The 2030 EU Energy Strategy and Iran's Energy Demand Security

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Abstract

Identification of reliable and stable markets is one of the most important requirements for oil and natural gas exports. The importance of this issue can be answered from standpoint of energy security demands. China, India and the European Union are Iran's potential strategic energy markets, regardless of sanctions. In October 2014 The European Council agreed on a new 2030 Framework for climate and energy, including EU-wide targets and policy objectives for the period between 2020 and 2030. In this study, we seek to investigate the effects of this policy on the security of Iran's energy demand. To this end, we examine the effects of this policy on the energy demand of one of the EU countries, namely Greece, which was also a customer of Iranian oil. Despite the fact that the EU Energy Strategy 2030 reduces the security of Iran's energy demand, it is necessary to examine the possible scenarios of this strategy and assess the Iran's situation in each of these scenarios. During the next ten years Greece energy policies will have to be harmonized with the European Union Directives, focusing on the reduction of the greenhouse gas (GHG) emissions, penetration of renewable energy sources (RES) and energy saving. In this study, Goal

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programming method is used to model the macro-energy policies of Greece up to the 2030 EU Energy Strategy. After creating the mathematical model of goal programming, environment scenario and Renewable efficiency and Influence scenario have developed. The Shannon-Wiener index and the share of oil and natural gas in primary energy in Renewable efficiency and Influence are higher than in environment scenario. Therefore, Renewable efficiency and Influence scenario in EU countries is favorable for Iran in terms of increasing security of energy demand in 2030.

Keywords: *Iran's energy demand security, 2030 EU Energy Strategy, Goal programming approach, Greece Energy Policies*

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Introduction

Identification of reliable and stable markets is one of the most important requirements for oil and natural gas exports. The importance of this issue can be answered from standpoint of energy security demands. There are several definitions for the term “energy security” in various sources which can be exemplified in the following: In all definitions of energy security, the term "security of supply" and "energy security" are equivalents and not differ semantically (Koyama & Kutani, 2012). Therefore, there is no need to define separately "energy security", since "energy supply security" of an energy-importing country equals "energy demand security" of an energy-exporter country. In other words, energy demand security ascertains to purchase enough energy at an affordable price. Therefore, considering the mentioned definitions and the nature of Iran’s oil and natural gas exports, determination of export destinations is an essential factor to guarantee energy demand security. The most vital questions that need to be answered in oil and natural gas exports is which market is better in oil and natural gas exports demands at present time and in the future. Oil and natural gas, as vital fuels, have a special place in economic policies of oil-producing countries. Also, they have a special importance in security strategies of energy consumers. Thus, access to energy resources is not the only concern of old importers like EU countries, but also it is an important issue for newcomer countries of energy consumers such as China and India. In this study, we review resources and literature of the subject along with China, India and the European Union energy markets in 2015, 2020 and 2030 in terms of energy consumption and imports, energy transfer routes and major energy supplying countries. Focusing on the EU 2030 energy strategy, we will assess the impact of this policy on the energy system of Greece by Goal programming approach, which was a former customer of Iranian oil, and analyze the security situation of Iran's energy demand. It should be noted that in this study, the effects of sanctions on the security of Iran's energy demand have not been seen and all potential markets have been addressed. The paper is structured as follows: Section 2 shows energy markets conditions. Section 3 explains Case study of Greece. Section 4, Overview of the Greece energy system. Section 5 explains the objectives of Greece and the European Union energy policy until the 2030 horizon. Section 6 shows research methodology. Section 7 explains details of Mathematical model. Sections 8, 9, 10 and 11 are Research background, Research scenarios, Comparison of scenarios in terms of energy security and Conclusion and Analysis respectively.

I. Energy Markets

China

Nowadays, China is one of the most important countries playing a big role in shaping future energy thorough the world. China's energy demand as the world's largest energy consumer and continued high economic growth, over the past decade, imply its important role in making energy market development. Current outlooks indicate the continued need for energy consumptions and imports, thus making China the target of several energy exports projects. In Fig. 1, china's energy demand, oil and gas consumption are specified in 2015, 2020 and 2030.

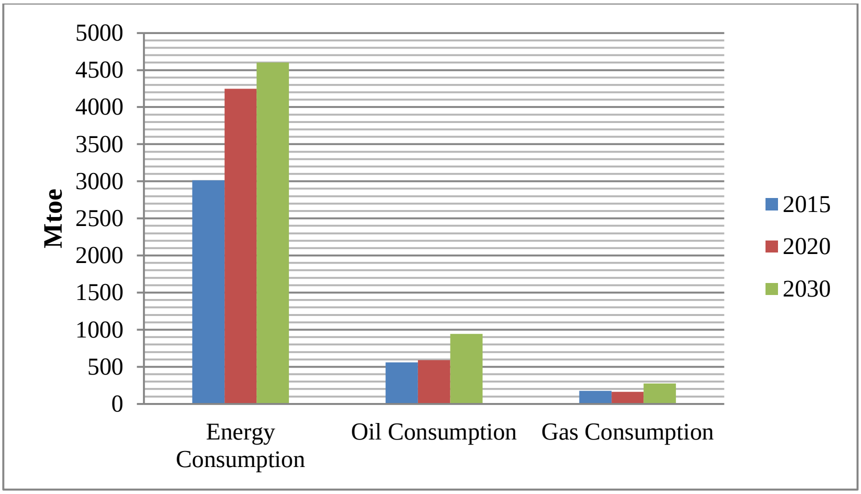

Figure 1. Energy, oil, natural gas consumption in China market

Source: Statista 2015 and Berkeley Lab, China energy and emissions paths to 2030

China's energy demand grows 41 and 52 percent compared to 2015 respectively in 2020 and 2030. In addition, China's energy consumption will reach 4,600 Mtoe by 2030 and 3,014 Mtoe by 2015. Also, oil and natural gas demand are 559.7 and 177.6 Mtoe respectively in 2015. Oil and gas demands are 592 and 161.8 Mtoe, respectively, at 2020 indicating oil demand increase 5.7 percent and gas demand decrease 9 percent, respectively, in comparison to 2015. Oil and gas demand is 945.4 and 274.4 Mtoe at time 2030, which will be 69 and 54.5 percent more than in 2015. The growing trend of energy consumption, especially oil and gas carriers, makes all sellers and exporters of the energy carriers to pay attention to China market as a reliable market for the long run. In the following, Fig. 2 shows China's import rate of crude oil and natural gas in 2015 and in 2020 and 2030. According to Fig. 2, oil and natural gas imports to China have been continually increasing. Crude oil and natural gas imports rate is 335.5 and 64 Mtoe, respectively, in 2015. Also, in 2020, oil and gas imports are 386 and 38 Mtoe respectively which is 15% higher, for oil, and 40% lower, for natural gas, than in 2015 as well as in 2030 the imports will be 744.1 and 140.8 Mtoe, which will respectively increase 121 and 120 percent in 2015.

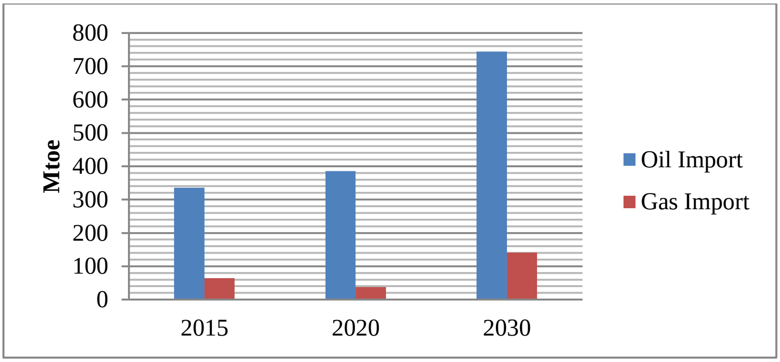

Figure 2. Oil and natural gas import in China market

Source: BP 2015 and Northeast Asian Energy Community, Energy Outlook in China for 2030

China's economic growth in next two decades, while reducing dependency on coal and decreasing energy basket its share to reduce pollution emissions, imply gradual oil and gas consumption increase in China's energy basket (Refers to 5th China Development Plan). In Fig. 3, the countries that supply China's crude oil is demonstrated precisely. Of course, Chinese politicians give priority to improve energy supply security through Central Asia pipelines, Russia pipelines, and deep water ports in Southeast Asia (Maleki & Raufi, 2016).

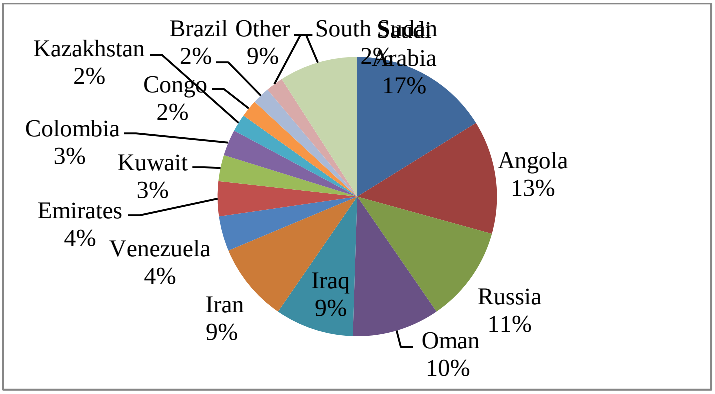

Figure 3.Oil exporter countries to china in 2014

Source: IEA 2016

Natural gas has been imported to China via LNG and through pipelines. Also, China was the third-largest LNG importer in the world, after Japan and South Korea according to international statistics established in 2015. China invests in pipelines to import gas from the west and the north of the country. In 2010, the first gas pipeline from Turkmenistan to China was implemented through the Central Asia–Center gas pipeline system (CAC). Later, natural gas from Uzbekistan and Kazakhstan was exported to China through this pipeline in 2013. Over these years, China has completed the Myanmar pipeline to increase gas supply security and has invested $ 400 billion in pipelines to increase the total capacity of pipelines to 1.3 trillion cubic feet per year by 2018. In 2014, China’s natural gas imports volume was 31.2 and 27.1 billion cubic meters through pipelines and via LNG respectively (IEA, 2015a). In the following, Fig. 4 shows the status of natural gas pipelines and LNG ports to China implying China's strong strategy of diversifying energy supply routes.

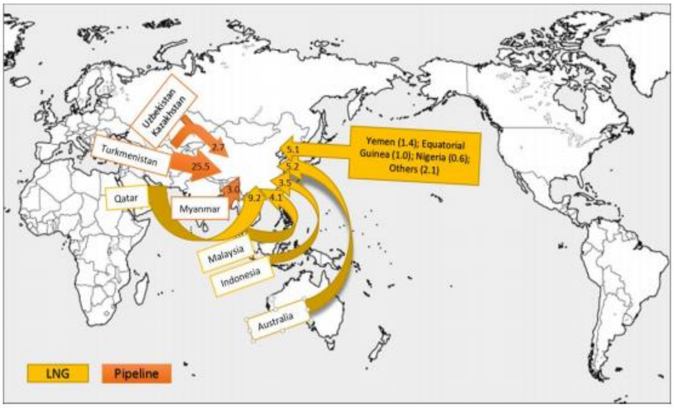

Figure 4. The LNG ports and natural gas pipeline feeding China in 2014

Source: IEA 2015

Fig. 5 demonstrates the share of countries exporting natural gas to China. Clearly, the number of countries exporting natural gas to China is 9 in 2013 which reveals China is seeking to implement a strategy to import natural gas from various countries (IEA, 2015a).

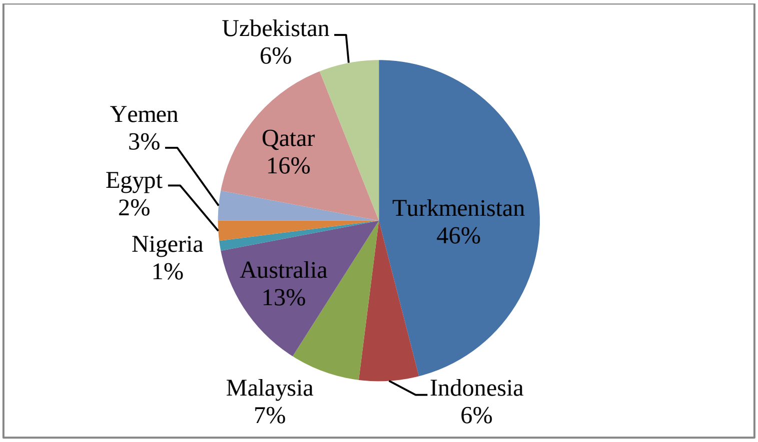

Figure 5. Natural gas exporter countries to China in 2013

Source: IEA 2015

India

Nowadays, India, as one of the five emerging economies and member of the Brix Group, is the world's largest industrial pole which has further increased India's energy demand. As shown in Figure 6, India's primary energy demand has been on an upward trend. Therefore, based on the new policy scenario, energy demand in India is estimated at about 900, 1018 and 1440 Mtoe in 2015, 2020, and 2030 respectively. In 2015, India's oil and natural gas demand is 219 and 54 Mtoe respectively, which makes India the world's third largest energy consumer after Japan (IEA, 2015c). Nowadays, it has a much-growing oil demand due to economic development and high energy demand in its factories and automotive sector. According to Figure 6, India's oil and gas demand will be 229 and 58 Mtoe respectively in 2020 where the growth of 4 percent for oil demand and 7.5 percent for natural gas demand could be observed compared to 2015. Also, in 2030, India's oil and gas demand will be 329 and 103 Mtoe which face the growth of 50 percent, for oil demand, and 90 percent, for natural gas demand compared to 2015.

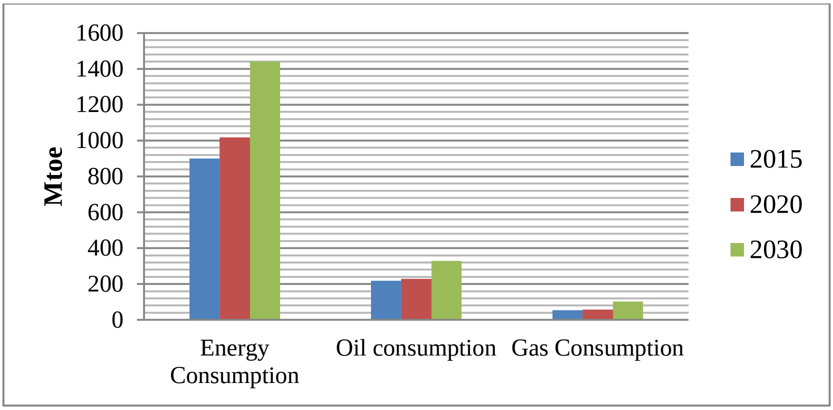

Figure 6. Energy, oil, and natural gas consumption in India

Source: IEA oil market report 2015 and India Energy Outlook 2040

In 2015, India's oil and natural gas import needs are 170.9 and 24 Mtoe respectively (Trading Economics, 2016). As shown in Fig. 7, India's oil and natural gas import, in 2020, will be 194 and 26 Mtoe, therefore, there are the growth of 13.5 % for oil import and 7.5 %, for natural gas import compared to 2015. Also, in 2030, India's oil and natural gas import demand is 298 and 57 Mtoe respectively which provides growth of oil and natural gas imports 74.3% and 137% higher compared to 2015.

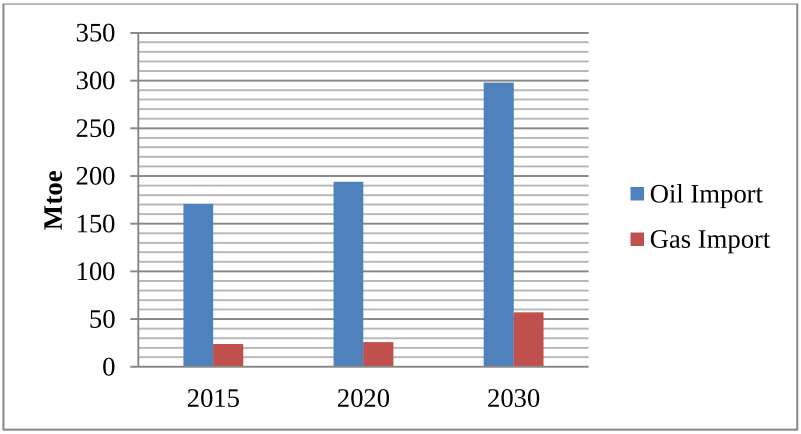

Figure 7. Oil and natural gas imports in India

Source: Trading Economics 2016 and India Energy Outlook 2040

In the following, Figures 8 and 9 demonstrate various countries exporting oil and natural gas to India using LNG (export of natural gas to India using pipelines is zero in 2015).

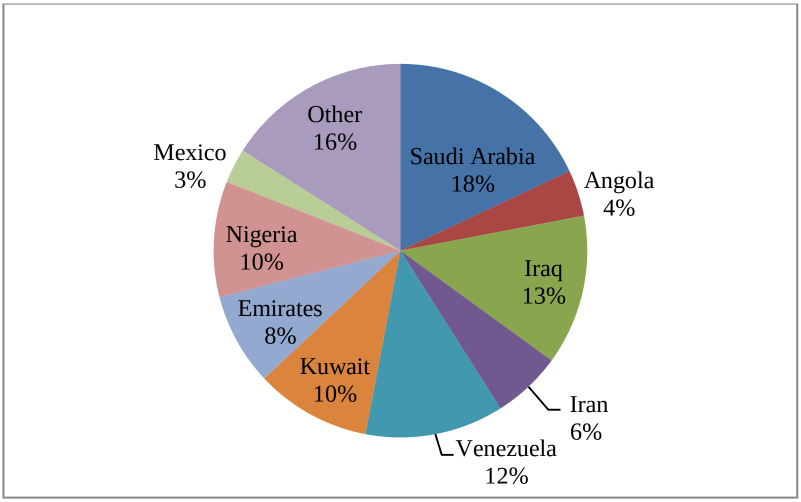

Figure 8. Oil exporter countries to India between 2014 to 2015

Source: IEA 2015, India Energy Outlook 2040

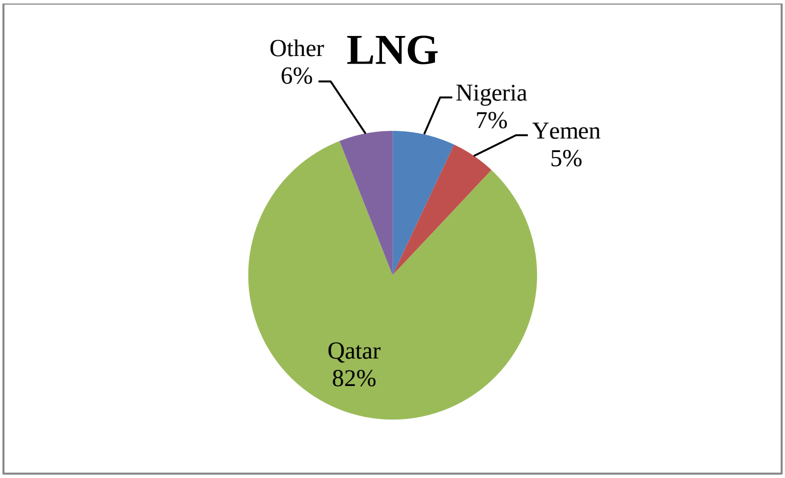

Figure 9. Natural gas exporter countries (LNG) to India between 2014 to 2015

Source: IEA 2015, India Energy Outlook Outlook 2040

As it is shown in Figure 10, in 2030, 10 billion cubic meters of natural gas will be exported to India through pipelines crossing in the Middle East and the Caspian region which implies the development of gas pipeline toward India in the long run.

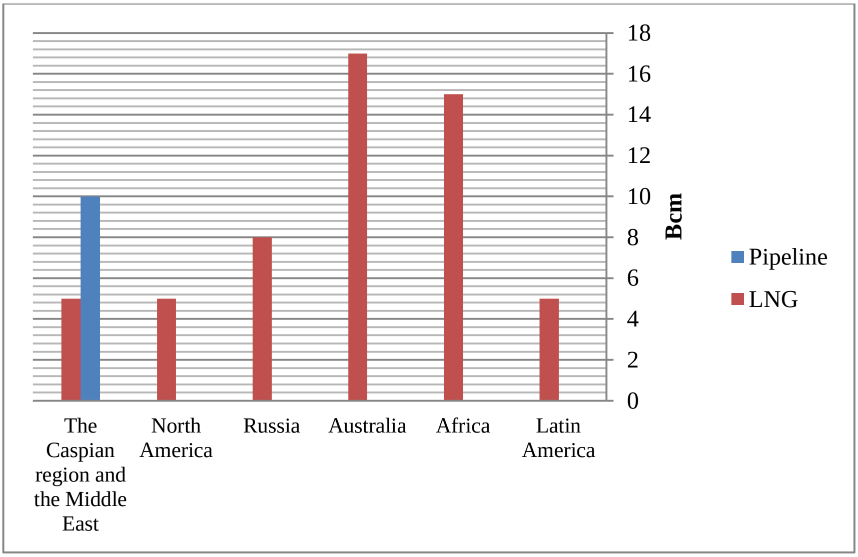

Figure 10. Natural gas imports to India in 2030

Source: IEA 2015, India Energy Outlook 2040

As shown in Figure 11, oil products demand in India transportation sector is 2.1 and 3.3 Mboe per day in 2020 and 2030, respectively. Also, the share of other energy carriers, such as biofuels, in supplying transportation needs is very low, therefore, it is not possible to eliminate India's dependency on crude oil in the transportation sector of India.

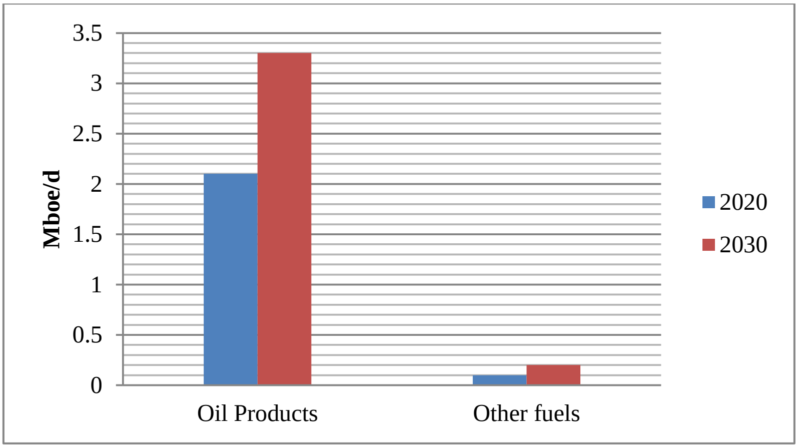

Figure 11. Share of different fuels utilization in the transportation sector of India

Source: IEA 2015, India Energy Outlook 2040

European Union

Analysis of the procedure of consumption and import of energy in the European Union energy market, especially utilization of oil and natural gas, is essential for exporter of both energy carriers. As depicted in Fig. 12, the use of oil and natural gas in the European Union, in 2015, are 735 and 353 Mtoe, respectively. Also, in 2020 and 2030, European Union oil consumption is 551 and 520 Mtoe, respectively, whilst natural gas consumption is 406 and 397 Mtoe. As mentioned earlier, the European Union seeks to decline fossil fuel utilization due to its policy concerned with environmental issues and diversifying energy primary resources.

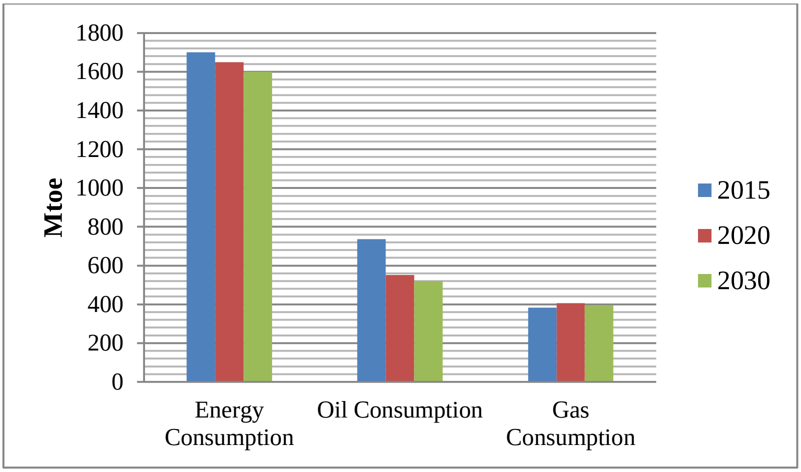

Figure 12. Energy, oil, and natural gas consumption in EU

Source: European Commission 2016 and Europe Commission, Trends to 2050

In 2015, import of energy carriers in European Union, as about 20 percent of total EU commodity import, is about 1 billion Euro per day. Nevertheless, 90 percent of oil usage and 66 percent of natural gas consumption in the EU are imported from abroad in 2015 (European Commission, 2016). As depicted in Fig. 13, it is obvious that import of crude oil is decreasing and natural gas import is increasing.

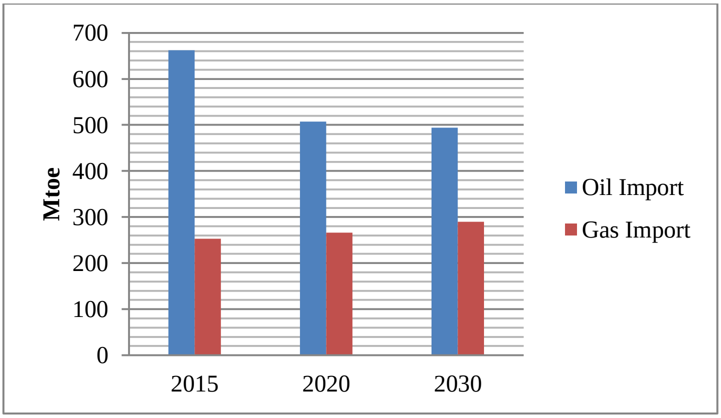

Figure 13. Oil and natural gas import in the EU

Source: European Commission 2016 and Europe Commission, Trends to 2050

In the following, as illustrated in Fig. 14, European Union imports share of 56, 52, 53 percent of its primary energy needs from out of the union borders in 2015, 2020, and 2030, respectively.

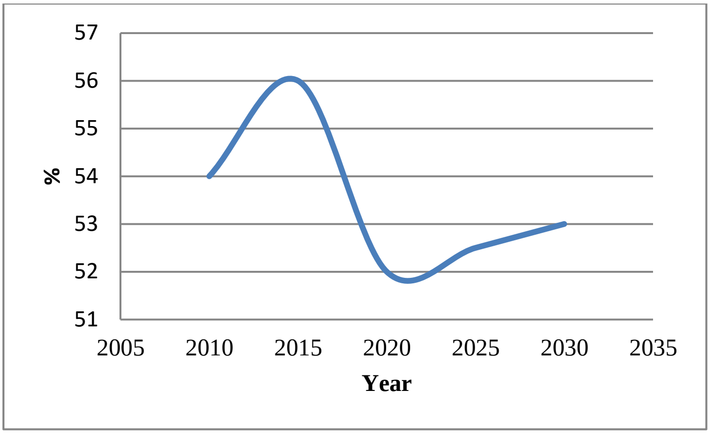

Figure 14. EU Energy import

Source: EU energy, transport and GHG emissions: trends to 2050

Also, the share of countries exporting oil to EU, in 2014, is depicted in Fig. 15. As shown in the figure, Russia is the biggest oil exporter to EU by supplying share of about 28.9 percent of total EU oil consumption.

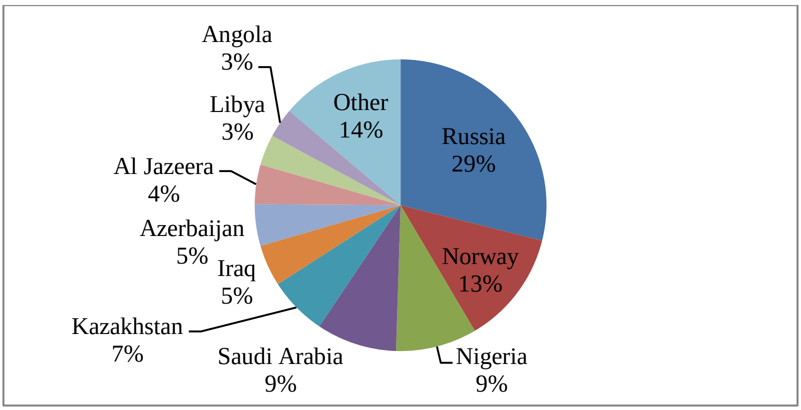

Figure 15. Oil exporter countries to the EU in 2013

Source: European Commission 2014

In the same manner, Fig. 16 shows the detail of EU natural gas import share in 2014 and 2015. It is noteworthy that Russia, indeed as the biggest oil supplier of the EU, is also the supreme country exporting gas to EU.

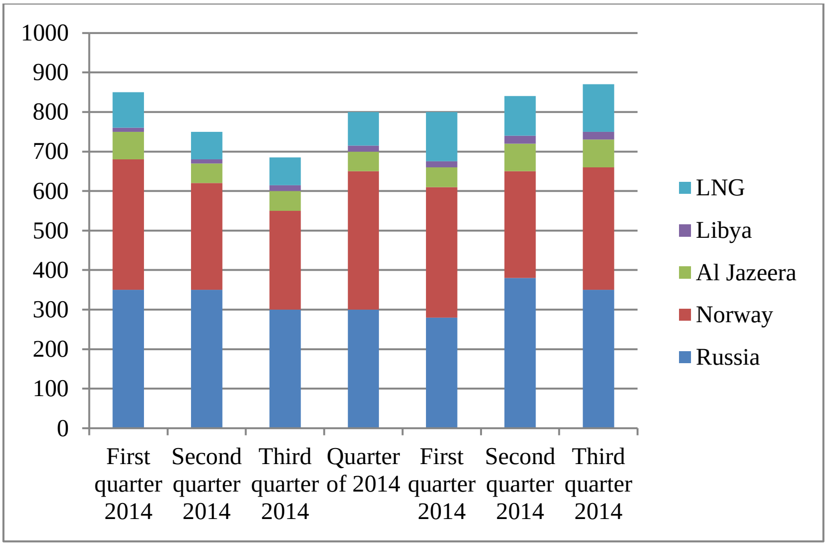

Figure 16. Natural gas exporter countries to the EU in 2014 to 2015

Source: ENTSO-G 2015

Fig. 17 shows the details of oil and natural gas transmission projects heading to EU which are under construction or planned to be constructed in early future. Baku- Tbilisi- Ceyhan and North Stream transmission pipelines are the most important of the under-constructed projects as well as Nabucco pipeline, Agri pipeline (in Azerbaijan, Georgia, and Romania), South Stream pipeline, Khazar pipeline, and etc. are the long-term projects of EU to supply natural gas throughout the union securely (ENSTO-G, 2015).

Figure 17. Available gas transmission pipelines feeding the EU

Source: ENTSO-G 2015

II. Case study of Greece

Focusing on the EU 2030 energy strategy, we will assess the impact of this policy on the energy system of Greece by Goal programming approach, which was a former customer of Iranian oil, and analyze the security situation of Iran's energy demand. In October 2014 The European Council agreed on a new 2030 Framework for climate and energy, including EU-wide targets and policy objectives for the period between 2020 and 2030. These targets aim to help the EU achieve a more competitive, secure and sustainable energy system and to meet its long-term 2050 greenhouse gas reductions target. Development of renewable energy (RE) has been at the forefront of European policies (Lavidas 2019). Greece is at a pivotal point regarding the formulation of energy policies in conjunction with environmental protection. During the next ten years these will have to be harmonized with the European Union Directives, focusing on the reduction of the greenhouse gas (GHG) emissions, penetration of renewable energy sources (RES) and energy saving (Angelis-Dimakis, Arampatzis et al. 2012).

The Greece government clearly needs to develop a comprehensive energy and climate policy that goes beyond the EU target and that specifically takes into consideration ambitions for energy efficiency and renewable energy. Such a comprehensive policy would also support infrastructure planning by enhancing certainty for investors. It should be reflective of the domestic resource endowment and economic and environmental considerations, and aim to use the country's impressive skills base. The government's commitment to prepare a national energy and climate plan towards 2030, by the end of 2017, is commendable. The Greece government's declared policy is to diversify energy sources and reduce the carbon dioxide (CO_2) intensity of the economy while increasing energy security and implementing comprehensive energy market reforms to make the sector more competitive (IEA 2017). Greece, in particular, is considered to be among the most attractive countries to invest in solar photovoltaics (PV) in, mainly due to the country's solar irradiation levels. A series of policy efforts, starting in 2011, to encourage solar investments resulted in Greece ranking among the top countries worldwide for solar power share (more than 7%) in electricity generation, in just three years (Ramírez, Honrubia-Escribano et al. 2017). In this study, Goal programming method is used to model the macro-energy policies of Greece up to the 2030 EU Energy Strategy. In this model, the 2030 energy objectives of the European Union and Greece in the field of power generation and plant capacity are examined, and ultimately, the composition of the Greek power plant is determined.

Greece energy system: According to Figure 18, the primary supply of energy from 1990 to 2000 increased from 21,000 to 27,000 tons of oil equivalent and then decreased by 2015 from 27,000 to 23,000 TOE in Greece (IEA 2017). Since 1990, the energy consumption intensity has been roughly equal to 0.0001 tons (TOE/ 2010 US $). Given the persistence of the energy intensity index and per capita energy supply, as well as the growing trend of gross domestic production, it can be concluded that the Greek economy is not energy-based. However, the role of energy saving programs at the state level, in accordance with EU programs is evident in the stability of energy.

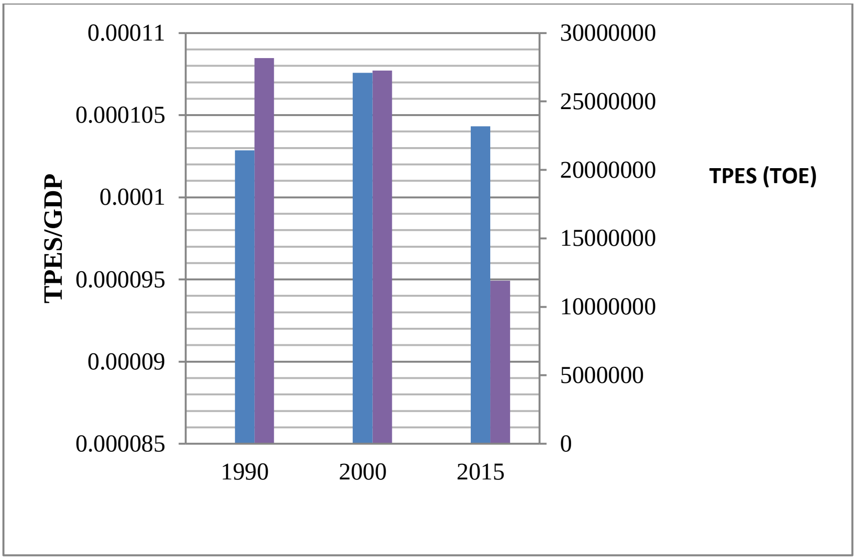

Figure 18: Primary supply of energy and energy intensity changes.

The diagram has been elaborated based on the IEA data (2017)

The policies adopted from 1973 onwards have focused on the exploitation of domestic energy resources, such as lignite and hydro, the creation of domestic infrastructure for generating electricity and oil refining, the construction of electrical interconnections to neighboring countries, and finally, the diversification of supply (Angelis-Dimakis, Arampatzis et al. 2012). In the twenty-first century, the energy policy and energy supply of Greece faces both challenges and opportunities. One of the most difficult issues concerns the country's heavy reliance on fossil fuels (Arapostathis and Fotopoulos 2019). The proportion of imports to total imports and primary energy production in the country was 30 percent in 1990, 33 percent in 2000 and 81 percent in 2015, indicating an increase in dependence on energy imports during 1990 to 2015. The share of natural gas (from 1 to 7 percent), crude oil (from 63 to 69 percent), renewable energy (from 4 to 7 percent), and electricity (from 0 to 2 percent) in primary energy resources has risen during 1990 to 2015, but the share of coal has fallen from 32 to 15 percent, which can be attributed to environmental policies. Among the renewable energy sources in Greece, biomass with 1266 TOE (46%), geothermal with 939 TOE (34%) and hydropower with 524 TOE (20%) have the highest share in total primary energy supply (TPES) in 2015 (IEA 2017). Biomass is seen as a possible sustainable and renewable energy source and also as a way to reduce the global warming potential (GWP) of transportation fuels (Kraatz, Sinistore et al. 2013). The government support policies for deployment of solar and domestic solar heaters energies have also led to the development of these technologies in recent years. Greece's major energy imports consist of crude oil and petroleum products (94% crude oil import). Natural gas imports reached 9 percent of total imports in 2015 from zero percent in 1990. This is because of government policy to increase the diversity of energy sources supply. Electricity imports in Greece indicate that the country is connected to the electricity network of neighboring countries, which was 953 thousand TOE exported and 127 thousand TOE imported electricity in 2015. The share of electricity imports of total imports declined from 5% to 3% during the 1990-1995 period (IEA 2017). With the creation of an integrated electricity grid in Europe, the energy exchange between the member states of the network has increased since 2000. Greece imported 61 TOE in 1990 and 826 TOE in 2015 from the integrated European electricity grid. As shown in the Figure 19, power generation by fossil power plants increased from 1990 to 2000, followed by a decreasing trend in 2015 (IEA 2017). The reason is that the share of CHP plants and renewable sources of electricity has increased.

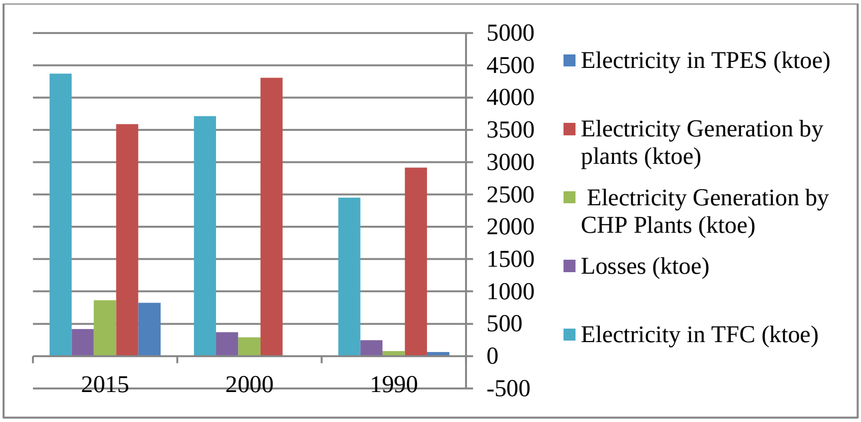

Figure 19: Electricity generation and losses in conversion sector.

The diagram has been elaborated based on the IEA data (2017)

While the Greek population has remained almost constant, the energy consumption of the country has risen exponentially. Electricity loss in Greece is less than 10% of the total generated electricity, which was 8% in 1990 (European average 6,804%), 7% in 2000 (European average 7.222%) and 7% in 2015 (average European 6.444%). The share of CHP electricity increased from 2% in 1990 to 15% in 2015, as the result, the share of fossil power plants in electricity generation Dropped from 88% in 1990 to 63% in 2015 (IEA 2017). With Greece moving toward industrialization from 1990 to 2000, final consumption of energy in the industrial sector of the country has increased over these years. But then the Greek government reduced the energy intensity of the industry sector by applying energy efficiency policies, and eventually reduced its industrial energy consumption in 2015. According to the same logic, the increase in final energy consumption and energy consumption in the transport sector in 2000, compared to 1990, and its reduction in 2015, can be justified (Figure 20).

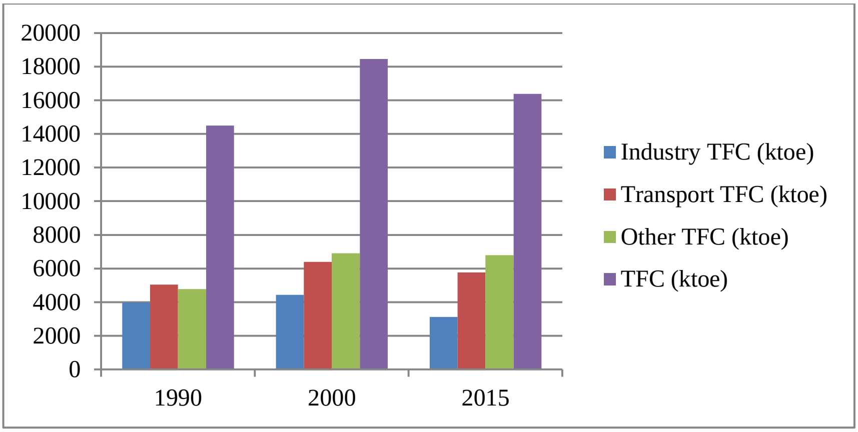

Figure 20: Final energy consumption by sector.

The diagram has been elaborated based on the IEA data (2017)

The share of energy consumption in the industry fell from 29% in 1990 to 20% in 2015. Also, the share of consumption of the transport sector has remained stable between 37-36% (IEA 2017).

III. Greece and the European Union energy policy until the 2030 horizon

In October 2014, the EU approved the 2030 Energy vision in the framework of the Energy Community Initiative. The objective of the strategy is to send a strong signal to the market, encouraging private investment in new pipelines, electricity networks, and low-carbon technology. The targets were based on a thorough economic analysis measuring how to achieve decarburization by 2050in a cost effective way. The cost of meeting the targets does not substantially differ from the price we need to pay anyway to replace our ageing energy system. The main financial effect of decarburization will be to shift our spending away from fuel sources and towards low-carbon technologies.

These objectives are as follows (deLlano-Paz, Fernandez et al. 2016):

● 40% reduction in greenhouse gas emissions compared to 1990

- 61% reduction in power plant sector
- 27%increase in energy efficiency
- A 27% share of renewable energy consumption
- 43% share of renewable electricity

Conclusion and Analysis

China, India and the European Union are Iran's potential strategic markets, regardless of sanctions. In October 2014 The European Council agreed on a new 2030 Framework for climate and energy, including EU-wide targets and policy objectives for the period between 2020 and 2030. In this study, we seek to investigate the effects of this policy on the security of Iran's energy demand. To this end, we examine the effects of this policy on the energy demand of one of the EU countries, namely Greece, which was also a customer of Iranian oil. In this study, the security of the country's energy supply was examined in accordance with the 2030 EU Energy Alliance goals set by the Energy Union in October 2014. These three goals are as follows: • 61% reduction in greenhouse gas emissions in the power plant compared to 1990 • An increase of 27% in energy efficiency • A 43% share of renewable electricity.

After creating the mathematical model of goal programming, environment scenario and Renewable efficiency and Influence scenario has developed. In order to assess these two scenarios in terms of energy security, the Shannon-Weiner Index is used in this study. The Shannon-Wiener index and the share of oil and natural gas in primary energy in Renewable efficiency and Influence are higher than in environment scenario. Therefore, Renewable efficiency and Influence scenario is favorable for Iran in terms of increasing security of energy demand in 2030.

References

Angelis-Dimakis, A., et al. (2012). "Monitoring the sustainability of the Greek energy system." Energy for Sustainable Development 16(1): 51-56.

Arapostathis, S. and Y. Fotopoulos (2019). "Transnational energy flows, capacity building and Greece's quest for energy autarky, 1914–2010." Energy Policy 127: 39-50.

Chalvatzis, K. J. and K. Rubel (2015). "Electricity portfolio innovation for energy security: The case of carbon constrained China." Technological Forecasting and Social Change 100: 267-276.

Chang, C.-T. (2015). "Multi-choice goal programming model for the optimal location of renewable energy facilities." Renewable and Sustainable Energy Reviews 41: 379-389.

Chen, A. and X. Xu (2012). "Goal programming approach to solving network design problem with multiple objectives and demand uncertainty." Expert Systems with applications 39(4): 4160-4170.

deLlano-Paz, F., et al. (2016). "Addressing 2030 EU policy framework for energy and climate: Cost, risk and energy security issues." Energy 115: 1347-1360.

ENTSO-G. (2015). transparency platform. Retrieved from https://transparency. entsog.eu/

European Commission. (2014). Import and secure supplies. Retrieved from https:// ec.europa.eu/energy/en/topics/imports-and-secure-supplies

European Commission. (2016). Imports and secure supplies. Retrieved from https:// ec.europa.eu/energy/en/topics/imports-and-secure-supplies

Europe Commission, Trends to 2050. (2013).

Hocine, A., et al. (2018). "Optimizing renewable energy portfolios under uncertainty: A multi-segment fuzzy goal programming approach." Renewable energy 129: 540-552.

Holley, C. and E. Lecavalier (2017). "Energy governance, energy security and environmental sustainability: A case study from Hong Kong." Energy Policy 108: 379-389.

Huang, Z., et al. (2017). "A goal programming based model system for community energy plan." Energy 134: 893-901.

IEA. (2015). China's gas imports in 2013. Retrieved from https://www.iea.org/ newsroomandevents/ graphics/ 2015-04-07- china-gas-imports-in-2013. html

IEA. (2015). India energy outlook 2015. Retrieved from https://www.iea.org/ .../india-energy-outlook-2015.html

IEA. (2015). Oil market report. Retrieved from https://www.iea.org/ oilmarketreport/ reports/2015/1215/

IEA. (2015). https:// www. iea. org/ statistics/ statisticssearch/ report/? country= CHINA& product= balances& year=2015

IEA. (2015). https://www.iea.org/statistics/statisticssearch/ report/?country= INDIA&product=balances&year=2015

IEA. (2015). https://www.iea.org/statistics/statisticssearch/report/? country= EU28&product=balances&year=2015

IEA (2017). "Greece energy policy."

IEA (2017). "statistics search,Greece."

Koyama, K., & Kutani, I. (2012). Study on the Development of an Energy Security index and an Assessment of Energy Security for East Asian Countries. Books.

Kraatz, S., et al. (2013). "Energy intensity and global warming potential of corn grain ethanol production in Wisconsin (USA)." Food and Energy Security 2(3): 207-219.

Lavidas, G. (2019). "Energy and socio-economic benefits from the development of wave energy in Greece." Renewable energy 132: 1290-1300.

Maleki,A. Raoufi,M. (2016). "A new silk road; a belt, a road", a book pressed by Abrar Moaser publisher, Tehran. (in persian)

Pilpola, S. and P. D. Lund (2018). "Effect of major policy disruptions in energy system transition: Case Finland." Energy Policy 116: 323-336.

Ramírez, F. J., et al. (2017). "Combining feed-in tariffs and net-metering schemes to balance development in adoption of photovoltaic energy: Comparative economic assessment and policy implications for European countries." Energy Policy 102: 440-452.

Trading Economics. (2016). India crude oil production.

Zografidou, E., et al. (2017). "A financial approach to renewable energy production in Greece using goal programming." Renewable energy 108: 37-51.