge amount of territory, population, and energy resources consumption, the economy did not improve themselves with high energy intensity, energy-related smogs and carbon emissions. Comparison of Energy intensity and carbon emission level of former Soviet Union's planned economy with market economies clearly demonstrated strikingly higher indicators. When planned economy tried to fulfill the set production plan despite the huge energy consumption and huge carbon emissions, the action of the market economies concentrated on the production of competitive goods with less energy usage for all goods. At those times, Uzbekistan's energy intensity was very high, with low energy efficiency technologies especially in energy industry and power generation sector which were the main contributor of CO_2 emission levels (Chandler, Makarov, & Dadi, 1990).

Energy efficiency issues are an urgent and one of the deepest problems, but another side, increasing income value, and exporting potentials, as well as mitigations of CO_2 emissions should be reached by guiding the appropriate energy efficiency investment policy. Energy efficiency opportunity of the supply and demand-side has a great potential for improvement. As we mentioned above, the country is one of the energy inefficient states in Europe and CIS. According to the World Bank's estimations (Kochnakyan et al., 2013), these low-energy efficiency factors cost the economy at least 4.5 percent of GDP annually every time and major contributor of CO_2 emissions.

Joint report of IEA, OECD, and Nuclear energy agency (IEA & Action, 2010) confirmed that, among technologies coal-based electricity production is a highest carbon emitter with value 0.3404 tons of CO_2 for per megawatt hour (MWh), and second highest carbon emitter is oil-based electricity generation with 0.2785 ton of CO_2 for per megawatt hour, and among fossil fuels natural gas-based electricity production by combined cycle gas turbine (CCGT) is lowest carbon emitter with 0.2303 ton CO_2 per megawatt hour (Ryu, Dorjragchaa, Kim, & Kim, 2014). The achievement of Uzbekistan in terms of CO_2 emission mitigation is due to changing energy mix structure after 1990. As we mentioned at above chapter, primary energy consumption is significantly increased at last decades, the same time consumption of high CO_2 emitter fossil fuels like coal and oil significantly decreased, and the decreased amount of high CO_2 emitter fossil fuels replaced with less CO_2 emitter which is natural gas by achieving its share 88% in 2016 from 64% in 1990. Also, government understood that energy efficiency is one of the supporter pillars to ensure future energy security and environmental quality. The transition from conventional thermal power plant technology into CCGT technology will provide environmental improvement as well as economic benefit. There is evidence that renewable energy consumption can be the main determinant factor to reduce environmental degradation (Bilgili et al., 2016b). But according to our findings, renewable energy consumption has the insignificant effect to reduce CO_2 emission levels in case of Uzbekistan. This result can be explained by not matured level of usage of renewable energy resources and technologies. The country has the enormous natural potential (Bahtiyor et al., 2011; Eshchanov, Grinwis, Eshchanov, & Salaev, 2011; Saidmamatov, Salaev, Eshchanov, & Shimin, 2014) for utilization of renewable energy technologies (solar, hydro, and wind). Despite many encouraging and enabling factors at present time consumption and production of renewable energy does not have a sufficient level. Earlier in 2013 Draft law "On renewable sources of energy" was started to design which should serve as a main legislative document to support renewable energy development and deployment[26]. Unfortunately, this draft law is still not finalized and approved. Nonexistence of appropriate legislation is a major factor in hampering the dissemination of renewable energy usage through all

[26] https://renewablesnow.com/news/uzbekistans-draft-renewable-energy-law-to-be-completed-this-month-report-358400/

over the country. Scholars, (Couture & Gagnon, 2010) mentioned that already proved by global experience and successfully implemented by more than 63 countries, Feed-in tariffs (FITs) is a major effective policy for stimulating the quick adoption and deployment of renewables usage. (Butler & Neuhoff, 2008; Klein, 2008; Publishing & Agency, 2008; Sawin et al., 2013). In Uzbekistan, the case of introduction FITs mechanism by the Draft law "On renewable sources of energy" will be an effective policy to the booster and increase renewable energy usage by the private sector as well as by householders.

VI. Conclusion and Policy Implications

6.1 Conclusion

This research investigated the Environmental Kuznets Curve Theory existence in case of Uzbekistan by testing the relationship among economic development, fossil fuel and renewable energy consumption, trade openness and CO_2 emission over the period 1990-2016. After reviewing several methodologies and considering a sample size of time series data, ARDL approach applied for finding the answers to our research questions. The existence of an EKC in our case was obtained in the model which include additional explanatory variables: trade openness (TO), fossil fuel consumption per capita (FFPC), and renewable energy consumption per capita (RECPC).

The answer to the first research questions was clear that the outcomes of ARDL bounds test proved the existence of Environmental Kuznets Curve Theory with inverted U shape relationship between CO_2 emission and GDP per capita and its quadratic terms coefficients in the long-run. This proves the consistent relationship between economic growth and environmental degradation.

The second research question was about to define the main determinants of CO_2 emission in case of Uzbekistan. Empirical results showed that, in the long run, CO_2 emission level is positively and significantly impacted by fossil fuel consumption. Another main determinant which has a negative impact is - trade openness; overall trade openness influences significantly to mitigation the carbon emission levels in the country. From the results, we could not find a significant influence of renewable energy consumption into environmental improvement, but the slope parameter of renewable energy consumption is negative, which can be the determinant factor to reduce emissions level when its share of total energy balance will increase in the future significantly.

6.2 Policy Implication

This study enables us to build the below-mentioned recommendations for Uzbekistan's policymakers to ensure sustainable development. They include;

1. Since the EKC Concept exists in the case of Uzbekistan, it will be plausible for government and policymakers to put measures

in place for the development of our trade openness policy. Investors should be encouraged to invest in efficient energy technologies with a view to growing our country income and also reducing CO_2 emissions.

2. Since renewable energy consumption has insignificant effects on carbon emission, Uzbekistan is lagging in use of existing renewable energy potential and sources, the share of renewable energy in total energy consumption confidently can be enlarged via:

   a) Improving legislation - the blueprint of legislation basis for using renewable energy might be discussed and approved which can create the base legislation to introduce the popular renewable energy deployment policy - Feed-in tariffs mechanism;

   b) Undertaking the measures to increase the awareness of the populace and private sector about renewable energy technologies and remuneration policy (Feed-in tariffs mechanism) for private power producers and householders;

3. The consideration of developing appropriate measures towards the reduction of energy intensity by introducing high energy efficient technologies which will help to improve the quality of the environment.

Analyses on the relationship between aforementioned independent and dependent variables for Uzbekistan case was not investigated so far. This is the first attempt to apply EKC concept in the case of Uzbekistan. Research is a “Pioneer study” of the examination of ECK concept by utilizing time series data which is based on the uniqueness of our research model. ECK is mainly observed in developed countries cases (Bilgili et al., 2016a; Jebli et al., 2016; López-Menéndez et al., 2014). This study is a next after (Farhani et al., 2014); Jalil and Mahmud (2009); (Muhammad et al., 2011; Shahbaz et al., 2013), which is proved the existence of ECK in the case of developing countries like Uzbekistan. Research model also can be tested by using time series data of Central Asian countries as well as Commonwealth of Independent States, which are a similar economic situation with Uzbekistan.

6.3 Limitation of Study

The developed model is appropriate to test EKC concept and level of significance of renewable energy usage in terms of environmental improvement for individual developing countries which has enormous renewable energy sources.

The main limitation of this study was data availability. As Uzbekistan acquired sovereignty in 1991, data for some variables are available after 1990. Particularly the annual data of export and import of goods and services are available only from 1990. As a result of data limitations, we utilized time series data only for 27 years. In the future, this study can be improved by utilizing more than 30 years' time series data or using quarterly data and outcomes might be clearer.

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Appendix

Appendix A. Data Information

Source of Data:

a) GDP and population (total), the total value of export and import goods and services were collected from World Bank (http://databank.worldbank.org/data/reports.aspx?source=2&country=UZB) as a constant 2010 US$

b) Fossil fuel consumption, renewable energy consumption (hydropower and renewables) and CO_2 emissions data were collected from Statistical Review of World Energy 2017 published by British Petroleum (BP). (https://www.bp.com/content/dam/bp/en/corporate/pdf/energy-economics/statistical-review-2017/bp-statistical-review-of-world-energy-2017-full-report.pdf)

The variables fossil fuel consumption, renewable energy consumption, and CO_2 emissions converted into per capita value.

All variables were transformed into natural logarithms.

Variables:

1. Ln(GDPC) – natural log of GDP per capita
2. Ln(TECPC)- natural log of Total energy consumption per capita
3. Ln(FFPC) - natural log of Fossil fuel consumption per capita
4. Ln(RECPC) - natural log of renewable energy consumption per capita
5. Ln(CO_2) - natural log of CO_2 emission per capita
6. Ln(TO) - Trade openness (a percentage of the whole value of exports and imports as a share of GDP).
7. Ln(TECPC) - natural log of total energy consumption per capita

The time series frame:

Uzbekistan acquired sovereignty earlier 1991, for this reason, data is available for only 27 years. Time series data interval is from 1990 to 2016.

Appendix B

Time series data on fossil fuels consumption (by type) and renewable energy consumption of Uzbekistan [27]

Year	Carbon dioxide emissions (million tons)	Natural gas consumption (Mtoe)	Renewable energy consumption (hydroelectric and other renewables) (Mtoe)	Oil consumption Mtoe	Coal consumptio n Mtoe	Total energy consumption (Mtoe)
1990	114.7	32.2	1.5	10.1	3.3	47.0
1991	116.4	32.4	1.4	10.7	3.1	47.6
1992	108.3	32.6	1.4	8.7	2.0	44.7
1993	115.5	35.5	1.7	9.2	1.4	47.8
1994	108.3	36.1	1.6	7.9	1.4	47.0
1995	102.8	37.0	1.4	6.7	0.9	45.9
1996	104.2	37.8	1.5	6.6	0.8	46.7
1997	108.1	39.7	1.3	7.0	0.8	48.8
1998	115.6	41.0	1.3	6.9	0.8	50.1
1999	119.9	43.0	1.3	7.1	0.8	52.2
2000	116.6	41.1	1.3	7.1	0.7	50.3
2001	124.2	44.6	1.2	6.8	0.8	53.4
2002	125.7	45.8	1.6	6.6	0.8	54.8
2003	116.9	41.2	1.7	7.3	0.5	50.7
2004	114.0	39.1	1.6	7.5	0.8	48.9
2005	107.8	38.4	2.0	5.1	0.9	46.4
2006	106.0	37.7	2.1	5.1	0.8	45.7
2007	114.0	41.3	1.4	4.7	1.0	48.4
2008	116.0	43.8	2.6	4.6	1.0	52.0
2009	97.7	35.9	2.1	4.3	1.0	43.3
2010	97.6	36.8	2.5	3.6	0.9	43.8
2011	111.4	42.9	2.3	3.4	1.1	49.7
2012	109.6	42.5	2.5	3.0	1.2	49.2
2013	108.5	42.2	2.6	2.9	1.1	48.7
2014	112.4	43.9	2.7	2.7	1.2	50.5
2015	115.1	45.2	2.7	2.7	1.1	51.7
2016	117.0	46.2	2.7	2.8	1.0	52.7

[27] BP Statistical Review of world energy, 2017

Appendix C

Time series data on GDP, amount of export and import goods and services[28]

Year	GDP (billion US$)	Exports of goods and services (billion US$)	Imports of goods and services (billion US$)	Population, total
1990	20.5	3.9	6.4	20510000
1991	20.4	4.8	5.4	20952000
1992	18.1	3.5	5.6	21449000
1993	17.7	4.4	4.0	21942000
1994	16.7	2.2	2.7	22377000
1995	16.6	4.9	4.9	22785000
1996	16.9	3.9	4.8	23225000
1997	17.8	4.0	4.4	23667000
1998	18.5	3.4	3.4	24051000
1999	19.3	3.1	3.1	24311650
2000	20.0	3.4	3.0	24650400
2001	20.9	3.2	3.2	24964450
2002	21.7	3.0	2.8	25271850
2003	22.6	3.8	3.1	25567650
2004	24.4	4.8	3.9	25864350
2005	26.1	5.4	4.1	26167000
2006	28.0	6.3	5.4	26488250
2007	30.8	8.9	8.2	26868000
2008	33.5	12.2	11.4	27302800
2009	36.3	11.5	11.7	27767400
2010	39.3	12.5	11.2	28562400
2011	42.6	15.0	14.2	29339400
2012	46.1	14.2	16.8	29774500
2013	49.8	15.3	17.8	30243200
2014	53.7	14.6	17.1	30757700
2015	57.9	13.8	14.8	31298900
2016	62.5	13.9	14.4	31848200

[28] World Bank data - World Development Indicators

Appendix D Empirical outcomes of the research

ARDL Error Correction Regression
Dependent Variable: D(CO2)
Selected Model: ARDL(1, 1, 0, 0, 0, 0)
Date: 11/11/17 Time: 03:51
Sample: 1990 2016
Included observations: 26

ECM Regression
Case 4: Unrestricted Constant and Restricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-7.269030	1.227791	-5.920413	0.0000
D(FFC)	0.948677	0.035648	26.61203	0.0000
CointEq(-1)*	-0.691556	0.116863	-5.917651	0.0000

R-squared	0.970549	Mean dependent var	-0.016175
Adjusted R-squared	0.967988	S.D. dependent var	0.060190
S.E. of Regression	0.010769	Akaike info criterion	-6.116105
Sum squared resid	0.002667	Schwarz criterion	-5.970940
Log-likelihood	82.50936	Hannan-Quinn criteria.	-6.074303
F-statistic	378.9804	Durbin-Watson stat	2.135904
Prob(F-statistic)	0.000000		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	3.697616	10%	2.49	3.38
k	5	5%	2.81	3.76
		2.5%	3.11	4.13
		1%	3.5	4.63

국문초록

본 연구는 1990 년부터 2016 년까지 우즈베키스탄의 통계데이터를 활용하여 탄소 배출량과 에너지 원별 소비, 경제 성장률 그리고 무역 개방도의 장기간의 관계를 살펴보았다. 본 연구의 목적은 우즈베키스탄의 데이터에서 환경쿠즈네츠곡선(Environmental Kuznets curve: EKC)이 성립하는지 확인하는 것이다. 시계열 데이터의 간격을 고려하기 위해 실증분석에는 자기회귀시차분포(autoregressive distributed lag: ARDL) 모형을 사용하였다. 분석 대상 기간 동안 우즈베키스탄에서는 인당 소득과 인당 소득의 제곱 그리고 탄소 배출량 사이에 환경 쿠즈네츠 곡선이 성립하는 것을 확인할 수 있었다. 뿐만 아니라 화석 연료 소비는 탄소 배출량에 양(+)의 유의한 영향을 미치는 반면, 무역 개방도는 탄소 배출량에 음(-)의 유의한 영향을 미친다는 사실을 발견하였다. 재생에너지 소비의 경우, 유의하지는 않았지만 탄소 배출량에 음(-)의 영향을 미치는 것으로 나타났다.

이러한 실증분석 결과는 정책입안자에게 다음과 같은 시사점을 제공한다. 우선 탄소배출량을 줄이기 위해 국제 무역의 자유화를 추진하는 방법이 있다. 이를 통해 고효율 에너지 기술이 도입됨으로써 에너지 이용 효율을 높일 수 있다. 또한 법적 제도의 개선을 통해 에너지믹스에서 재생에너지의 비중을 늘리는 방안 역시 고려해볼 수 있다.

주제어: 경제성장, 에너지소비, 탄소배출량, 자기회귀시차분포(ARDL), 환경 쿠즈네츠 곡선, 무역 자유도.

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