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## Article

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## The Role of the Energy Sector in the Iranian Economy

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### ABSTRACT

This paper is devoted to analyzing the processes that took place in the energy sector of Iran for the period from 2004 to 2021. It is emphasized that for the sustainable development of the country's economy, a reliable, long-term, and economically acceptable supply of various types of energy in their optimal combination is necessary. Despite the territory of Iran having an extremely high potential for the development of non-traditional energy, the analysis shows that the development of the Iranian economy is mainly based on oil revenues. In the context of the growing crisis in the global economy, an increase in demand for oil and oil products, oil accents in energy diplomacy began to intensify, which allows us to speak about the actualization of the problems of developing the oil and gas sector of Iran and shifting the focus towards traditional energy sources. Nevertheless, to achieve sustainable development, along with the possession of a resource base, the availability of modern equipment and technologies, and dominance in the market for products that foreign partners are interested in acquiring are necessary. It is concluded that Iran is vulnerable to geo-economic risks in the current conditions of the development of the world economy.

**Keywords:** Iran, Energy Sector, Oil Revenues, Renewable Energy Sources, Energy Efficiency, Energy Crisis

**JEL Classifications:** F0, H8, L71, L72

### 1. INTRODUCTION

The current evolution of the energy crisis, coupled with the impact of COVID-19 on energy consumption, has meant that today the economic sustainability of oil and gas exporting countries depends largely on the combination of fossil fuels and renewable energy sources in the production process. The sharp drop in oil prices in April 2020, coupled with lower demand for hydrocarbons, was expected to force oil-producing countries, and in particular, Iran, to rethink their oil-dominated economic growth model in favour of developing renewable energy sources, which could neutralize the dependence of liquid fossil fuel exporting countries on price volatility in the global oil market and accelerate the process of the global energy transition. In the world economy, the volatility of oil prices is the main factor determining changes in the terms

of trade. Meanwhile, the signing of the OPEC+ agreement and the reduction in oil production led to a slowdown in the fall in world oil prices and a gradual return of oil prices to their previous values against the backdrop of the downturn of the COVID-19 pandemic and the recovery of the global economy. The ensuing energy crisis, which engulfed, first of all, Europe, caused by the growth in demand for energy carriers, was a factor in the return to the model of economic development of oil-producing countries based on the oil demand, and its actualization, while shifting the emphasis in the development of world energy from renewable sources to traditional ones.

This shift in focus in the energy sector explains the increased interest of researchers in exporting countries of traditional energy sources.

Iran's energy sector research covers two priority areas. First, the issues of efficient use of energy potential. Secondly, the possibility of Iran's energy transition from traditional sources to renewable sources of energy generation.

According to Iranian scientists (Khodamoradi and Sojdei, 2017), the increase in the country's energy efficiency has been constrained by sanctions imposed by Western countries and a lack of financial resources, which did not allow for the halving of energy intensity from 2011 to 2021, as expected, according to the General Policies adopted in 2011 of Consumption Reform. The same position is shared by German researchers (Moshiri and Lechtenböhmer, 2015), who believe that it was the lack of sufficient financial resources invested in the development of the energy sector that did not allow an increase in energy efficiency in the period under review. The opposite opinion is shared by (Mortazavi and Garoosi, 2019), who, based on econometric calculations, conclude that the efficiency of using the Iranian energy sector has increased in recent years, largely due to the energy policy pursued by the state.

Researchers on the development of renewable energy sources in Iran note that the country has a high potential for the development of alternative energy. (Minier, 2020) notes that, given the geographical features of its territory, Iran can become one of the largest producers of low-carbon energy. However, the effective implementation of renewable energy technologies is hindered by the geopolitical situation and the system of public administration, which do not contribute to attracting investments and developing technologies in the field of alternative energy. (Minier, 2020) concludes that Iran, in order to make a technological transition, needs to establish stronger trade and economic ties with China. By selling oil to China, Iran can buy innovative Chinese renewable energy technologies in exchange. According to (Shayan et al., 2022), the introduction of energy generation from renewable sources will not only affect Iran's energy balance but can also lead to the reform of social systems and, in general, give impetus to the development of modern technologies. Meanwhile, (Ghouchani et al., 2021) believe that three uncertainties, i.e., political stability, foreign investment and technological capability are facing Iran's renewable energy management and accepting the approach of technology acquisition rather than technology transfer can contribute to progress in this field.

## 2. RESEARCH

In this paper, the exploratory analysis of quantitative and qualitative data with thoughtful research, and graphic and tabular presentation has been applied. The used statistical data includes the main economic indicators of Iran, including the GDP, trade, production, and consumption of energy resources.

According to OPEC data for the 2021/2022 Iranian calendar year, Iran is among the top five countries with the largest reserves of oil and natural gas. In terms of oil reserves (14% of the world), Iran ranks third in the world after Venezuela and Saudi Arabia, and in natural gas reserves (17% of the world) – ranks second after Russia (OPEC, 2022). The sustainable development of the Iranian economy is largely dependent on the energy sector, namely its oil

component. The driver of economic growth is electricity generated mainly from hydrocarbons.

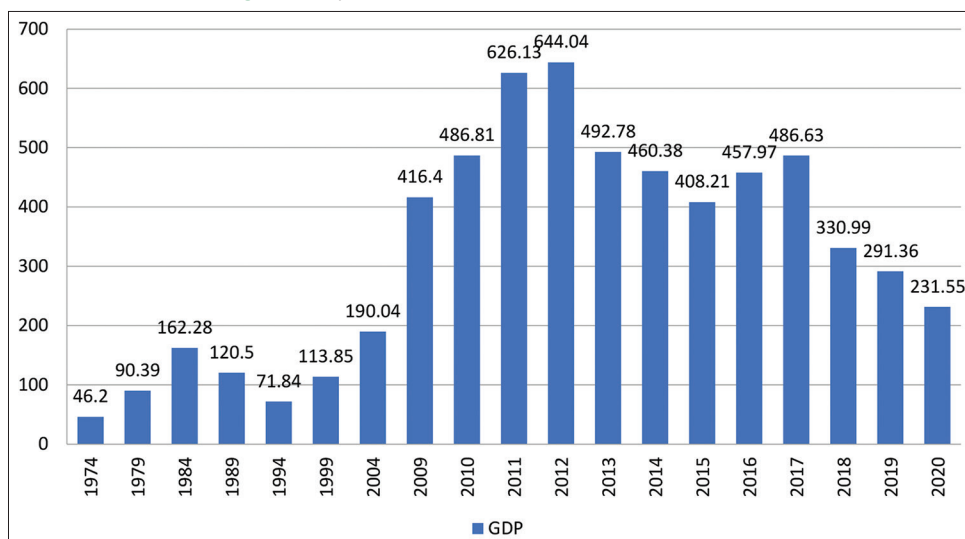
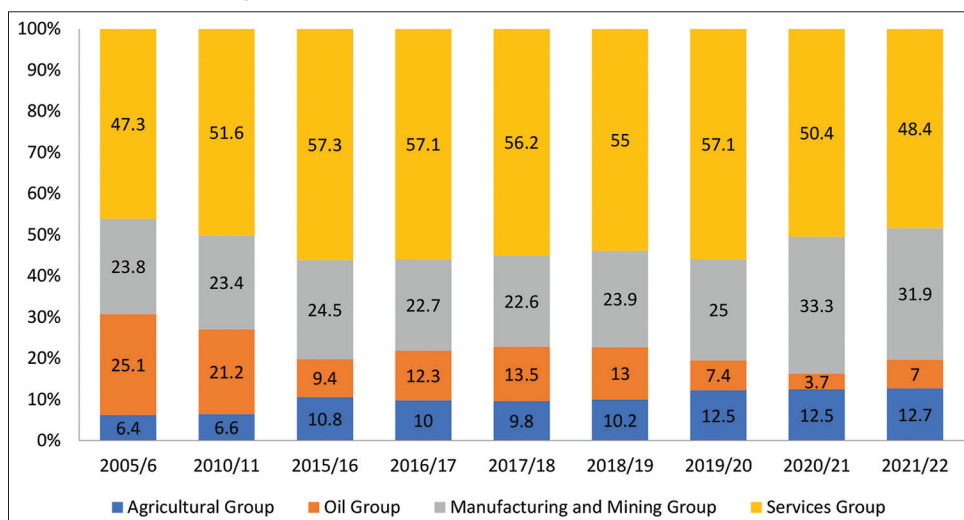
Oil revenues make up a significant share of Iran's GDP, which has grown annually since 1994, amounting to \$644.04 billion in 2012. In 2013-2020 there was a decrease in the volume of GDP to 231.55 billion US dollars. From 2017 to 2020, the volume of GDP decreased by 2.1 times (WorldBank, 2022). The dynamics of Iran's GDP are presented in Figure 1 (WorldBank, 2022).

The fall in GDP was caused by the strengthening of the sanctions' regime against Iran, the consequences of the crisis caused by the coronavirus pandemic and the decrease in oil export revenues due to the fall in world oil prices, which affected the volume of industrial and agricultural production in the direction of their decline in absolute terms. Meanwhile, in relative terms, the share of industry and agriculture has grown, which indicates the diversification of the structure of the economy and the gradual shift away from direct dependence on the oil factor, which can be found in detail in Table 1 (CBI, Central Bank of Iran (CBI), National Accounts, 2022).

As can be seen from Table 1 and its graphical presentation in Figure 2 (CBI, Central Bank of Iran (CBI), National Accounts, 2022), in 2021/2022 the oil industry provided 7% of the country's GDP, and in 2020/2021 - 3.7% against 25.1% in 2005/2006. The share of the oil industry in GDP significantly decreased in the 2010s due to a reduction in oil production due to restrictions imposed on the import of Iranian oil by its traditional consumers. In contrast, the share of manufacturing and mining in GDP increased from 23.8% to 31.9% between 2005/2006 and 2021/2022; agriculture - from 6.4% to 12.7% or twice. During the period under review, efforts were directed to the development of production and expansion of supplies of products of the oil refining industry given the continued problem of providing the domestic market with gasoline and fuel oil as well as petrochemical products. Taking into account the country's gas potential, the development of gas chemistry is expected in the future.

Despite the ongoing efforts to diversify the economy and, as a result, the reduction in the share of the oil sector in the country's GDP, oil and oil products are still the main energy resource and a profitable part of the state budget of Iran, which is largely due to the growth of world oil prices, which compensates for the decline in oil production and physical volumes of oil exports. Revenues from oil exports for 2021/2022 increased to \$39 billion, accounting for 12.1% of budget revenues (MPORG, 2022).

Income from oil export is an important factor in ensuring the sustainable development of the Iranian economy. Iran's oil production is driven by exports to China, which accounted for 30% of total Iranian crude oil exports in 2021, with shipments peaking at 49% in 2015 and 19% at their lowest in 2020 over the period from 2014-2021 (OPEC, 2022). At the same time, the share of Iranian oil in the import structure of China has significantly decreased from 8% in 2015 to 1% in 2020 and 2% in 2021 (GACC, 2022). Thus, Iran is much more dependent on oil supplies to China rather than China on Iranian imports, which is provided in Table 2 (OPEC,

**Figure 1:** Dynamics of Iran's GDP, in billion US dollars**Figure 2:** Share of economic sectors in Iran's GDP, in %

Source: Central Bank of Iran (CBI), National Accounts (<https://www.cbi.ir/simplelist/2054.aspx>)

**Table 1:** Share of economic sectors in Iran's GDP, in %

	2005/06	2010/11	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22
Agricultural Group	6.4	6.6	10.8	10	9.8	10.2	12.5	12.5	12.7
Oil Group	25.1	21.2	9.4	12.3	13.5	13	7.4	3.7	7
Manufacturing and Mining Group	23.8	23.4	24.5	22.7	22.6	23.9	25	33.3	31.9
Services Group	47.3	51.6	57.3	57.1	56.2	55	57.1	50.4	48.4

**Table 2:** Iran oil export by destination

Destination	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
China	21%	35%	48%	49%	30%	24%	32%	46%	19%	30%
India	16%	10%	19%	17%	24%	22%	29%	14%	0%	0%
Other Asia	35%	21%	1%	3%	2%	1%	1%	10%	78%	57%
Latin America	0%	0%	0%	0%	0%	0%	0%	0%	0%	3%
Middle East	0%	0%	0%	0%	0%	0%	0%	0%	1%	9%
Africa	5%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Total	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

2022). With a reduction in oil consumption by China in 2020, Iran redirected flows to Asian countries adjacent to China, in particular,

to the Republic of Korea, Japan and Singapore. Until 2020, India was among the largest consumers of Iranian oil.

The predominant focus on oil supplies to China is explained by the continued ban on oil imports from Iran by Western countries, which hinders the process of diversifying the geography of export supplies of crude oil from Iran and at the same time is a factor in the real growth of price risks in trade with China. It refers to the possible pressure of China, as the largest buyer, in the implementation of direct deliveries of Iranian oil on its cost in order to form the most acceptable actual price for the Chinese side, which is underestimated compared to the spot market price. Between 2017 and 2021, China saved \$816 million on indirect oil supplies from Iran (GACC, 2022). The illegal nature of Iranian oil under sanctions means that it is sold at a deep discount from market prices.

In addition to price risks, the predominant orientation of oil exports to China leads to the fact that the amount of oil revenues received by the Iranian budget largely depends on the geo-economic situation in the Chinese market for Iranian oil. The current situation in the world economy shows that the export growth model of the Chinese economy in the near future may be subject to significant shocks, which may lead to a decrease in the level of energy consumption in China and, accordingly, to a decrease in import purchases of oil, in particular from Iran. The stagnation of economic growth in Europe against the backdrop of the energy crisis is likely to have a negative impact on the volume of Chinese exports to the European market. The growth of inflationary processes in European countries, driven by rising energy prices, is holding back consumer demand. The average inflation rate in the EU countries in August 2022 reached 10%, and in the euro area - 9%, as can be seen in Figure 3 (HICP, 2022). In some countries, inflation exceeded the 20% mark, in particular in the Baltic countries. The inflation rate was 25% for Estonia, 21.4% for Latvia and 21.1% for Lithuania (HICP, 2022).

Rising energy prices will reduce the international competitiveness of European goods, reducing the income of Europeans, which will limit their ability to consume Chinese goods (HICP, 2022). As a result, Iran will either have to look for other sales markets, which is not so easy or agree to less attractive price terms for supplies to China.

Iran's energy complex is currently in a state of waiting for an "upgrade". Heavily worn-out equipment is being operated as a

result of insignificant investments in the renewal of fixed assets. Small projects were implemented by Chinese and European companies. Important problems for Iran are the low level of energy efficiency, the wasteful and irrational use of energy by consumers. Subsidized domestic fuel prices maintained at low levels lead to uneconomical electricity consumption year after year. With total oil production of 3.2 million barrels per day, Iran supplies the domestic market with 2.1 million barrels per day.

In order to ensure the efficient consumption of energy resources for sustainable development and economic growth in Iran, the Energy Consumption Reform of 2011, which envisaged halving energy intensity in 2021 compared to 2011, identified an energy efficiency strategy as one of the key priorities by using energy saving technologies in the field of renewable energy sources and increasing their share in electricity generation.

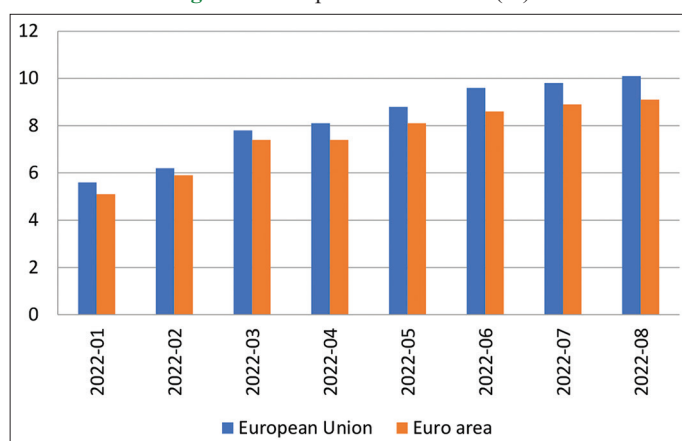
The Iranian Renewable Energy Organization (SUNA), established by the Ministry of Energy in 2012, aims to be an accelerator for generating electricity using green technologies. SUNA acted as a guarantor for the purchase of certain volumes of electricity by enterprises. Further, in 2013, the Renewable Energy Development Fund was established, which allowed the introduction of a tariff of 30 Rials/KWh (the equivalent of today 0.00072 USD) for the development of rural electricity networks. Established in 2015, the Energy Efficiency Monitoring Organization (SATBA) set in 2016 the optimal level of supply of electricity consumed by public and government organizations from renewable sources in the amount of 20%.

During the period from 2011 to 2020, with a decrease in the share of fossil fuels from 94.57% to 88.67%, the share of renewable sources in electricity generation increased from 5.39% to 9.43%. At the same time, as of 2011, hydroelectric power plants accounted for 5% of the total amount of generated electricity, in 2020 this figure was 9% (EIA, 2022). Nuclear power plants accounted for 1.9% of electricity generation in 2020, up from 0.04% in 2011, as a result of the construction of the 915 MW nuclear power plant in Bushehr, which became operational in 2011 (EIA, 2022). The other two 1,057 MW plants are expected to each will be put into operation in 2025 and 2027 (IAEA, 2022).

Iran has a high hydropower generation potential of 42 GW due to the river basin in the West, especially in the province of Khuzestan around the city of Ahvaz, where the rivers Karun, Dez and Karkheh flow (Jamali et al., 2013). Hydropower accounts for 96.48% of renewable energy production. Iran pays increased attention to the development of hydroelectric power plants, which ensures the growth of electricity generation by an average of 10% per year over the past ten years. However, due to climate change, rivers are projected to become shallow, which could lead to a 15% decrease in hydropower generation in 2050 and 23% in 2080 (Jamali et al., 2013).

Other renewable energy sources include wind turbines and solar panels. Wind power generation ranks second after hydropower in Iran's renewable energy mix with a share of 1.93% in 2020. Solar power plants account for 1.52% of electricity generated from renewable sources (IRENA, Irena Query Tool, 2020).

Figure 3: European inflation rate (%)





Iran's location in a seismic belt makes the country a suitable area for generating geothermal energy. Geothermal gradients vary from 2°C/100m in the Zagros belt to 13°C/100m near Damavand volcano, making 8.8% of Iran's area suitable for this power generation (Torshizi et al., 2018). Unfortunately, the geothermal potential remains essentially untapped. There are currently two geothermal power plants operating in Iran with a total capacity of about 130 MW (Torshizi et al., 2018).

In addition, Iran has the potential for tidal power generation. Considering that the country is located near the Persian Gulf and Oman Sea, and also has a coastline along the Caspian Sea, the potential amount of energy generated could be 6.2 GW (Tofigh and Abedian, 2016). Figure 4 shows the sources of electricity generation in Iran in the period 2004-2020 (EIA, 2022).

The commissioning of nuclear power facilities and renewable energy sources demonstrates the process of diversifying energy sources. The easing of sanctions pressure in 2016 facilitated attracting investments in the development of renewable energy sources in Iran, mainly from Europe, which announced an investment of \$3.6 billion (Minier, 2020), although it wasn't realized. According to the US EIA (Energy Information Administration) forecasts, it was believed that by 2030, 26% of

the generated electricity in Iran should come from renewable sources, which suggested a significant increase in green energy, given that in 2017 the share of renewable sources was only 1 % in the energy balance (Kalehsar, 2019). Meanwhile, the Trump administration's policy has cancelled out international investment activity aimed at developing alternative energy sources in Iran. Most companies left Iran, which led to the closure of most projects. For example, the Quercus Energy and Climate Change work group has closed a project to build its sixth solar power plant with an estimated capacity of 600 MW. Similarly, a \$2.9 billion project with the Norwegian company Norway Saga Energy was cancelled (Minier, 2020). The departure of foreign investors led to the closure of Iran's access to modern technologies for the development of alternative energy. The problems that have arisen with attracting foreign investment have had a negative impact on GDP growth, which is demonstrated in Figure 5 (Richter, 2020).

Despite the fact that Iran is striving to diversify its structure of electricity generation sources by putting into operation various types of renewable energy sources, thermal power plants operating on hydrocarbons: oil products and natural gas remain the main means of electricity generation. At the same time, it should be noted that the share of oil products is gradually decreasing, yielding

Figure 4: Electricity generation by source

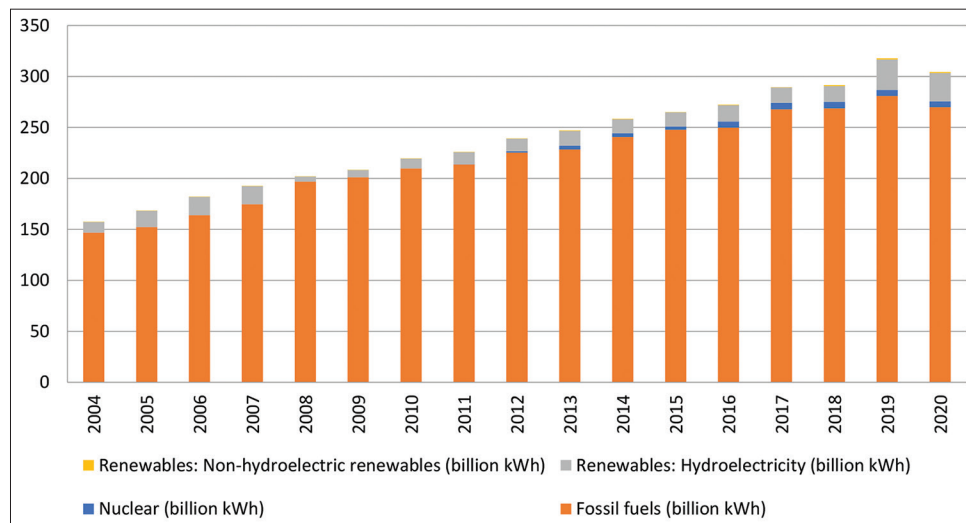
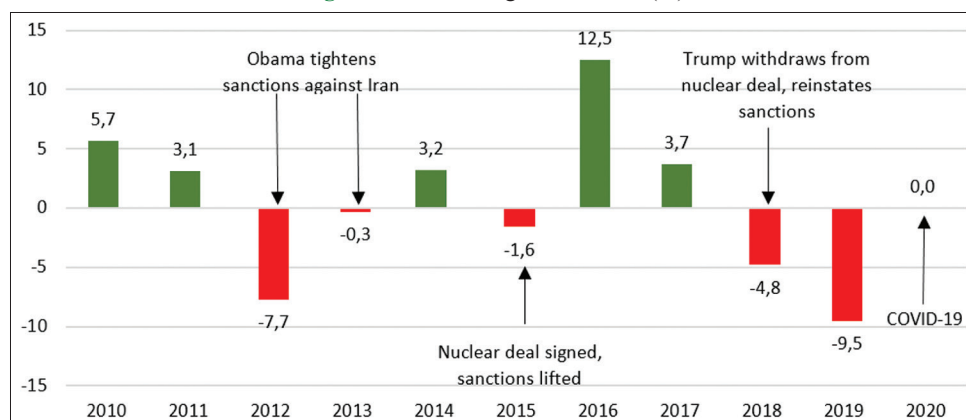


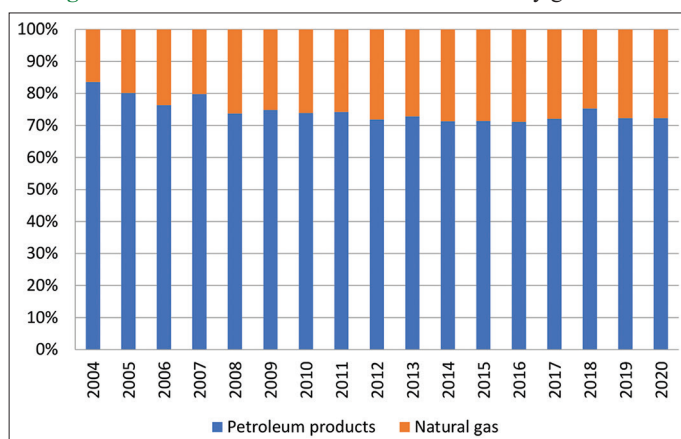
Figure 5: Real GDP growth of Iran (%)



growth in electricity generation from natural gas. So, in 2004, oil products accounted for 84%, and natural gas 16%, in 2011 the ratio was 74% to 26%, and in 2020 72% to 28%, respectively that's visualized in Figure 6 based on data from (IRENA, Renewable Energy Statistics, 2022). Thus, the basis of electricity production in Iran is thermal generation.

The increase in electricity production in Iran is driven by high levels of domestic demand from households and industries. Households and industries accounted for 33% and 32% of total electricity consumption in 2004, 31% and 35% in 2011, and 32% and 36% in 2020. Electricity consumption by the agro-complex in the overall structure of consumption increased slightly from 12% in 2004 to 14% in 2020, while consumption in the public sector decreased from 12% to 8% over the same period. The high level of household consumption is due to the wasteful use of electricity in households. In July 2021, Iran's daily electricity consumption reached a record high of 66,250 MW (66.25 GW). More than 70% of electricity consumed is subsidized by the state. Figure 7 shows the electricity trade balance and consumption in the period 2004-2020 (CBI, TSD, 2022).

**Figure 6:** Use of fossil fuels structure for electricity generation

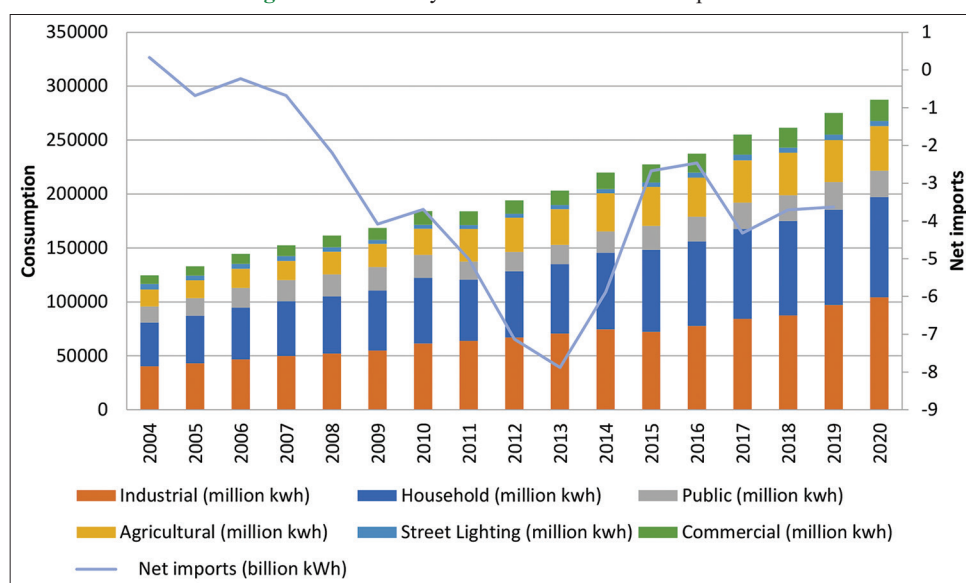


### 3. CONCLUSION

This research shows that the Iranian economy is highly dependent on oil revenues, even though in recent years there have been significant efforts to reduce the country's dependence on the oil factor. Cash receipts from oil exports provide a significant part of the country's state budget revenues. Iran's attempts to ensure the independence of the economy from hydrocarbons through the development of alternative energy face a number of restrictions associated with sanctions, which have reduced access to investment projects and modern technologies and, accordingly, have made it difficult to pursue a policy of diversifying the energy sector.

The increase in world demand for oil and oil products implies the expansion of indirect export supplies. The narrow diversification

**Figure 7:** Electricity trade balance and consumption



of the geographical structure of oil exports determines the high degree of dependence of the country's oil revenues on the geo-economic situation in the sales markets, the key of which is China. Under these conditions, Iran needs to manage price risks in trade with oil-importing countries. Fluctuations in oil prices are one of the most important economic factors affecting the macroeconomic performance of oil-exporting countries. A high level of risks, including geo-economic ones, may adversely affect the achievement of the goals of sustainable development of the Iranian economy, and the adoption of effective measures for the restructuring of the energy sector in the current conditions of confrontation with direct forms of external economic pressure.

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