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Futures of Iran's Oil and Gas; Scenarios by 2035

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ABSTRACT

Iran is one of the most important oil and gas producing countries in the world with 153.8 billion barrels of crude oil and 33.5 billion cubic meters of gas has 9.3% and 18% share of total oil and gas reservoirs, respectively. Rich hydrocarbon reservoirs along with a special geographical location are of the most important competitive advantages of Iran. The oil value chain has a special place in the social, economic structure and level of development of Iran. In policy-making, especially in global equations and in the long run, where uncertainty is an integral part it is necessary to pay attention to this area. As a strategic knowledge, futures studies can play an important role in mapping the future. In current study, the possible and plausible futures of Iran's fossil energies (oil and gas) in the 2035 horizon are presented in the form of four scenarios. In an environment where variables are dynamic and constantly changing and uncertainty is high, using scenario building methods is preferable for long-term horizons. In this study, 30 drivers with high uncertainty and impact on the future of Iranian oil and gas were produced. Using the cross-impact analysis model and the balanced impact model, out of 41,472 possible scenarios, 10 scenarios with maximum compatibility were obtained, that presented in four scenarios namely: clean scenario (low carbon), a bipolar Middle East scenario, a cooperation and development scenario, and finally a postponed dream scenario.

1. Introduction

oil and natural gas and their derivatives still have the largest share of the todays human's primary energy sources; Crude oil supplies 31.9% and natural gas 22.5% of the world's primary energy; Therefore, oil and gas as a primary energy supplier is one of the most important components affecting the production of wealth and power and are of particular strategic importance in the political and economic equations of the world (WEO, 2019; Sambo, 2009; Mbasuen & Darton, 2012b). Iran's recoverable natural gas reserves amounts to 34 trillion cubic meters (18% of world reserves) and 158.4 billion barrels of recoverable oil reserves (9% of world share) at the end of 2019, is the third largest gas producer and fourth largest oil producer in the world (BP, 2019). Based on various forecasts in the coming years this position in world's oil and gas production will be lost, so that in 2035 it will be reduced to the fifth largest gas producer and the seventh largest oil producer in the world (BP, 2019).

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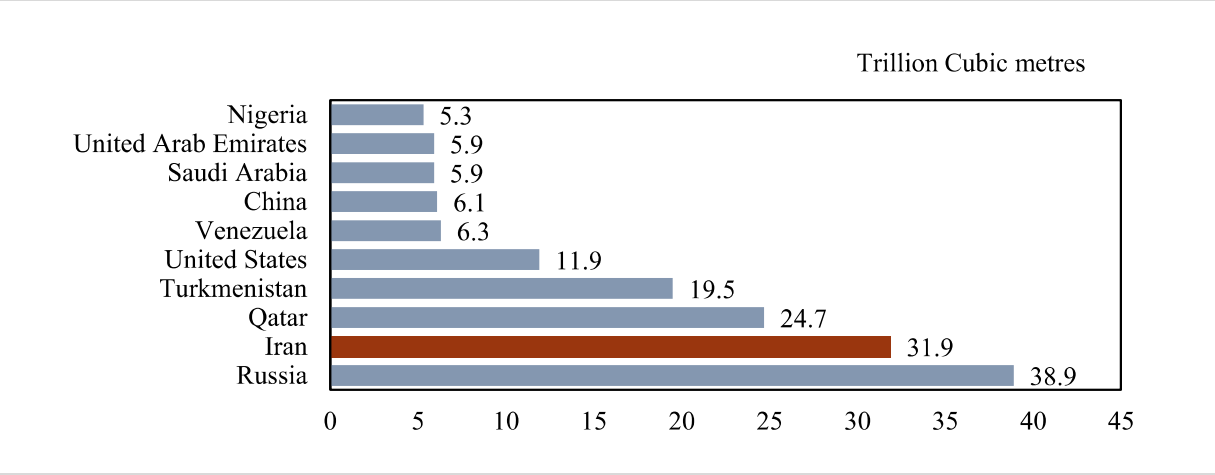

Figure 1. World gas reservoir Comparison (BP, 2019).

Of the world's 1,729 billion barrels of oil reserves, 836.1 billion barrels are in the Middle East, counting more than 48 % of the world's oil reserves, and more than 80 percent of this oil reserves are Saudi Arabia, Kuwait, and Iraq, and Iran. Historical observations show that this region is constantly in political turmoil, and it is natural to expect other political events in the future. In the natural gas sector, out of 196.9 trillion cubic meters of world gas reserves, according to the latest statistics, 38% of it is in the Middle East and 31.9% of gas reserves of the Middle East are in Iran. Iran and Russia currently hold 36% of the world's gas reserves (BP, 2019). Iran's oil industry has a special place as a driver of development, a high share in GDP and foreign exchange earnings (through crude oil, petrochemical goods and products) and a share of more than 95% in providing the country's primary energy needs gives it an undeniable role in energy security and economic stability. However, due to the high intensity of energy consumption, there are many problems in the energy structure and also the reduction of hydrocarbon reserves (Oketola, 2014).

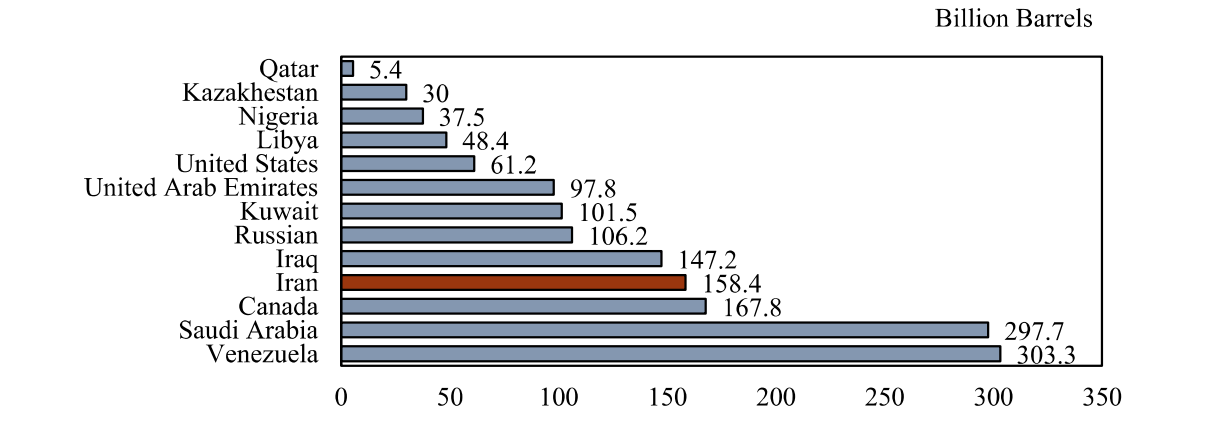

Figure 2. World crude oil reservoirs Comparison (BP, 2019).

In an environment with high uncertainty, policymakers and planners are presented with alternative solutions for planning and foresight decisions. Scenario design and presenting multiple possible alternatives is the key to developing comprehensive decision-making programs (Jetter and van der Heijden, 2003).

Scenario making has the ability to face and manage uncertainty and will make the decision-making process effective (van der Heijden and Varum, 2010). Scenarios

are a description of the future state and images of the paths that are our beacon to the future. (Pillkahn 2008) Implementing the scenario making process in the organizations will help organizational learning and modernization. (Chermack and Inayatullah, 2009). Recent studies on scenario planning have shown that the most effective use of scenarios is to help improve the process of identifying new issues and problems and to make efficient decisions about issues that may arise in the future (Varum, 2010).

Shell Oil Company is a pioneer in the field of recognizing and applying scenarios in the management of future planning at the corporate level in the world. This company applied scenario planning in business and commerce, thus predicting and managing the oil shocks of the 1970s. (Chermack et al, 2001). In the series of research and experiments conducted by Linman and Klein, it is clear that after the first oil crisis in the 1970s, the number of American companies that applied scenario planning has doubled (Linneman, Klein, 1979). Looking at the list of top international institutions that have addressed this issue, the importance of the issue in visualizing and predicting the future of energy is quite obvious. In current article, reports that are periodically issued by the following organizations are reviewed:

- Global Energy Outlook 2019 (IEA) [1]
- Energy Technology Perspectives 2019 (IEA)
- US Energy Information Administration (EIA) report[2]
- World Energy Association (WEC) Report[3]
- Shell energy scenarios for 2050, Shell Company
- Energy Vision 2035, BP Oil Company
- World Oil Outlook (WOO) 2019, OPEC
- GECF Global Gas Outlook (GGO)

Over time, these organizations and institutions have shifted from forecasting methods to using scenario writing for construct images of possible and plausible energy futures. In this article, it is tried to review these reference and credible reports in the field of energy future scenario writing. These studies are supported by major international sponsors and allocate significant research funding each year. The following criteria have been considered in analyzing and reviewing these studies and reports:

- Reputable international and related sponsors
- Continuous issuance and focus of fossil fuels
- Compilation based on scenario development structure
- Analyze and compare scenarios
- Has a time horizon of 2035 and above?

Although in compiling the scenario and content analysis, the reporting structure of each of them has its own methodology, but according to the common goal of all these scenarios in providing possible images of the future, there is no gap in the study and in principle each of these organizations They provide a good insight into the future state of energy, a common denominator that enhances their analytical nature over a continuous spectrum. Table 1 categorized the examined scenarios of these reports in terms of the type of scenario and the study performed.

Table1. Summary of types of scenarios retrieved from world report literature (by Authors).

organization	Title	Methodology
IEA	World Energy Outlook	Visioning, Interventive and Back casting
IEA	Energy Technology Perspective	Visioning, Interventive
WEC	World Energy Scenarios	Visioning, Interventive
BP	BP Outlook	Explorative, reference
SHELL	Shell's Energy Scenarios up to	storyline
OPEC	Global Oil Outlook	Visioning, Back casting
GECF	Global Gas Model	Explorative, reference

[1] International Energy Agency
[2] United States Energy Information Administration
[3] World Energy Council

Scenario development is basically based on a single model with a set of assumptions that regulate the relationships between variables. Then, experts in the field of scenario development change certain amounts of key factors and analyze its effects on the results of the study. In most cases, there may be tens of thousands of key factors (drivers) that can be varied, resulting in an infinite number of possible states. Also, even if two separate teams choose the same value for key factors, the results will vary depending on the type of uncertainty, which is usually reflected in the logic of the scenario model structure.

Each scenario-building process established by a common framework and produced using different logics and models may have different outcomes and this reflects the uncertainty in the models and the relationships that the models are designed to represent. The scope of this article does not include different types of modeling techniques; therefore, a brief description of each model is given to show that the models assumptions in the quantitative analysis of each scenario can be an effective factor in the difference in results. Table 2 summarizes the models presented in the International Energy Studies literature.

Table2. Models and scenarios used in international energy studies (by Authors)

organization	Model	Scenarios	Horizon	Methodology
International Energy Agency (IEA, 2019)	Simulation	1. Reference Scenario 2. Alternative policy scenario 3. Scenario beyond alternative	2050	Visioning, Backkasting, intervention.
International Energy Agency (IEA, 2019)	General Equilibrium	1- Operational Map Scenario 2. Low renewable energy 3. Scenario without carbon 4. Low energy efficiency 5. Technological scenario	2050	visioning, Intervention
British petroleum (BP,2019)	& Simulation Engineering Economy	1. Initial Energy Reference Scenario 2. Source toward Source	2035	visioning, Backcasting, Intervention
Shell Company	Simulation	1. Scramble 2. Blue prints	2050	Exploratory, reference
World Energy Council	Linear Optimization	1. Case A1 and A3 2.Case B 3.Case C1 and C2	2050	Exploratory, reference
Oil Producing and Exporting Countries	Supply and Demand	World Oil Outlook 2016	2035	Visioning, Backcasting
Gas Exporting Countries Forum	GGM	1.CMS (carbon mitigation scenario) 2.TAS (technology 3.RCS (reference case	2040	Exploratory, reference

In its report, strategic center of PWC[1] introduces the economic downturn (low and negative economic growth) as one of preventing factors for growth of this industry as one of the oil and gas trends. However, this study showed that by 2020, the repetition of the three-stage pattern of change in many areas related to energy economics, will lead to a temporary slowdown in global economic growth (Hillebrand E., PWC, 2018).

[1] PricewaterhouseCoopers

From the perspective of foreign policies affecting the future of oil and gas and changes in the international environment, especially in the Middle East, including tensions between Turkey and Russia, proxy wars in Syria, conflict between Arab countries and Iran led by Saudi Arabia, predicting the raise in Iran's acting and political power in this region is one of the most influential indicators (Ezzati, 2011; Pourahmadi, 2010).

In its report on global oil and gas trends, LukOil company showed a decrease in activities, mergers and acquisitions of companies in the oil and gas industry (in the United States and other countries); In terms of the value of transactions and the number of transactions. This reflects companies' focus on project and financial operations rather than abnormal growth; Companies that acquired major positions are now focused on optimizing production, simplifying operations, and increasing the rate of return on investment. Depending on the type of available reservoirs, the costs of oil exploration and production are growing compared to previous decades (Lukoil, 2018; Deloitte, 2019).

A study of past oil and gas market trends at Lukoil Co. suggests that the rich and oil-rich Persian Gulf states are seeking to diversify their economies by creating competitive industries. Increasing competition and diversity in alternative sources for oil and gas, as well as research and development activities in the promotion of technologies for exploration and exploitation of oil and gas resources and continuous improvement of efficiency are among the key factors to maintain a competitive position in the industry. The Deloitte report refers to the Arab countries efforts to maintain market share, especially in the United States. Based on oil market capacity, more than 2.5 million barrels of oil from OPEC[1] member countries such as Iran, Iraq and Libya are likely to be offset by increased production by the organization's major producers such as Saudi Arabia, Kuwait, Qatar and the United Arab Emirates. As a result, gaining market share will be at lower and more competitive prices. Saudi Arabia will prepare to compete with Iran and thwart Iran's activities (especially after the lifting of some sanctions). Also, according to the market demand for gas in the future, global competition between gas producers in the global gas market raises (Lukoil, 2018; Deloitte, 2019).

Among the factors affecting the oil and gas market, especially the demand side, is the progress and development of advanced technologies in increasing energy efficiency, which will lead to the competitiveness of alternative energy sources. Major consumers of oil and gas will support decreasing the dependence on fossil fuels and replace renewable and biological resources in transportation sector. Investing in diesel alternatives from plants such as soybeans, palms, canola and animal fats for aircraft fuel and commercial transportation is in the oil and gas companies' future plans. Diversification and replacement of other sources of energy production in sectors such as electricity generation and housing are also among the goals of these companies. (IBM, Deloitte, 2019).

Population growth rate, urban growth, lack of young and skilled labor due to negative population growth are major trends in the future affecting the economic environment and future energy demand. The growth rate of population and culture and the way energy is consumed by consumers indicate an increase in demand for oil. According to these trends, the world population will grow more than 1.2 billion between 2010 and 2025. These conditions require appropriate innovation and change in transportation models, urbanization and attention to the environment (green transportation). Pro-environment regulations and government support for a alternative, low-carbon fuels, such as natural gas, are drives this fuel into a preferred source in developed and predominantly consumer countries. The growing trend of using liquefied natural gas in cars with a greener future with low carbon fuels such as natural gas, increased consumption of gas instead of petroleum products (expansion of GTL[2] and NGL[3]) Due to improved fuel quality and the development of hybrid and electric technologies, we are witnessing a steady trend in reducing the fuel consumption of passenger cars. The study predicts a 30% reduction in fuel consumption by 2025 for passenger cars and a rapid growth in demand for natural gas by 2030 in this study (John Mitchell, 2012; IBM, 2016; Lukoil, 2019).

Studies by ExxonMobil have suggested that Iran is one of the future economic powers. In this study, the trend of economic growth rate is considered as one of the important factors and is closely related to the demand for energy. The World Bank also says that by lifting the sanctions, Iran will increase its GDP in the coming years. (ExxonMobil and pwc, 2016)

Ghalambar et al. (2012) using the methodology of

[1] Organization of petroleum exporting countries
[2] Gas to liquid
[3] Natural gas liquids

scenario development, have prepared images of the future of oil products. In this study, future study methods such as cross impact analysis, Delphi and scenario and MICMAC software have been used. To analyze the environment, PESTEL environmental model was used to identify the factors and in two stages using Delphi, experts' opinions were monitored and finally reached 22 drivers. Then, using MICMAC and Fultone model 4 scenario namely the sleeping lion, the playful rabbit, the runaway snake and the noble horse have been developed, and at the end, the operational strategies for each scenario are presented.

Saritas and Smith 2011; have been used intelligence: Environmental and Horizon Scanning. Scanning can be carried out at two levels. The first one is scanning the wider context of influencing factors, which may be mentioned as "Environmental Scanning". A STEEPV framework can be used for this purpose. The second one is "Horizon Scanning" which is concerned with what could plausibly unfold in the future in the form of Trends, Driving of Change, Weak Signals of emerging developments, Wild Cards/Shocks/Surprises and discontinuities. (intelligence: Environmental and Horizon Scanning)

In 2011, Mohammadnejad et al. In an article entitled "A review of Energy Scenarios and Sustainable Energy of Iran" examined energy supply and demand scenarios (Mohammadnejad et al., 2011), although this study is completely qualitative, and descriptive scenarios were the output of the study. Renewable energy portfolio in Iran and its development strategies have been reviewed in a literature review in which renewable energy development strategies in the Iranian energy portfolio have been presented after studying the status of these resources (Bahrami and Abbaszadeh, 2013). In 2013, Abbaszadeh and his colleagues presented future scenarios for Iranian oil on the horizon of 2025. In this study, 4 scenarios have been developed and the combined methods of expert's panel- cross impact matrix have been used (Abbaszadeh et al., 2013).

Abbaszadeh et al. (2013) presented a study entitled "Scenarios for the development of Iran's oil resources until (2025)" while examining the current state of energy in Iran and then worldwide on developments in the oil field in terms of production and consumption and on existing priorities In the Iranian oil industry, of course, only from the point of view of some researchers of the field. The study of the world energy situation had a general view and using reliable global statistics, the trend of factors changes in the past and taking advantage of current developments and decisions taken by the country, four scenarios in the field of oil production and consumption constructed: The thunder scenario, Behemoth scenario, Snowman scenario and poor addict scenario.

Considering Iran's competitive advantage over the two sources of crude oil and gas, this research, in comparison with previous researches, focused on both hydrocarbon resources and the possible and plausible futures of Iranian oil and gas up to 2035 horizon and extracted 4 scenarios.

2. Methodology

In this research, the ontological and epistemological paradigm and principles presented by Jennifer Gidley have been used. Jennifer Gidley's paradigm views on futures studies are newer than the approaches updated by Vorose.J(2008)

Gidley considered positivism and post-positivism to be the main paradigms of futures studies, but considered other branching approaches to them. New paradigm perspectives such as Interpretive/ Holistic, predictive/ participatory, cultural / interpretive and critical / postmodern for positivism and predictive / empirical for positivism derived from the conclusion were presented by Gidley in the figure number 3 is given. This research uses critical and participatory post-positivist paradigm.

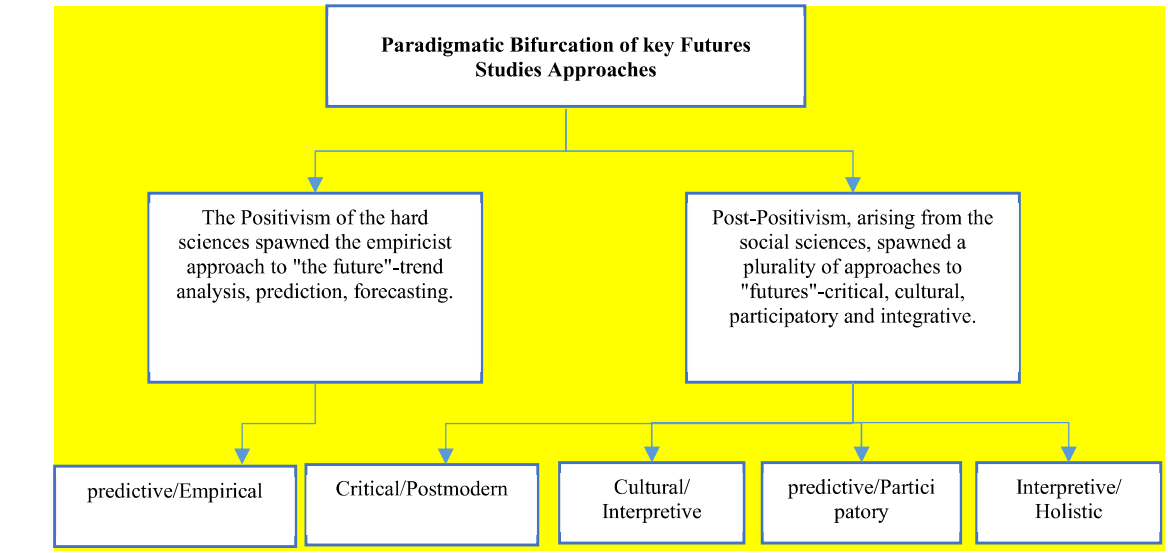

Figure 3. Paradigmatic bifurcation of futures studies approaches (Gidley.J,2016).

In this article, in the first stage, important variables, key factors or dominant trends that had the greatest impact on the Iranian oil and gas industry on the research horizon were identified. What enriches the work in applying the scenario method in this paper is a combination of quantitative and qualitative methods. For this purpose, a set of appropriate methods and tools were used the process of performing the methodology is schematically described in Figure 4.

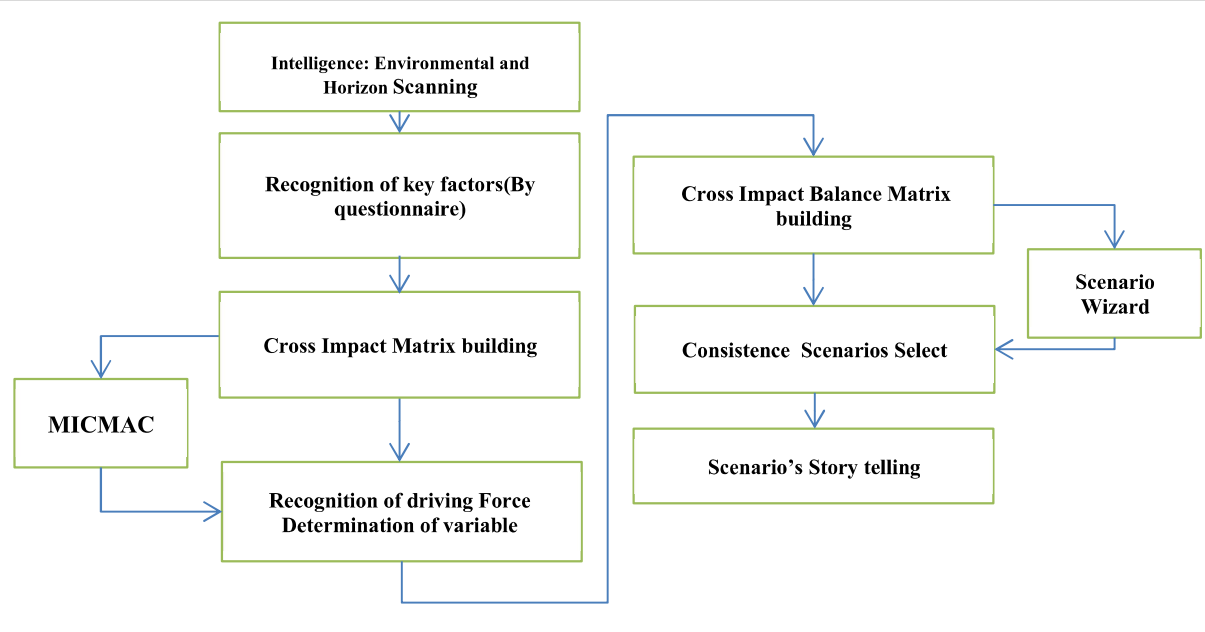

Figure 4. Steps of Methodology (by author's).

2.1. First Stage Identify Key Factors

Key trends or main variables in the formation of scenarios are variables that have a great impact on the main topic of research. Trends are tangible and visible changes over time. There are several ways to identify the trends. In this study, the Saritas and Smith (2011) model was used to scan the environment/horizon. Using the environment and horizon scanning method, the identified factors were classified into five groups.

At this stage, experts in the field of energy and futures study were identified. For this purpose, the method of extracting key individuals was performed in accordance with the ECA[1] standard. These steps and processes are shown in Figure (5).

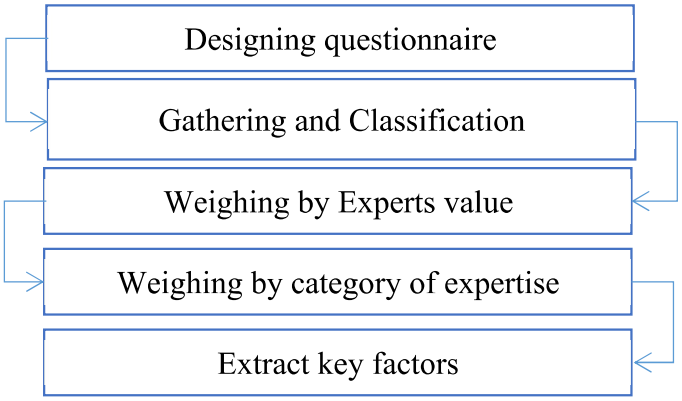

Figure 5. Selection of key factors (by authors).

In this article, by using and designing a new questionnaire and methodology and using prominent and recent scientific models, relevant experts and specialists were surveyed and appropriate measures were taken to validate the opinions and views. Finally, by inviting elites, policymakers, managers and senior experts in the field of energy to answer the questions of this questionnaire, the answers were collected and analyzed.

The statistical population of the present study includes experts in the field of energy and futures studies. Given the subject of research and the new field of futures research in the field of fossil energy in the country and the fact that there are very few experts who have mastered both futurism and fossil energy issues, the statistical population is inevitably small. This community is estimated at 20 to 25 people. Tables showing more details are available in the appendix.

2.2. Second Stage Synthesis of Key Drivers

At this stage, using the Cross-Impact Matrix (CIM), we seek to extract key drivers through cross-impact analysis. The resulted matrix was subjected to the judgment of experts and specialists of the field. The scale of this judgment is between 0 and +3. The effects of all rows and columns are measured in terms of impact on each other. Each of the numbers has the following meanings: number three = strong effect, number two = medium effect, number one=weak effect, zero = no effect.

Then, using the MICMAC software, the created matrix is analyzed by cross impact analysis (CIA). The output of this software has four poles. In this diagram, we consider the factors that have the highest effects and the least impact or the so-called low dependence on others. These drivers are the input to the stage of achieving scenario modes.

2.3. Third Level Scenarios

After identifying the key drivers in the previous step, we look for specific combinations that create the scenario structure. For this purpose, Dr. Wolfgang et al. from the University of Stuttgart, Germany, developed a model called the Cross-Impact Balance Matrix and the Scenario Wizard software. This model is a method for analyzing effective networks of factors. This model uses qualitative insights into the relationships between the factors of an influential network to achieve a set of combined and consistent factors about network behavior.

To do this, we first examine the Cross Impact Balance matrix, which examines the effect of the variable x from the descriptor X on the variable y from the descriptor Y, which is done by a two-by-two judgment scale of the variables between 3- and 3+ (3-:

[1] ECA: European Consortium for accreditation.

strong limiting effect [1], 2-: Moderate limiting effect, 1-: Weak limiting effect, 0: No effect, +1: Weak developing effect, 2+: Moderate developing effect, +3: Strong developing effect) Formed and subject to judgment Experts agreed.

2.4. Step 4 Storytelling for Each Scenario

To analyze this matrix, Scenario Wizard software was used, which performs all possible states to predict the placement of variables based on mathematical models. The output of this software is multiple scenario packages. The most important feature of this software is extracting the most compatible scenario mode that can be obtained from countless modes. In addition, numerous reports and analyzes can be obtained that can be used to construct scenarios with maximum compatibility. In other words, in each scenario, the descriptors are the main actors and the variables of each descriptor state indicate the role that the descriptor plays in the story of the scenario.

Table 3. Key and uncertain factors (by authors)

Row	Dominant trends	Row	Dominant trends
1	Global oil price	17	Climate Change Issue
2	Peak Oil	18	Changes in energy consumption patterns
3	Iran GDP growth	19	Planning legislation
4	Cohesion of OPEC	20	Alternative Resources
5	Risks of investment in energy sector	21	Social Impact
6	Geopolitical environment	22	Reduce financial corruption
7	Minimize fossil fuels	23	Technological changes in the exploration and exploitation of oil and gas
8	Energy Export (Iran as Energy corridor)	24	International treaties for the use of renewable energy
9	Flow of Iranian oil	25	Elite migration and social cleavage
10	The people approach to clean energy and green	26	Energy production capacity
11	Energy political priority	27	Empowering young influential women
12	Regional tensions	28	Increasing the relationship with the East Asian countries
13	Subsidy system	29	Rules of attract foreign investment
14	Assets and Reserved Oil &Gas	30	Total Factor Productivity Ratio
15	Water stresses and droughts	31	Dependence to energy carriers import
16	Iran foreign policy		

Thus, in this paper, key elements with high uncertainty were used in constructing the scenarios. However, so far this level of the policymaking with prototype of this research has not been used in Iran. This model can be revised according to the needs and necessities of each subject as a suitable and practical model. In this study, the possible and plausible futures of Iranian oil and gas in the horizon of 2035, in the form of four scenarios including Clean (low carbon) scenario, Bipolar Middle East scenario, Cooperation and Development scenario and finally the Postponed dream scenario has been written.

3. Iranian Oil & Gas Scenarios

As described in the methodology, using environmental and horizon scanning, all the effective, constructive factors and the factors influencing the future of Iran's oil and gas were identified. Approximately 107 factors were obtained from this scan, which were placed in standard categories according to methodology. Each of these factors has its own unique orientations,

[1] For example, if T1 has a strong limiting effect on T2, judgment value will be 3.

individually or in combination with other spatial factors that will lead the future of this Iranian oil and gas industry in a specific direction. But which of them has a higher degree of probability and the effect of occurrence was judged based on the perceptions of experts in each field? The results are key factors that have a dominant and affected on the future of the oil and gas industry. The output of this section was determined to be 30 key effective factors with a high probability of uncertainty compared to other factors. In the next step, table number (4) as the input of the cross-impact analysis model in the MICMAC software was used. Cross impact analysis is a way to identify the interactions between factors. In this model, the effect of each factor on other factors is graded. In other words, the CIA is a semi-quantitative method in which, instead of simple cause-and-effect relationships, the relationships between different subsystems are analyzed in a matrix.

Table 4. Drivers with uncertainty.

	Assumption
A	Global oil price
B	Iran GDP growth
C	Cohesion of OPEC
D	Geopolitical environment
E	Energy political priority
F	Iran foreign policy
G	Climate Change Issue
H	Planning legislation
I	Social Impact
J	Assets and Reserved Oil &Gas
K	Alternative Resources

The output of this model was key drivers (assumptions) according to Table (5).

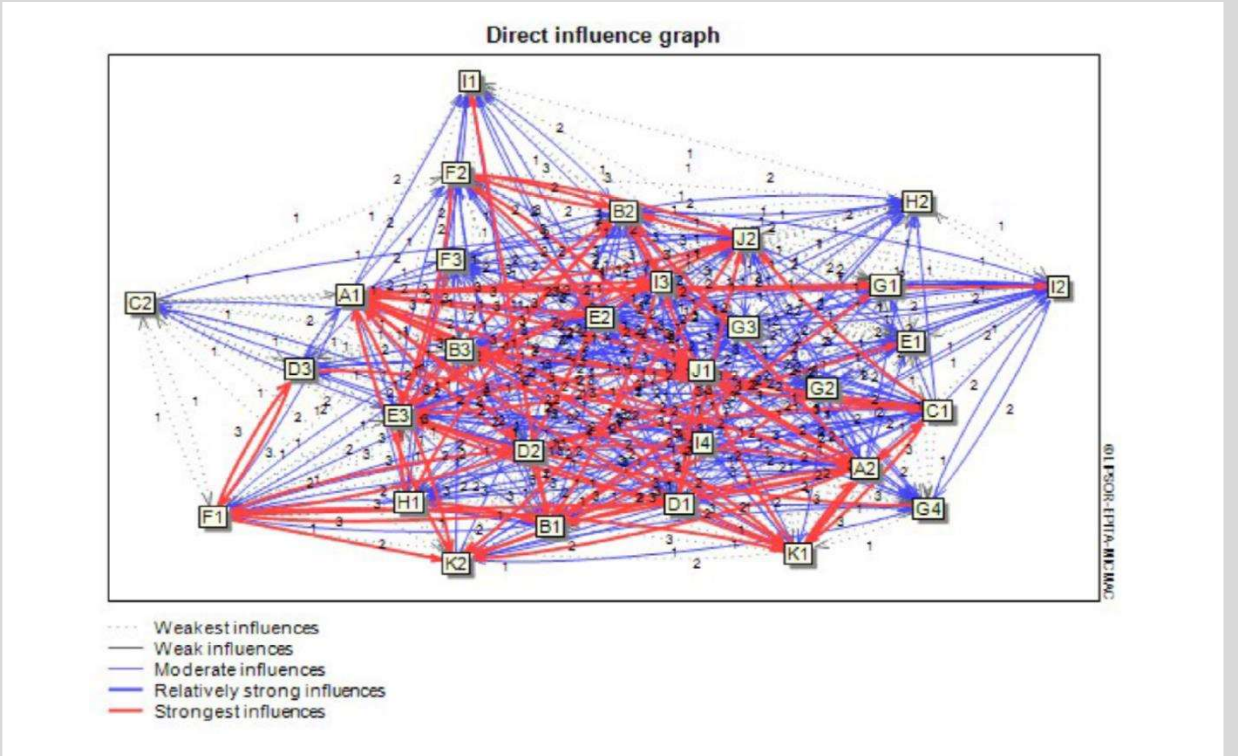

Figure 6. Drivers' network in the CIA model at the MICMAC output (by authors).

Cross impact analysis, and the use of MICMAC software tools, helped us to identify the role of a variable in relation to other variables within a network system (Figure 6). These maps are important and meaningful in the development of the system in the future. The result is a image of the interactions between factors and variables with the same degree of importance. This image shows which variables are dependent or independent, which are drivers, and which are driven by other factors. The Drivers known by this method were inputs of our scenario making stage. (Figure 7).

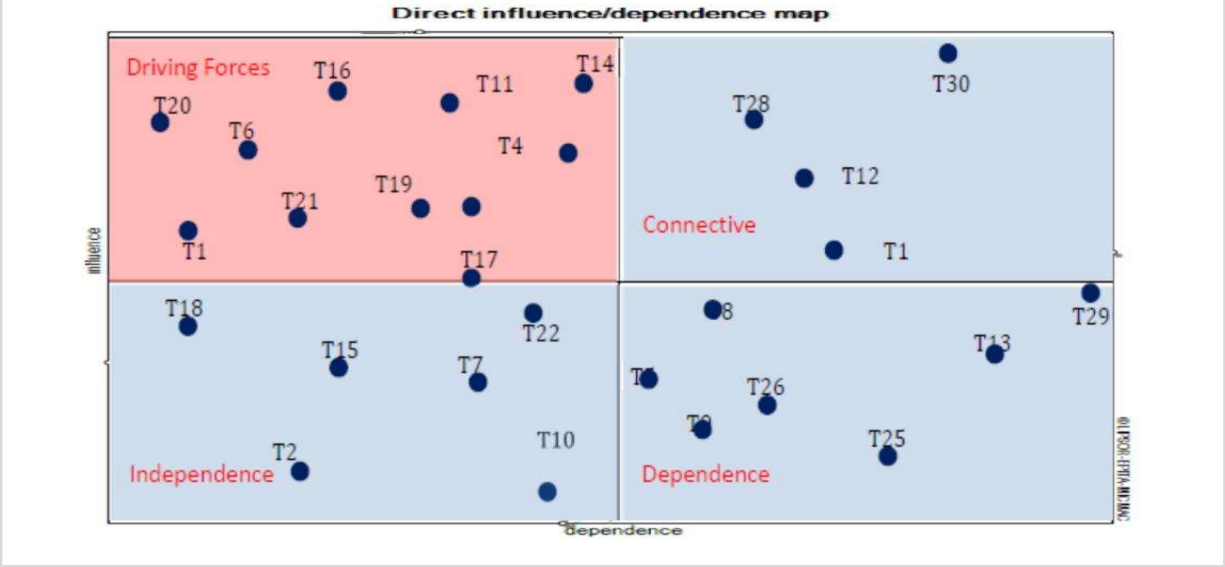

Figure 7. Distribution of the driving forces in the CIA model in MICMAC software.

Finally, the key drivers located at the first pole of the Figure 6 matrix are summarized in Table 5 These factors will be used as drivers with high uncertainty and degree of effectiveness as the input of the scenario writing.

Table 5. Key drivers of Iran's future fossil fuels.

	Driver	*Descriptor*
1	***T1***	Global oil price
2	***T3***	Iran GDP growth
3	***T4***	Cohesion of OPEC
4	***T6***	Geopolitical environment
5	***T11***	Energy political priority
6	***T14***	Assets and Reserved Oil &Gas
7	***T16***	Iran's foreign policy
8	***T17***	Climate change
9	***T19***	Planning legislation
10	***T20***	Alternative energy resources
11	***T21***	social Impact

The key drivers of Table 5 are called descriptive based on the Cross Impact Balance model logic. Each of these key drivers has a high degree of uncertainty in most of the research and reports under investigation. In the next step, for each of the descriptors, the identified qualitative/quantitative alternatives were entered into the CIB model as shown in Table (6). These alternatives are variables that affect each of the descriptors. Variations of each descriptor were identified during environmental and horizon scans Cross Impact Balance matrix was adjusted based on the variables and descriptors of Table (6).

Table 6. Descriptors and variables (by Authors).

	Assumption		Variant	
1	A	Global oil price	A_1	drop/slumping < 30$
3			A_2	Rapid growth > 60 $
4	B	Iran GDP growth	B_1	Inflation
5			B_2	2-speed economies
6			B_3	Economic oil dependence
7	C	Cohesion of OPEC	C_1	Effects on world oil price and production
8			C_2	Influence on Non-OPEC producers
9	D	Geopolitical environment	D_1	Middle East harmony
10			D_2	Arabic neighbors' conflicts (Saudi Arab)
11			D_3	Middle East dis-harmony
12	E	Energy political priority	E_1	Security
13			E_2	Economy
14			E_3	Petrochemical development (preventing of crude oil selling)
15	F	Iran foreign policy	F_1	RSII(Russia-Iran-Syria) coalition
16			F_2	Preventing with west conflicts
17			F_3	Cooperation development with BRIICs
18	G	Climate Change Issue	G_1	CO2 emission reduction and GHG restrictions
19			G_2	COP 21. International commitment
20			G_3	water tensions
21			G_4	Energy efficiency and conservation
22	H	Planning legislation	H_1	Coherent
23			H_2	Promoting Speed and participation
24	I	social Impact	I_1	Aging and Brain drain
25			I_2	Urban population ratio and Internal migration
26			I_3	Unemployment (Jobless growth)
27			I_4	Deeping income inequality and civil unrest
28	J	Assets and Reserved Oil &Gas	J_1	Production capacity
29			J_2	Renew technology and productivity
30	K	Alternative Resources	K_1	shell (Oil &Gas) revolution
31			K_2	New emerge technology and Growth of RE. s

Cross Impact Balance matrix was adjusted based on the variables and descriptors of Table (6). These variables and descriptors were used as input to the Cross-Impact Balance model. This matrix was provided to the experts for final judgment. After completing the matrix by the experts, compiled views imported to the Scenario Wizard software and the program (model) was executed. The output of this model out of 41472 scenario modes (Table No 7) contained 10 compatible scenario modes that had the highest total impact score. The resulting compatible scenario map is shown in Figure 8.

In our research (elven interacting descriptors) 2*2*4*2*4*3*3*3*2*3*2 = 41472 possible configurations exist. Checking all configurations in the way shown in Fig. 6 reveals that only ten configurations are free of internal inconsistencies. The ten consistent scenarios are grouped into four scenario families (scenario groups)

Number of permutations means the number of variables stacked in the CIB model that the set of variables may be stacked side by side. (The multiplication of all the variables in each other) hence there are approximately 41,472 scenarios. But what is important is to produce scenarios with the maximum compatibility; this is what we are looking for in the CIB method. After running the model in Scenario Wizard software, 10 compatible scenarios were obtained. These 10 scenarios had the strongest degree compatibility (Figure 8), which after reviewing and analyzing the values of the cross-impact set, we classified them into four 4 scenarios with a higher total cross impact score. (Table 8).

Table 7. Number of permutations resulting from the implementation of the model.

	Driver	*Descriptor*
1	***T1***	Global oil price
2	***T3***	Iran GDP growth
3	***T4***	Cohesion of OPEC
4	***T6***	Geopolitical environment
5	***T11***	Energy political priority
6	***T14***	Assets and Reserved Oil &Gas
7	***T16***	Iran's foreign policy
8	***T17***	Climate change
9	***T19***	Planning legislation
10	***T20***	Alternative energy resources
11	***T21***	social Impact

Table 8. Compatility scor of each scenario

	Driver	*Descriptor*
1	***T1***	Global oil price
2	***T3***	Iran GDP growth
3	***T4***	Cohesion of OPEC
4	***T6***	Geopolitical environment
5	***T11***	Energy political priority
6	***T14***	Assets and Reserved Oil &Gas
7	***T16***	Iran's foreign policy
8	***T17***	Climate change
9	***T19***	Planning legislation
10	***T20***	Alternative energy resources
11	***T21***	social Impact

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3.1. Scenario 1 Postponed Dream Scenario

The main feature of this scenario according to the software output is:

Table 8. The drivers and thrusts of postponed dream.

		Scenario's code: 8		**interaction impact score :80**
1	B	GDP Growth	B2	2-speed economies
2	A	Oil Price	A1	drop/slumping < 30$
3	K	Alternating resources	K2	New emerge technology and Growth of RE. s
4	E	Energy Policy Priorities	E3	Petrochemical development (preventing of crude oil selling)
5	F	Foreign politics	F3	Cooperation development with BRIICs
6	G	Environmental issues	G2	COP 21. International commitment
7	I	Social issues	I4	Deeping income inequality and civil unrest
8	D	Geopolitical Environment	D1	Middle East harmony

		Scenario's code: 8		interaction impact score :80
9	J	Oil and Gas reservoirs	J2	Renew technology and productivity
10	C	Cohesion of OPEC	C1	Effects on world oil price and production
11	H	Planning legislation	H1	Coherent

In this scenario, the 'real private sector economic variable' has a very high impact on the realization of conditions compared to other variables in this scenario. With further investigation into other parameters and model outputs, economic variables play a more colorful role.

Due to the mentioned feature, "postponed dream" is the chosen name of this scenario. Postponed dream is a concept that was chosen for this scenario due to the non-realization of the country's development plans so far, the high degree of uncertainty at the end of the oil age and the time for reaching the peak of oil. In this scenario, productivity and modernization of technologies in the upstream sector, especially in reservoirs, takes place according to plan, although the price of oil is below 30$ per barrel, but due to improved productivity in production factors and proper management, costs are low and competitive production is provided. The prosperity of the business environment along with the real and powerful private sector relying on market principles plays a key role in the economy. Extensive employment and decent welfare are the result. Investments are made throughout the chain, especially downstream, with more value-added, and the development and production of new products. Studies over the last forty years show that the economic growth of 8% has not yet been achieved. The basis for this event is the active foreign policy in the region and the international level. Petroleum, petroleum products, natural gas derivatives and petrochemical products are sold with good circulation in important global and regional markets. The policy of chaining the interests of emerging economies to the major oil and gas, refining, distribution, petrochemicals projects, and the dependence of neighboring countries has created a favorable security haven for the country. The country's oil, liquid and condensate production capacity has reached a maximum of 6.2 million barrels per day of crude oil equivalent. Income gap and inequality and sometimes social unrest and trade unions is the most important social phenomenon that is the result of the actions of some companies to reduce costs and create competitive power. This companies have found the way in fire their employees. Fortunately, no one is left unemployed in this open economic space due to the proper education system and the improvement of the workforce skills and the appropriate insurance support of the government. However, the presence of artificial intelligence and super-intelligent robots has narrowed the field to manpower, to the extent that anti-technology and anti-robot movements have been launched by various trade unions. Energy subsidies are quite purposefully targeted and provided to GDP. Diversification in the use of energy resources has led to the rapid development of renewable energy infrastructure of the country. Energy saving and energy optimization have provided good opportunities for economic prosperity.

In this scenario, the population growth rate is mild, but the growth rate of the domestic economy is equal to 8% and the production of oil, liquids and condensate reaches 6.2 million barrels equivalent to crude oil and 1.5 billion cubic meters per day. Therefore, according to the postponed dream scenario, this rate of economic growth in Iran is one of the fastest growing countries in the world. With this description and economic conditions, the dependence of the public budget on oil has decreased and oil revenues have no way to the public budgets, and this wealth is spent on the development of appropriate, targeted and balanced infrastructure for the future. Economic growth with high rate, stability and dynamism in the right business environment and security of the region well supports this scenario.

3.2. Scenario 2: Bipolar Middle East

The main features of this scenario are:

Table 10. Drivers and thrusts of bipolar middle east scenario.

		Scenario Code: 5		Interacting impact score: 71
1	E	Energy political priority	E3	Petrochemical development (preventing of crude oil selling)
2	K	Alternative Resources	K2	New emerge technology and Growth of RE. s
3	A	Global oil price	A2	Rapid growth > 60 $
4	F	Iran foreign policy	F1	RSII(Russia-Iran-Syria) coalition
5	G	Climate Change Issue	G4	Energy efficiency and conservation
6	B	Iran GDP growth	B2	2-speed economies
7	H	Planning legislation	H1	Coherent
8	J	Assets and Reserved Oil &Gas	J1	Production capacity
9	C	Cohesion of OPEC	C2	Influence on Non-OPEC producers
10	D	Geopolitical environment	D2	Arabic neighbors' conflicts (Saudi Arab)
11	I	social Impact	I4	Deeping income inequality and civil unrest

At the heart of this scenario is the geopolitical situation in the Middle East and Iran's Saudi-led tensions with Arab neighbors. These conditions and Iran's potential to create a niche in the region caused this country and its allies Russia and Syria to form a strong alliance called "Russia-Iran-Syria (RIS)" against the aggression of rich Arab West backed countries. The scenario was called the Bipolar Middle East.

In this scenario, tensions in the Middle East show that oil prices have risen sharply. Conflicts between Iran and its allies have pushed the Middle East toward bipolarity. With the depletion of some energy sources in some parts of the world, Middle East -the heart of the world's conventional energy sources- has once again come to the attention of consumers. The price of fossil fuels has risen, and the region's producing countries have relentlessly raise the production to compensate their military and defense budgets. By investing in and developing suitable infrastructure for high-value-added petrochemical industries in the Makran region – the gate to the Asia- Iran along with restoring regional security make a winsome wealth, and will not create barriers to crude oil sales in economic programs and conditions. Due to the re-creation of fossil energy, the development of renewable energy infrastructures is underway with little growth. The tendency of economies to rely on oil and gas revenues is one of the features of this scenario. But environmental concerns remain strong. Insufficient coherence in the accurate implementation of development plans is evident due to incoherent and fragmented political behaviors or irrational operational methods in not providing the required resources and facilities, including deterrents and obstacles to government development plans. Due to political tensions and the critical situation in the Middle East, there is a strong tendency to sell crude and earn immediate income from of oil and gas and its products transactions, while solidarity among OPEC members is a destructive factor in the market. The country has abandoned its development plans and is pursuing ill-considered adventures in the Middle East. The class division plunges and discontent has dragged unrest into the streets. This radical political behavior has made the ease of the business environment difficult and the experience of stagflation and recession has backed. However, due to the heterogeneous development and implementation of sterile programs and policies in the country's macro-energy sector, the development and operation of energy infrastructure, especially renewables, will not grow much in 1414. Also, there will be a decline in domestic energy providence and growing energy intensity in industry worsens the situation. Iran's energy intensity index is almost three times more than what it is in developing countries, and this has seriously endangered energy security and the implementation of development programs.

Although oil prices are rising above $ 60 a barrel, the economic growth rate on the horizon of 1414 is falling sharply, the budget dependence on oil is high and the domestic economic growth rate is falling freely below zero. Oil production, which is due to the efforts of the

previous decade, is declining to 4.8 million barrels per day and crude gas production is reduced to 1.4 billion cubic meters per day. Shale oil and gas have hit markets again. North America and China have revived their unconventional resources. Under these circumstances, OPEC does not play an important role in regulating the oil and gas market, so "goodbye to OPEC."

3.3. Scenario No. 3 Clean Scenario (Low Carbon)

The specifications of Scenario No. 3 according to the output of Scenario Wizard software are as follows:

Table 11. Drivers and thrusts of clean scenario.

		Scenario's Code: 3		Interacting impact score: 73
1	B	Iran GDP growth	B2	2-speed economies
2	G	Climate Change Issue	G4	Energy efficiency and conservation
3	K	Alternative Resources	K2	New emerge technology and Growth of RE. s
4	A	Global oil price	A2	Rapid growth > 60 $
5	E	Climate Change Issue	E3	Petrochemical development (preventing of crude oil selling)
6	F	Iran foreign policy	F1	RSII(Russia-Iran-Syria) coalition
7	H	Planning legislation	H1	Coherent
8	J	Assets and Reserved Oil &Gas	J1	Production capacity
9	C	Cohesion of OPEC	C2	Influence on Non-OPEC producers
10	D	Geopolitical environment	D2	Arabic neighbors' conflicts (Saudi Arab)
11	I	social Impact	I1	Aging and Brain drain

In this scenario, the average economic growth due to the relative stability of oil prices around 60$ there is not serious changes in the country's energy sector. Economization of production, high efficiency, conservation of energy and the move towards low-carbon and renewable fuels are the main features of this scenario.

Environmental variables and climate change play a key role in this scenario. This scenario defers from other scenarios based on a strong supportive effect of other variables on the issue of environment and energy conservation. The economic growth rooted from the business environment, obviously has strengthened and prospered the private sector and promoted the protection of the environment, in which energy efficiency and energy conservation programs are well implemented. Non-governmental organizations and environmentalists have a strong demand from producers for green production. Diversity in energy sources and decentralization across the country has reduced the consumption of fossil fuels and the rising oil prices strengthens this movement. The transportation sector has reduced its reliance on fossil fuels. Energy distribution networks have been modernized and optimized, and energy waste has been minimized. Problems related to the production, transport and storage of hydrogen have been solved and the hydrogen economy has responded well in this area.

Clean fuels have increased in the country's primary energy basket. The lowest amount of crude oil and the highest amount of crude gas is produced in this scenario. Productivity in this scenario is the driving force of the economy. Productivity and optimization have occurred in high-consumption sectors, especially the home sector, transportation and even industry.

Beside the price of oil in the range of 60$ per barrel in this scenario, the rate of economic growth in the horizon of 1414 is not very successful, but the situation is not acute, the dependence of the budget on oil is reasonable and decreasing. In addition to this economic situation in the horizon of 1414, oil production to the level of 3.3 million barrels per day and natural gas production with a major share in the country's fossil fuel basket by 1.6 billion cubic meters per day of low carbon fuel can be achieved.

The dark shadow of the private sector of the economy is gradually fading from the real and public private sector, and this promises a brighter future. International environmental treaties and the reduction of greenhouse

gas emissions, along with the determination of strong NGO networks, have been required to reduce fossil fuel use and have been successful. Fossil fuels have shifted to conversions and new product production. Most of the electricity generated is produced with new technologies with minimal pollution and high efficiency. The share of electricity in the transportation sector has increased dramatically due to this success and new storage and battery technologies, which is estimated to be close to 50% in Iran's metropolitan areas. The phenomena of "metropolitan inversion" can only be seen in historical studies. The amount of oil production with the strategy of maintaining production capacity and relying on the total productivity of production factors (especially capital) has decreased by nearly 3.3 million barrels of crude oil equivalent per day and crude gas production has increased by 1.6 billion cubic meters per day. Environmental activists have completely forgotten and haltered the international conventions on low-cost renewable technologies and the price of fossil energy in the shale oil and gas revolution. The main habitat of flamingos is in Lake of Uroomia. The white clouds and blue sky of Tehran and Beijing are back. "Old is the Beast".

3.4. Scenario 4 Cooperation and Development Scenario

The main characteristics of this scenario are mentioned in following table:

Table 12. Drivers and thrusts of cooperation and development scenario.

				Interacting impact score: 59
1	B	Iran GDP growth	B2	2-speed economies
2	E	Energy political priority	E3	Petrochemical development (preventing of crude oil selling)
3	K	Alternative Resources	K2	New emerge technology and Growth of RE. s
4	A	Global oil price	A1	drop/slumping < 30$
5	C	Cohesion of OPEC	C2	Influence on Non-OPEC producers
6	H	Planning legislation	H1	Coherent
7	D	Geopolitical environment	D2	Arabic neighbors' conflicts (Saudi Arab)
8	F	Iran foreign policy	F3	Cooperation development with BRIICs
9	G	Climate Change Issue	G2	COP 21. International commitment
10	I	social Impact	I1	Aging and Brain drain
11	J	Assets and Reserved Oil &Gas	J1	Production capacity

One of the key points of this scenario is the development of cooperation both nationally and internationally. This event has a significant impact on other key elements of the scenario.

This scenario is one of the most consistent scenario elements that cooperation, participation and consequently development in the implementation of programs and goals set in the energy sector will have a significant speed. Hence this scenario is called cooperation and development. In this scenario, population growth is increasing with a slight slope, but the phenomenon of aging is still prevalent. In the economic sector, the real private sector is flourishing well in an environment of stability and moderate economic growth. The fossil energy sector has been able to attract a significant amount of foreign investment and technology due to good cooperation in the field of foreign policy and interaction with countries with stylist in the field of oil, gas and petrochemical industries. In this favorable environment, the growth of knowledge-based companies in the oil and gas industry has been greatly enhanced under the influence of good international relations and the participation of the private sector, and is superior in terms of knowledge in the region.

The country remains committed to the implementation of its international environmental treaties. In this scenario, the solidarity and art of consensus among OPEC members at the highest level of decision-making is still maintained. Although political differences and tensions with Arab neighbors still occasionally arise, the wisdom and foresight of the ruling experts have prevented them from deepening and expanding, and at least in the common interests of the oil and gas market. The opportunity of the private sector and the involvement of the country's capital and attracting foreign investors has led to the development of the downstream petrochemical sector and the most important support factor is the existence of rational stakeholders and planners and coherent development plans that are formulated and implemented with the cooperation of all stakeholders. Despite good cooperation at the national and international levels, the many opportunities for new and renewable energy in the country have not yet found their true place. Energy policy in this scenario is more focused on completing the value chain. Energy security is also one of the most important business activities. Cooperation and development scenario include the conceptual dimensions of value chain completion: fair and equitable price, durability and sustainability and environment.

In this scenario, the price of oil is around 30$ per barrel. In this scenario, the economic growth rate on the horizon of 1414 is stable and growing at a gentle slope. Oil production is reasonably available at a limit of 4.1 million barrels per day and natural gas production at a reasonable 1.4 billion cubic meters per day.

For this purpose, the elements and state variables of each scenario are examined separately to analyze their degree of coherence. For convenience in examining the scenarios obtained from this research, the elements and state variables are shown in Table 2-5.

4. Results

In this paper, the possible and plausible futures of Iran's fossil energy (oil and gas) in the horizon of 1414 AH (2035 AD) were presented in the form of four scenarios. From 107 factors identified by environmental and horizon scanning method, based on the opinion of experts, 30 key factors with high uncertainty and affecting the future of Iran's oil and gas were identified. Then, 11 drivers were obtained by using the cross-impact model, and then by using the balanced cross impact model, out of 41,472 possible permutations, 10 scenarios with maximum compatibility were obtained. The result of work in the form of four scenarios with titles; A clean (low carbon) scenario, a bipolar Middle East scenario, a cooperation and development scenario, and finally a postponed dream scenario were developed. Figure9.

In Table (13), each scenario is categorized based on the type of influential variables and the index of each descriptor and determines in each scenario which variable related to which Drivers has a stronger impact than the others in the scenario.

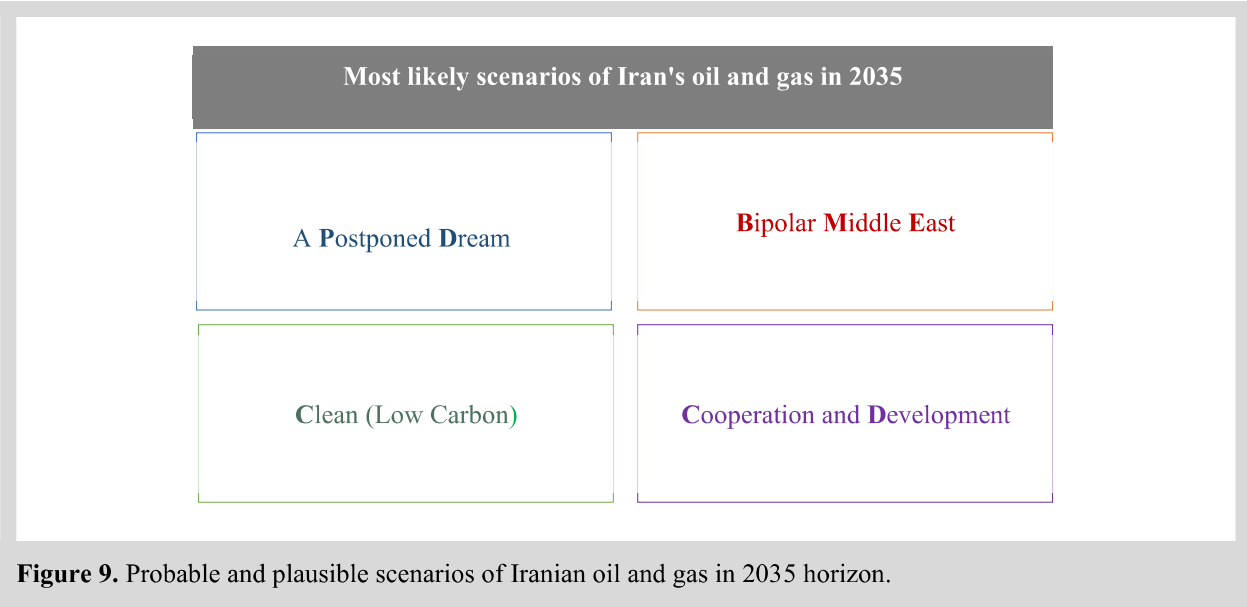

Figure 9. Probable and plausible scenarios of Iranian oil and gas in 2035 horizon.

Table 13. Variable matrix of each scenario.

Scenarios	A	B	C	D	E	F	G	H	I	J
A Postponed Dream	A1	B2	C1	D1	E3	F3	G2	H1	I4	J2
Middle East Bipolar	A2	B2	C2	D2	E3	F1	G4	H1	I4	J1
Low Carbon)) Clean	A2	B2	C2	D2	E3	F1	G4	H1	I1	J1
Cooperation Development	A1	B2	C2	D2	E3	F3	G2	H1	I1	J1

Each of these modes is the strength and focus of the scenarios in the three scenarios, the postponed dream, clean and cooperation and development, the economic growth is the main driver, but in the postponed dream scenario, economic growth is more active, in fact, it is more compatible with other factors.

In the postponed dream scenario, the drivers of the real private sector economy with a consistency value of 16, has acted very strongly among all the accelerators, while oil prices have stabilized around 30$, but the development of the petrochemical industry and renewable technologies aside the development of an active economy has provided good adaptation to countries with emerging economies and Middle East drivers. Other drivers do not have much effect in this scenario. In the bipolar Middle East scenario, the role of oil prices above 60$ and the strong alliance between Russia-Iran-Syria and the focus on the petrochemical currency industry with a compatibility value of 4 have created the highest compatibility in this scenario. Economic prosperity and coherence in planning and production capacity have a weaker effect on the scenario, and the other factors are almost ineffective.

In the clean scenario, there is a very harmonious compatibility between the energy efficiency economy and the development of renewable energy technologies with a compatibility value of 4. Also, the most important correlation between factors is the issue of efficiency and energy conservation and the use of emerging technologies and new resources in the field of renewable energy. In this scenario, the price of hydrocarbons is related to natural gas as a clean fuel.

In the cooperation and development scenario, compatibility has been established between the economic growth of petrochemical development, renewable energy substitution and suitable conditions of oil exporting countries (OPEC). The highest value of economic growth adjustment is 8. In this scenario, the Drivers of tension with the Arab neighbors have a very weak effect on the social unrest in the country. In sum, the drivers of the real private sector economy have the most action (incremental action) among all the drivers. These drivers are highly compatible with other drivers. In the next place is the Driver of downstream development (petrochemical), which is highly compatible with other drivers. Then there is the use of renewable technologies and resources. The least

effective drivers are social phenomena that have not been well adapted. Table (14)

Table 14. Effective variables of each scenario.

Descriptors	A Postponed Dream	Bipolar Middle East	Cooperation & Development	Clean (Low Carbon)
A.Global oil price	A1 modest	A2 fast	A2 declining moderate	A1 moderate
B.Iran GDP growth	B2 fast growth	B1 decline	B1 steady increase	B2 modest
C.Cohesion of OPEC	C1 modest	C1 fast decline	C1 slow increase	C1 decrease with gentle slope
D.Geopolitical environment	D1stability	D3 instability	D2 declining moderate	D3 stability
E.Energy political priority	E3 greater add-value, lower crude sell	E3 add-value and crude sale	E3 add-value and logical crude sell	E1 increase in average value added
F.Iran foreign policy	F3 Development Cooperation with Emerging Economies	F1 RIS strong alliance	F1 economic corporation	F2 strengthening allies in the region
G.Climate Change Issue	G2 Run properly at the optimal level of applications	G1 decrease in domestic energy consumption	G1 being loyal to treaties	G3 Efficiency and energy conservation, severe energy intensity decline
H.Planning legislation	H1 great coordinate	H1 weak coordinate	H1 cooperative Coordinate	H2 Coordinate
I.social Impact	I4 deepening of inequity	I1 social unrest and class gap	I1brain drain	I3 decrease in population and aging
J.Assets and Reserved Oil &Gas	J2 rebuild and development of productivity	J1weak increase in capacity	J1 Increase recovery rate and high capacity	J2 logical increase in capacity
K.Alternative Resources	K2 appropriate share of renewables	K1 No attention	K1 Introducing technologies and collaborative production of renewable resources	K2 growth and diverse production of energy from renewable sources

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Appendix A

ECA: European Consortium for accreditation

Value Category

In the context of natural considerations, it will be important to evaluate and select individuals in a set of policy makers with a P symbol, managers with an M symbol, retirees with an S symbol, and experienced experts with an E symbol. Therefore, in each of the rhombus sides of the expert category, considering the position of the expert, his opinions and theories in the future field of fossil energy should be analyzed.

Expert Category

The value category refers to the competencies of individuals in the framework of the ECA evaluation criteria in the selection of elites, which includes academic, professional and experimental competencies in the field of energy policy. With the focus on this issue, the background is examined and in the classification between HV, MV, V, the value classification is evaluated.

Appendix B

In this research, by designing a questionnaire with a new and applied methodology based on scientific models, a survey has been conducted in this regard and some strategies for validating opinions and opinions have been used. In this regard, help the elites and policy makers in the field of energy, managers and senior experts to complete the leading questionnaire.

Identify key factors affecting the future of Iran's oil and gas field in 2035			
The effect of occurrence on the horizon (4-1)	Probability of occurrence on the horizon (4-1)	Factors X affecting Iran's oil and gas sector	Variant
Also identify other important events and trends from the perspective of experts			