The seventh line: a scenario planning strategic framework for Iranian 7th energy progress plan by 2020-2025

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Manuscript received 11 June, 2020; revised 15 September, 2020, accepted 23 October, 2020. Paper no. JEMT-2006-1243.

Iran, not just as an oil-exporting country, but also because of its geopolitical position, is one of the world's most important countries. Since the recent events of the Middle East, the importance of the country has grown globally. Because of this growing importance, the short term future of Iran is significant to be studied. In this study, a descriptive approach has been taken to synthesize the world's energy portfolio and the global energy balance outlook to provide insights into the development of local energy portfolio scenarios focusing on Iran. The shell company represents two basic scenarios, which are the scramble and blueprint. According to shell scenarios world energy portfolio might be organized in two images in which each image concludes different energy portfolios. Thus, developing energy portfolio scenarios is essential. In this paper, after reviewing the four selected developing countries' energy portfolios and developed countries, the scenarios of Iran's energy portfolio in 2020-2025 will be presented. For this purpose, a combination of qualitative and quantitative methods will be used for scenario building.

keywords: *Energy Policy, Scenario planning, Public policy, Strategic planning*

http://dx.doi.org/10.22109/jemt.2020.234795.1243

1. INTRODUCTION

Iran is the fourth country with crude oil resources and the second country with natural gas resources in the world. But international sanctions, lack of investment, and upstream development have influenced the energy section and caused the deferment of many upstream projects, which finally causes the reduction of producing oil and other subsequent problems [1].

British petroleum analysis of the world energy portfolio shows that the energy market will change like other ones until 2035. However, the dependence of human energy is not deniable. The types of energy sources and their shares are changing. Accordingly, evaluation of the energy market shows that renewable energy sources, natural gas, and unconventional energy sources will have more to share in the future [2].

Fig. 1 is the forecast of the world energy portfolio published by the international energy agency. In this portfolio, the data are actual until 2012, and for the other years, they are forecasted. The energy consumption in Iran has increased by 50 percent in the last decade. To control energy consumption and demand, Iran's government pursued the national policy of energy subsidy and increased the in house oil, gas, and electricity prices. The first step of this law was passed by Iran's parliament in 2010, and the second step started in 2014. The cumulative energy consumption of Iran, which was published by two different sources, is depicted in Fig. 2 [2].

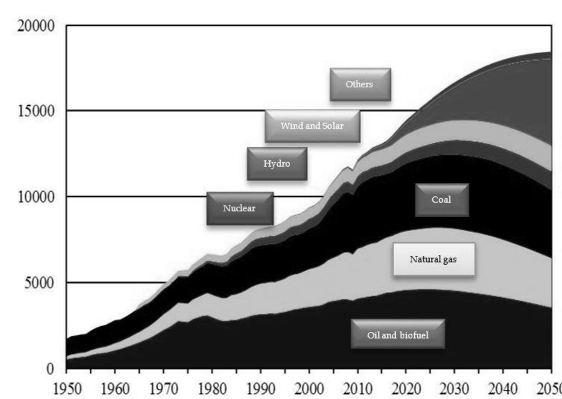

Fig. 1. The forecast of world primary energy consumption in a million tons of oil equivalent [2].

As it is shown in Fig. 2, oil and gas have the highest rate of consumption. In some part of the energy future study, the researches have been focused on MACRO-PROCESSES. In this part, we investigate the future studies and the way that MACRO-PROCESSES enter these studies. The simple methods and models were firstly developed by other researchers. DASGUPTA and MISHRA generalized the growing patterns and considered the natural resources in these patterns showed that for a constant interest rate, the efficient growth causes diminishing natural resources, economy fall, and public welfare reduction in the long term (2007). One of the weak points of this study is the lack of considering technology progression as an internal agent of future evolutions [1, 2].

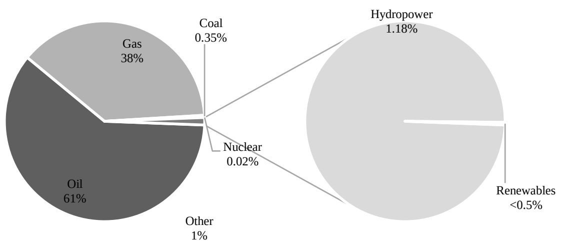

Fig. 2. Iran's energy portfolio [1].

Also, many studies have investigated different parts of the energy system in Iran. Literature shows that the researches in this field mainly consist of two categories in the term of research methods, which are the macro-energy system analysis and Micro-energy system analysis.

Micro-energy system analysis methods mainly consider some case studies and investigated it in detail and provided suggestions to optimize its performance. These studies mainly use mathematical modeling. Some of the novel cases in this category can be mentioned as follows:

Yousef Nezhad and Hosseinzadeh (2017) developed a MATLAB/SIMULINK model of a solar water heater, which has been developed and simulated for an aviculture building in Tehran, Iran. The thermal behavior of the subsystems, such as temperature changes of the collector, heat exchanger, and storage tank, etc., has been determined. Three different simulation approaches have been considered. The thermal performance of the system was evaluated by proposing two auxiliary heaters within the storage tank and using them in three different cases [3].

Hoseinzadeh et al. (2019) studied buildings with zero energy consumption in the north of Iran (Qa'emshahr city), and the feasibility study for constructing such buildings in this humid mountainous area was also investigated. In this regard, a residential building with a conventional condition was considered as a sample, and energy efficiency parameters were investigated; and the energy consumption of the building was reduced to zero using different methods [4].

Hoseinzadeh and Azadi (2017) studied a transient simulation model of solar-assisted heating, and cooling systems were investigated for a duplex house in a northern city of Iran. It should be noted that the simultaneous use of electrical energy during the day to cool domestic and industrial buildings increases peak electricity demand, so this matter generates many problems. The cooling capacity of the absorption chiller and the solar collector area was designed on the basis of the maximum cooling load, and the auxiliary gas-fired boiler was also used in summer to feed the absorption chiller, in case of scarce solar irradiation. The building was simulated using a single-lumped capacitance model and developed by Matlab software, including an analysis of the dynamic behavior of the building in which the solar-assisted heating and cooling systems were supposed to be installed [5].

The macro-energy system analysis can be considered as policy-making or macro-multidisciplinary studies. In this category, a system is considered as a whole, and a bulk investigation is conducted on the unit. Scenario planning is one of the novels and most comprehensive methods in this category, which not only considers the past and present feedback of the system but also predicts its responses to the different uncertainties that might be happened in the future, such as inflation, negative economic growth and other aspects of economic uncertainties.

GROTH and SCHOU answered to this question: With considering the non-renewable energy as an essential factor of production, is the sustainable development possible? This study shows that by maintaining the population growth rate patterns, this possibility is not achievable for demand control [6].

DI MARIA and VALENTE developed a two-step model that consists of MACRO-PROCESSES of technology changes and non-renewable sources as an essential factor of production. In this study, two cases of capital and natural resources are considered for technology production. The results show that if there are technological changes and the use of equilibrium growing rate, there will be a future in which the energy demand and its safety are sustainable [7].

In the aforementioned studies, the effects of MACRO-PROCESSES on the environment are not considered. The importance of the negative effects of pollution on the STABLE development of countries has caused the fulfillment of many theoretical and empirical types of research on this issue. In recent years, the analysis of STABLE development and environmental policies in the framework of growing patterns are regarded by researchers. According to this method, future studies are conducted by using environmental parameters such as pollution or environmental quality. The main part of these studies focused on the desired sustainable development [8].

In the framework of future study based on INTERNAL GROW theories, the side effects of environmental consequents affect efficient growth and welfare due to pollution accumulation. In this framework, it is assumed that the environment affects the economy through different channels such as environmental amenity, health, and efficiency. Environmental amenity and health are introduced to growing patterns by considering pollution or environmental quality. However, the effect of efficiency can be investigated by considering environmental quality as a factor affecting production [9].

SMULDERS, in a future study model based on INTERNAL economic growth, investigate the condition of achieving sustainable and appropriate economic growth with limited natural resources. The results of this study show that sustainable growth needs proper environmental policies, investment in environmental resources, and the development of green technologies [10].

MOHTADI used an INTERNAL growth model of future study to investigate and analyze the efficient environmental policies for achieving a long term growth with effective environmental quality and life welfare. Accordingly, a combination of controlled value policy and subsidy policy is more effective for achieving social welfare, respect to the conduction of this policy separately [7].

ARIGA used a future study pattern, including simple internal growth that is entered both production function and consumption function to investigate the effects of environmental policies on production, consumption, and sustainable balance of condition (2002). The model is used in this study is a modification of the model developed by SMULDERS and GRADUS (1996), which is used to study the relationship between economic growth and environment, especially efficient environmental policies and the effects of these policies on growth rate and social welfare. The results show that environmental quality is a time-dependent parameter [8].

In the aforementioned studies, economic growth, population patterns, technological growth, and environmental patterns are the main parameters of the study of the balance of energy consumption in the future. One of the studies that consider various forwarding parameters is the model of the international energy agency (IEA) for the prediction of the world's future energy issues. These parameters are economic growth, population, oil price, technology improvement, and environment (2016). This model (i.e., WEM) is used to develop systems and patterns that are used for three scenarios of WEO-2016. This is a balancing model that answers to this question: how do the energy markets will work in the middle and long term. After several modifications during many years, WEM works based on six principles:

- Final energy demand (with various sub-models)
- Production of heat and force
- Refinement, Petrochemistry, and other exchanges
- Oil, natural gas, coal, and fossil fuels
- CO2 emission
- Investment

One of the other studies about the future of energy is the reports published by the world energy council. This organization, with 80 years of background in the study of different types of energy like coal, oil, natural gas, nuclear energy, hydroelectricity, and new types of energy, tries to improve human life in the world with sustainable peace. The model of the world energy council is published with the title of World Energy Evaluation. The outputs of this report are three cases: case one (A) or high growth case includes three groups: A1: plentiful oil and gas, A2: return to coal, and A3: future without fossil fuel. Case B or the middle period case includes the gradual change in the path of the future, and finally, case C or ecological agents' case includes two groups: C1: modern renewable energy and C2: renewable and nuclear energy [9].

Shell's scenarios for energy in 2050 is another study in this field. In this research, two alternative scenarios are presented for the next 50 years. The title of these scenarios is: with schedule and without a schedule, both of them are challenging scenarios, and even though none of them describe an ideal world, they are achievable [10].
The presence of various studies about the future of energy shows the importance of conduction research in this field in Iran until 2025. The availability of different international studies is good support for the development of models and scenarios for Iran's energy portfolio.

The main idea of this field is that the price is an effective function for choosing alternatives for an energy type. Nowadays, according to the oil price in the world market, fossil fuels can be replaced by green fuel and batteries [6]. According to the quick changes that happen in the energy market, a flexible method with good performance in an uncertain situation is necessary for each country.

Creating a scenario is an important tool for the development of methods and analysis. One of the powerful ways of creating scenarios is a combination of the methods. In this paper, data gathering, which is the recognition of the key processes, is conducted by a new method. A combination of the Delphi method, skill weight categorizing, and questionnaire is used for the improvement of data gathering. In this method, mathematical weight function is used in three subcategories of ecology, expertness, and values class. The questions are extracted by experts and are classified into three classes of the theoretical, main parameter, and interrogative. The data are balanced by experts for recognition of DRIVING FORCES and their interaction. Therefore, in this study, the main innovation is the way of data gathering and development of judgment weight to quantitative balance, which improves the accuracy of collecting data. After the determination of the main research process, a combination of several methods for the detection of compatible scenarios is used, which is discussed in the next section [11].

2. METHODOLOGY

In the majority of methods of creating scenarios, the first step is the detection of the main process. From the conceptual point of view, the onset point is the detection of key factors that have the greatest effect on the main subject of the scenario. A combination of quantitative and qualitative methods can improve the structure of a model. In this paper, a set of appropriate tools has been used; the summary of these methods is shown in Fig. 3 [9].

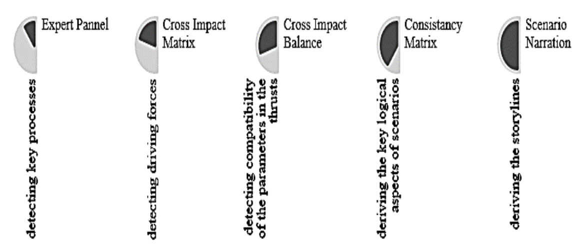

Fig. 3. Method of scenario making [1].

A. Detection of key processes

The key processes have the greatest effects on the main subject concerning other processes. The Expert Panel Method is used for gathering data that is needed for the detection of key processes. In this method, the selection of panel members is made according to ECA (European Consortium for accreditation) standard. The selection method is based on the proposed model of ECA organization that is the output of 15 committee members with the management of Dr. Hanman from Austria. The structure of the selection method was passed 12 juridical members of the consortium in 2005 and was authenticated by the European committee in 2014. According to this model, expert people are categorized based on the evaluation field, such as industry, population, resources, and ecology. And they are evaluated based on the relative background and experiences like skills, education, and organization background. This model has been used and evaluated by organizations and ministries of several countries (Austria, Germany, France, Spain, Swiss, Turkey, and China) for creating Delphi panels [12].

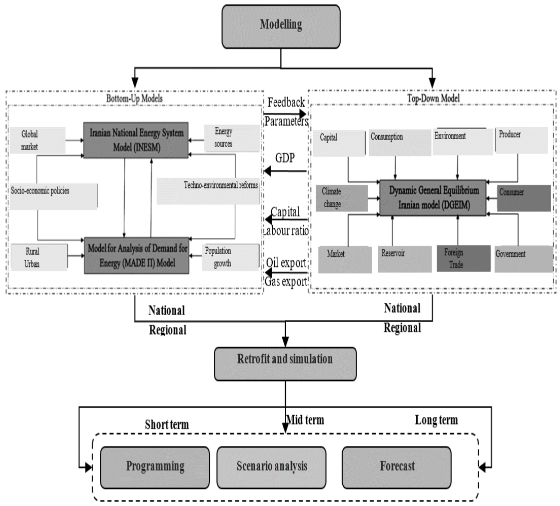

Fig. 4. The schematic of the research and modeling method [12].

B. Detection of Driving forces

After the detection of the key processes, driving forces are detected by the interaction matrix method. The driving forces are those that have great effects on other processes but are not affected by other ones. The creation of an interaction matrix is done by Mic-Mac software. In this software, the interaction between processes is investigated. The output of Mic-Mac is the categorization of processes based on independent, dependent, moving, and BONDING; because the driving forces are more independent and effective, they are used for further analysis [13].

C. Detection of compatibility of driving forces

Each moving process contains phase parameters that represent the properties of the process. In this step, the most compatible combination of parameters is found. This is fulfilled by Scenario Wizard software using the cross-impact balance method. In the CIB method, the total number of permutations that can unify the phase parameters is considered a scenario assumption. In this method, the combinations that have more interaction, respect to other ones are considered compatible. The complete description of the model will be discussed in the running model section [14].

D. Extraction of scenario logic

The logic of the scenario or theme of the main scenario is highly dependent on the model of scenario creating. According to the software output, the combinations that have high interaction are selected as the theme of the main scenario. In other words, the more internal support of phase parameters, the more capable of convergence and compatibility. Such a combination is considered as the logic of the scenario. In this step for uniformity of the model, according to the type of phase parameters that joint together in this combination, a name is selected for each combination [15].

E. Depiction of the story of each scenario

For the next step, according to the logic of each scenario and the acquired data in the previous steps, a story is created for each scenario, considering the obtained data and other assumptions are very important in the method of definition of the story. In this paper, a data relevant method of the depiction of the story has been used. According to the obtained data from driving forces and their descriptors, the process of scenarios is analyzed using linear extrapolation. The methodology of this model is described in Fig. 4, including steps, tools, and software that are used in this study [8].

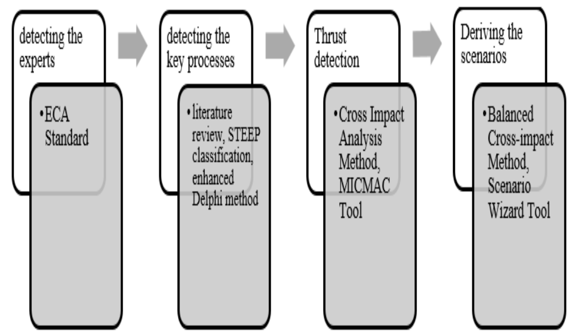

Fig. 5. Methodology of the paper [16].

3. RESULTS AND DISCUSSION

A. Detection of the key processes

As has been mentioned in previous sections, the first step is the detection of the key processes. The key processes include the ongoing processes that have the greatest effects on the main scenario. Firstly, the experts in the energy field were detected. Before discussing the steps of choosing experts, the concepts of this mechanism should be clarified:

A- Ecological class: it is very important to classify the panel member in terms of ecology, population, resources, and industry. This classification has a great role in the evaluation of technical issues, which is also very important in the evaluation of social challenges. Based on this framework, the proper classification of these four parameters causes an accurate evaluation of the panel member [15].

B- Expert class: in the natural regards of choosing people in the series of politicians, managers, retired and experienced experts, "evaluation and selection of people, are very important. Therefor for each side of this diamond, the views and roles of experts should be considered [14].

C-Values class: this classification is based on the ECA evaluation method, which considers education, proficiency, and experience of experts in the field of energy decision making. According to this subject, the background of the member is evaluated and classified between: V, MV, and HV [16].

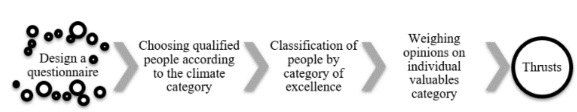

Fig. 6. Method of detecting the driving force trends [17].

The mechanism of choosing the experts is especially important in this study, and its steps are shown in Fig. 5.

Table 1. The derived trends [14].

Trend	Description	Trend	Description
T1	Technology development	T16	Economic growth
T2	The Level of Technology Access	T17	Energy subsidies
T3	Oil price	T18	Fossil fuel resources
T4	Population Growth	T19	Domestic energy savings
T5	Energy intensity	T20	Planning legislation
T6	Energy Policy	T21	Climate change
T7	Exchange rate	T22	Pareto efficiency
T8	Energy productivity	T23	Industrial energy savings
T9	Labor productivity	T24	Energy security
T10	Social development	T25	Energy conservation
T11	Mobility	T26	Energy consumption culture
T12	Energy open market	T27	Infrastructure extension
T13	Capital labor ratio	T28	Energy market environment
T14	Growth of renewable energies	T29	Technology readiness
T15	New resource explorations	T30	Acceptance energy turnaround

B. Detection of driving forces

For the detection of driving forces, the key processes that were obtained previously are used as the input of Mic Mac software, as it is shown in Table 1. In this software, the interaction of processes is entered quantitatively. The effect of different factors on each other is defined in the range of 0 to 3, while; 0 means no effect, one means weak, two means average or intermediate, and 3 means strong effect. Character P is used for the processes that have effects, but with no specific value. Thirty key processes detected in the previous section have been entered in Mic Mac for the detection of driving forces [13]. The output of software for the detection of key processes is shown in Fig. 6. According to this figure, X-axis shows the dependence of the process, and the Y-axis shows the effect of the process on the other ones; therefore, the driving forces are located in the places where there are low dependency and high effectiveness [14] (Fig. 7).

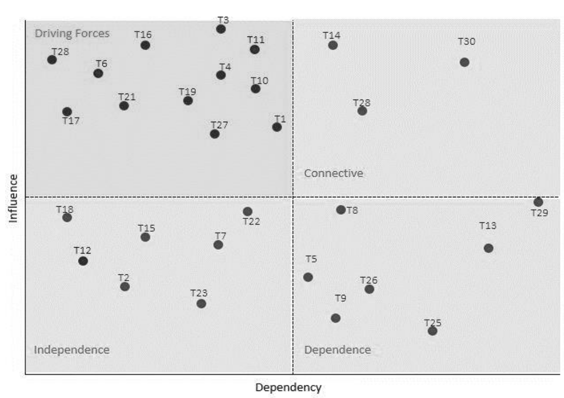

Fig. 7. Direct influence/dependency map.

C. Generation of Data

The data generated in this manuscript is done using the LEAP software. The scenarios developed using the MAN method, imported to the leap model, and by using the trends introduced by the expert panel and software derivation, the projections have been made in this manuscript. Leap model uses the econometric methods to forecast future projections based on the scenarios developed by the MAN model, and this characteristic of this model is the most important advantage of the model in the foresight planning studies [16].

D. Compatibility of the driving forces

In this step, each moving process obtained in the previous step is used as an input. The driving forces form the structure of the scenario. Each moving process is entered in Scenario Wizard software as a Description; then, for each description, the qualitative and quantitative alternatives are entered. These alternatives are the possibility of each description [9] (Table 2).

Among the 29 compatible scenarios, four scenarios that have more interaction are selected as the main scenarios for more analysis. Results show the scores of these scenarios. Items that are denoted by * are the final scenarios with the highest interaction (13, 15, 17, and 28) [21].

E. Scenario Results

The main characteristics of this scenario:
Scenario No. 13
The variables of this scenario have a higher interaction score. There are actors (variables) that are represented by characters A to M [22]. The phase of each driving force of this scenario is written against it. The dark is chosen for its name due to the characteristics of its phase parameters. The dark is being chosen because there is some resemblance between this scenario andSHELL's blueprint scenario; hence, it has been named the dark. In this scenario, the growths of technology, oil price, and population are slow, average, and slow, respectively. The economic growth rate is noticeable, and changes are supported by the energy politicians. The planning rules are made by more taking part in organizations. The main result of this scenario is the fast growth of energy infrastructures of the country and, consequently, the use of renewable energy sources. This is possible by saving energy in in-house and industrial parts. Alongside the low population growth rate, the average economic growth rate of the country has predicted 6.1%, whereas the maximum rate in the world is 8% for Laos and Turkmenistan, so Iran's growth rate will be one of the fastest in the world. The energy policy for increasing the role of energy and environment in the economic, political, and social activities is very important in this scenario. Being sure about appropriate and sustainable energy supply and proper growth of demand in the market is the main policy of the Dark scenario in Iran. Therefore, these policies will affect industrial businesses in local, national, and international domains. In this scenario, social intercommunity will grow impressively, which finally causes the development and extension of Iran's energy infrastructures in 2025 [23].
The main characteristics of this scenario:
Scenario No. 15
One of the main factors in this scenario is the fulfillment of energy policies in the country in an unbalanced and heterogeneous manner. The propagation and fulfillment of development programs need purposeful political treatments, systematic performance methods, and supply of resources and facilities; therefore, the lack of these items will prevent development. In

Table 2. Descriptors and variables.

Descriptors:	variant [1]	variant [2]	variant [3]
A. Technology development	A1 slow	A2 medium	A3 fast
B. Oil price	B1 stability	B2 medium growth	B3 rapid growth
C. Population	C1 slowly increasing	C2 strongly increasing	
D. Economic growth	D1 weak	D2 medium	D3 strong
E. Energy policy	E1 energy turnaround	E2 security	E3 economy
F. Energy intensity	F1 decrease by plan	F2 BAU.	F3 productivity
G. Implementation of energy legislation	G1 incoherent	G2 promoting speed	G3 promoting participation
H. Infrastructure extension	H1 slow	H2 fast	
I. Growth of renewable energies	I1 slow	I2 medium	I3 fast
J. Domestic energy savings	J1 small	J2 strong	
K. Industrial energy savings	K1 small	K2 strong	
L. Social development	L1 persistent structures	L2 Reduce consumption	L3 increase in consumption
M. Climate change	M1 strong	M2 moderate	

other words, the policies which prevent business boom or extend stagnation have not only developmental nature but also are a barrier against national economic growth [24]. This heterogeneity will be severe in the lazy scenario. This causes spending a long time and high costs of projects without any beneficial output. In this scenario, the population growth rate is low, the oil price is relatively sustainable, and consequently, the economic and technological growth rates are moderate, but due to heterogeneous development and fulfillment of energy policies, the energy infrastructure of the country has no significant growth in 2025. With this decline and accompaniment of factors like saving industrial and in-house energy, the condition will not be proper for the development of renewable resources in this scenario. Energy intensity is an indicator that shows the energy consumption per unit of gross domestic product (GDP). Iran's energy intensity is three times more than in developing countries, and in the lazy scenario, it remains at this value. If we want to discuss energy components like electricity, Iran's electricity consumption is three times the world's average. For instance, in many countries, domestic consumption is about 900 kWh, but this is 2900 kWh for Iran. Iran is among the 19 high consuming countries in the world. Moreover, natural gas consumption is in worse condition than electricity. After the USA and Russia, Iran is the third country with the highest consumption of natural gas resources. Iran's consumption growth of this energy source is 10% per year, and through the lazy scenario, this unfavorable condition will continue. The main characteristics of this scenario:

Scenario No. 17

This name is used for this scenario because, despite the high economic growth rate due to the stability of oil prices, there are no significant changes in the energy sector of the country. Therefore, the main parameters of the scenario have no or very low growth rates. This is just like the Heavy term animals that eat food properly but has no noticeable movement due to its high weight.

The economy plays a key role in the heavy scenario; therefore, concerning the lazy scenario, the greatest differences are in the economic factors. Economic growth causes moderate growth in energy infrastructures, and it consequently causes an average growth in renewable energy resources. In this scenario, the available parameters could not reduce industrial and in-house energy consumption. There is no attention to purposeful subsidies; therefore, the results are not successful. The policies are based on the economy, and other aspects of development, such as environment or energy security, are ignored. The energy intensity is high in this scenario, and the focus is on the exploitation of resources without considering efficiency.

The main characteristics of this scenario according to Scenario Wizard outputs are:

Scenario No. 28

This is one of the most agile scenarios. Whereas it has a low technology growing rate, but due to the preparation of conditions for energy policies and reforming programs and rules, it causes the development of energy infrastructure. Therefore it is called the Turbo scenario. In this scenario, the population growth is in favor of the development of energy infrastructures, so development with energy-saving helps to keep the developmental pace up by 2025.

The requirements of this scenario are a fulfillment of development policies in the energy section of the country. The energy policies of the turbo scenario are based on energy security, which is in favor of the population growth rate. Energy security is obtained by the availability of energy for the optimal supply of demands. Shortly, it can be mentioned that the turbo scenario includes three concepts of energy-changes in the world: price, continuity, and environment. The fluctuation of oil price causes extreme changes in the world economy, family budgets, factory budgets and instability, vulnerability, or flourishing the producing or consuming countries; therefore, the main concern of this scenario is attention to energy security policies. Any energy demand for planning the future need continuous, long term, and sustainable use of energy. So in this scenario, the country tries to find more efficient and low consumption energy plans at a favorable pace.

F. Discussion

F.1. Future of the Iranian energy industry

According to the outputs of each scenario for better analysis of scenarios, the energy portfolio is studied for each one. The data are obtained by extrapolation of phase parameters of each scenario; therefore, the energy portfolio of each scenario is compared with each other based on the breakdown of resources in 2025.

Scenarios on crude oil production by 2025

Generally, crude oil has significant growth in Iran's energy portfolio. In the Hippopotamus scenario, it has the maximum slope. In the model, the population grows extremely, and the policies are based on energy security and supplement on demand. The initial energy production based on crude oil will be 2587.38 bbl. Equivalent crude oil. According to the Turbo scenario, the oil production is very high in late 2020-2021, but its slope will decrease until 2025. The dark, lazy, and turbo show similar behavior. The heavy focus on the exploitation of oil resources and shows a significant growth that will start in the mid of 2020. Fig. 8 depicts these cases for oil the production portfolio. (See Fig. 8)

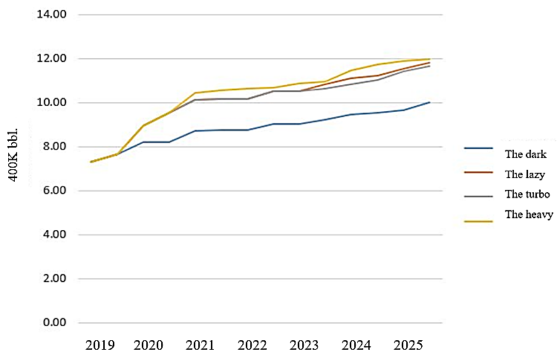

Fig. 8. Scenarios on crude oil production by 2025.

Natural gas production scenarios by 2025

The performance of energy portfolio scenarios of natural gas shows a similar trend. From 2020 the production of natural gas will increase; this is at its maximum value in the dark and heavy scenarios. This overshoot will be happening more quickly for the heavy scenario.

In recent years, natural gas has played an important role in the Iranian energy portfolio. Therefore, all of the four scenarios predict a significant increase in natural gas share in the energy portfolio of the country. According to dark and heavy scenarios, gas production will be 463,200.2M. Cubic meter equivalent crude oil in 2025 that shows considerable growth up to 192,500M. Cubic meter in 2018. Due to the supply-demand approach of the heavy scenario, it shows a greater initial energy production respect to other ones. Turbo scenario predicts that in 2025 the initial natural gas production will be 2.16 times more than those in 2018.

The increasing trend of natural gas share in the initial energy portfolio of the country shows that the economic, social, political, and technological descriptors in different scenarios consider an increasing role of this energy resource. Generally, the share of natural gas in the energy portfolio will increase 2.16-2.37 times until 2025. Fig. 9 depicts the natural gas scenarios until 2025.

Coal production scenarios by 2025

In all scenarios, coal as a conventional energy resource has a gentle increasing slope until 2025. The dark scenario shows an increasing trend for coal, where its production in 2025 will be 1752K tons, which is times 1.63 more than in 2018. The lazy scenario shows lower increasing trend respect to another; it also predicts unstable coal initial energy production of the turbo and the heavy scenarios. The coal energy production will be 1,538 Kilotons. Generally, the moving parameters that have a

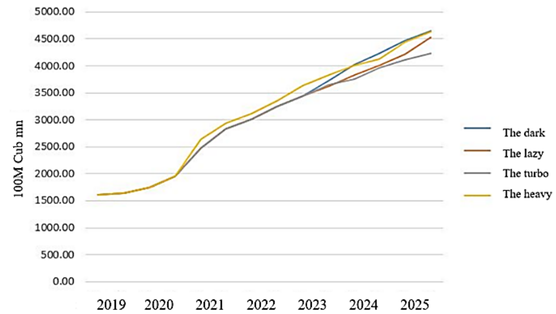

Fig. 9. Natural gas production scenarios by 2025.

fast increasing trend in some scenarios and a gentle increasing trend in some others with the types of energy policies based on energy and economy-security show an averagely 1.56 times increasing trend of the coal production until 2025. These trends are illustrated in Fig. 10.

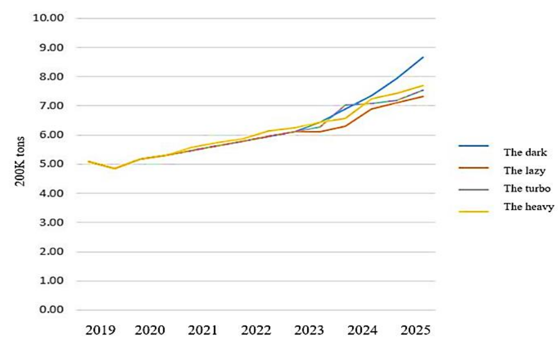

Fig. 10. Initial coal production scenarios by 2025.

Hydroelectricity production scenarios by 2025

The results of this scenario show that the unbalanced development of the energy portfolio will cause serious damages to the environment. Running this model shows that in the turbo, the lazy, and the heavy scenarios, the share of hydroelectric energy in the energy portfolio of Iran grows significantly. For the heavy scenario in 2025, the equivalent energy from hydroelectricity is 11.96 GW, which is 1.25 times more than in 2018. Increasing the capacity of the hydroelectric power plant by building dams in various locations in the country causes harmful damages to the environment and agriculture, and as a result, it interrupts the balance of ecosystems. The Urmia lake tragedy is an example of such developmental policies. The modeling shows a gentle growth for the dark scenario; in 2025, the share of hydroelectricity in the initial energy portfolio is 10.02 GW. Fig. 11 depicts these results.

Renewable energy production scenario by 2025

Renewable energy types show interesting results as the basis of sustainable development in the country. The turbo and the dark scenarios have the proper growth of the initial energy portfolio in 2025. The Turbo scenario predicts 2.42 GW in 2025; this value is 2.03 GW for the dark scenario, which shows 34 times and 29 times increase respectively. The heavy scenario with 0.85 GW, which is a very small share in the energy portfolio, has the lowest growth. According to Iran's 7th development program

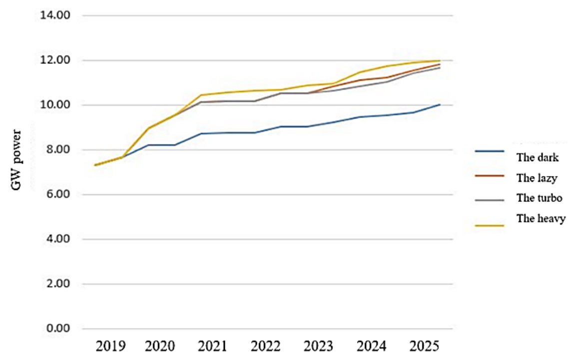

Fig. 11. The hydroelectricity production scenarios by 2025.

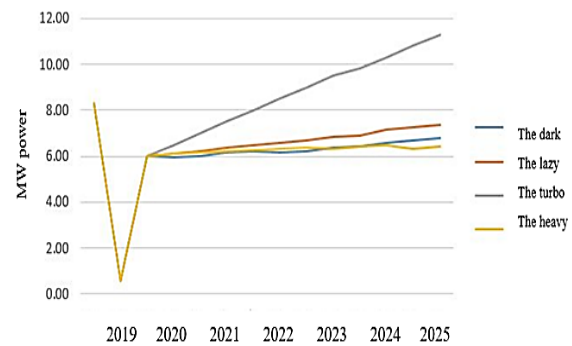

Fig. 13. Biomass production scenarios by 2025.

in which the share of renewable energy is 16-20% of the energy portfolio, the turbo and the dark scenarios are more compatible with this policy. These results are shown in Fig. 12.

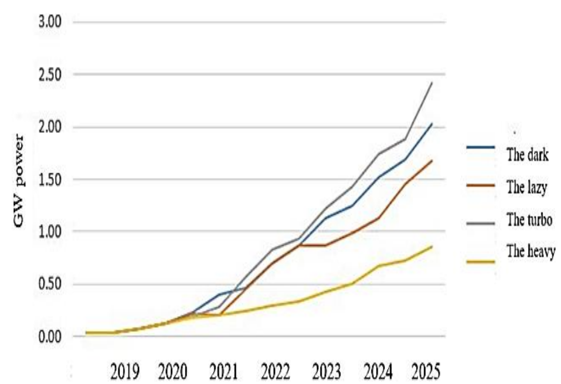

Fig. 12. The renewable energy production scenarios by 2025.

Biomass production scenarios by 2025

In recent years, the energy portfolio had significant fluctuations for biomass resources. The final slope was decreased in 2019 then increased by 2020-2025; this trend shows the instability of this section. Biomass has a small growth in the lazy, dark, and heavy scenarios. The Turbo scenario predicts a greater growth rate for this type of energy resource; for instance, in 2025, its share in the energy portfolio will be 11.3 MW, which is not a significant value. Among other scenarios, the dark's prediction is more reasonable and gentle. The performance of the dark, heavy, and lazy scenarios in increasing biomass energy until 2025 is similar. These results are illustrated in Fig. 13.

F.2. Overview of issues and problems

Energy sector Investment Requirement by 2025

Based on the results of demand, supply, and economy modeling in different Energy sectors in the four development scenarios. The total investment needed for optimal development of the energy sector (except for the electricity, substation, and distribution sectors of the Ministry of Energy) in the heavy scenario equals $ 278.2 billion; in the lazy case scenario is $ 270.9 billion and in the turbo scenario is $ 308.9 billion. In the meantime, the Ministry of Oil and its subsidiaries share the total investment needed to achieve 8% economic growth through the mentioned scenarios, including new development plans, optimization, transmission, upstream distribution, and downstream sectors in 2019. It is estimated at about $ 195.68 billion$. Of this amount, $ 121.2 billion is the share of the National Iranian Oil Company, $ 43.05 billion the National Petrochemical Company, $ 15.39 billion for the National Refining and Distribution Company, and $ 16.04 billion for the National Gas Company. It should be noted that the annual forecast of the amount of investment required by each company is stated separately in the report. Though the assumptions of the mentioned scenarios are greatly different, the investment required illustrates that the Iranian oil industry needs foreign investment to maintain its oil and gas production and its market share. Also, the great amount of investment for demand controlling plans shows that the demand side is gravely energy intensified and inefficient.

Energy supply by 2025

Exports of energy carriers increase during the seventh development program in the country. The amount of oil export with total exports amounting to 1834.75 million barrels of crude oil in the lazy scenario, 1726.69 million barrels of crude oil equivalent in the heavy scenario, and 2362.77 barrels in the Turbo scenario by 2021. Crude oil will continue to have the largest share in the country's export basket, ranging from 1.02 million barrels per day in 2018 to 2.72 million barrels per day at the end of 2021. Exports of liquids and condensates, on the other hand, will almost fall, dropping from about 94 million barrels to 65.7 million barrels a year. The most important reason for this decline is the exploitation of the Persian Gulf refinery, which reduces the amount of domestic consumption of this energy carrier. This causes the export of gas in the final years of the program to be 13.32 million liters per day in the lazy scenario and 11. 29 in the heavy scenario. Also, the recent plans and policies of the Ministry of Petroleum and the exploitation of gas fields will increase the export potential of this energy carrier from 25.43 million cubic meters per day to 166.66 million cubic meters per day in the lazy scenario and 336.47 million cubic meters per day in the turbo scenario by the year 2025. Also, exports of other petroleum products will increase during the seventh plan progress period (Table 3).

Energy intensity by 2025

The models predict that the intensity of the primary energy supply in the country will decrease automatically after a probable increase period to the start of the seventh program, which is generally due to delays in implementing program optimization and operationalization policies. The index will reach 1.02 barrels per 100$ (the base year 2003) in the lazy scenario while continuing the current trend to a maximum level of 1.097 barrels per year in

Table 3. The energy exports in the lazy scenario by 2020-2025.

Energy type	unit	2021	2022	2023	2024	2025
Crude oil	M bbl.	3.96	4.36	4.48	4.52	4.86
Rich gas	M cubic meter	963.07	1100.03	1170.32	1259.44	1333.80
Coal	Mt	1.14	1.18	1.21	1.24	1.27
Hydropower	GW/year	1.69	1.70	1.70	1.75	1.75
Wind-solar	GW/year	0.32	0.57	0.65	1.00	1.24
Biomass	Mt biomass	2.20	2.26	2.27	2.27	2.28
Sum	M. bbl.	3948.10	4448.50	4673.58	4923.00	5492.70

2020 and then with a very slight decrease to 0.99 barrels per day per 100 $ by 2021. In the heavy scenario, due to higher amounts of economic growth, the energy supply intensity with a slight slope is projected, and this indicator exceeds its maximum value at the beginning of the program, from 1.957 in 2016 to 0.955 in 2025, and the annual rate of reduction of primary energy intensity is projected to be about -1.32% in 2020-2021. However, in the turbo scenario, due to slope fuel optimization schemes, the decrease in the supply intensity is much higher, and this index is 0.9397 barrels per 100 $ in 2020, 0.7393 barrels per 100$ in 2025 with an average slope it will decrease by -5.27% (the base year of the $ is 2003).

Emissions by 2025

As societies evolve in the process of industrialization, energy consumption in the world is increasing. One of the consequences of increasing energy consumption is the production of emissions. Air pollutants that result from energy consumption can include materials such as carbon dioxide, carbon monoxide, nitrogen oxides, sulfur oxides, unburned hydrocarbons, nitrous oxide, and inorganic compounds.

Despite the increasing energy consumption in the country, emissions of carbon dioxide, carbon monoxide, and nitrous oxides and other pollutants due to the combustion of energy carriers are also increasing. The total emissions of environmental pollutants and greenhouse gases in Iran in all four scenarios of heavy, lazy, and turbo, increasing from 579 million tons in 2013 to 843.9, 807.6, and 630.7 in 2025, respectively. Also, the per capita emissions of environmental pollutants and greenhouse gases during the seventh plan years were 7.5 tons per person in 2013, and it has been increased to 9.9, 9.3, and 7.4 tons/capita in 2025, respectively. These trends indicate that carbon management and optimization in the oil and gas production sectors (upstream and downstream), as well as all consumer segments, will lead to a reduction in the increment rate of environmental pollutant emissions by 45% in 2013 to 6% by 2025. ***Oil and gas export income by 2025***

According to the report of Iran Energy Outlook in the seventh Development Plan, the latest policies and financial relationships have been used to forecast the revenues of the National Iranian Oil Company and the government from the hydrocarbon resources over the five years (2020-2025). The basic assumption in these calculations has been to adhere to the policies on how to divide and distribute income between the National Iranian Oil Company and the government, as well as the consistency of these policies in the years to come. Therefore, if these rules are changed during this period, the calculation results will also change.

According to the Executive Regulation of the Financial Relations of the Government and the Ministry of Petroleum, to determine the financial relationship between the Government (Treasury) and the National Iranian Oil Company. The 14.5% of total oil export value (crude oil and condensate) is considered as a share of the company in respect of all capital expenditure and expenses of the company, including debt and liability repayments, including the capital and countervailing obligations, and compensation for environmental damages and pollution caused by oil activities and export costs. Shipping and insurance costs (SAIF) are included. The share of government in 2018 and 2019 is 54.5% and 65.5%, respectively, the share of national development is 29% and 20%, and the share of oil and gas and deprived areas is 2% [25].

Forecasting Total Revenue from Petrochemical Resources, National Iranian Oil Company, and Government in four scenarios has been calculated [32]. The export earnings of the National Iranian Gas Company and the National Iranian Oil Refining and Distribution Company are also predicted in hydrocarbon sources [30].

The results show that the country's total export revenue from the hydrocarbon sources in the heavy scenario has increased from $ 29 153 million$ in 2018 to 60,274 million$ in 2025. The estimated values for the export earnings of the entire country and the National Iranian Oil Company for each of the four scenarios are presented in Table 4 [26].

Challenges of the future of the energy industry in Iran

In the coming years until the end of 2025, the country's oil industry faces many issues such as increased production of liquefied petroleum products (LPG), increase in heavy petroleum products such as furnace oil, government financial relations structure, and the National Iranian Oil Company. These issues increase the need for investment in the development and optimization projects and will increase the number of environmental pollutants on the supply and demand side of energy in the country compared to international standards, as the main challenge based on the results of the studies [29].

i. Increased production of gas products such as LPG.

With the development of gas supply in the country, especially in remote areas and villages, increased production of oil refineries, upstream liquefaction schemes, especially in the South Pars phases As well as petrochemical sector development plans increased production of liquefied petroleum products, especially LPG and there has to be a solution. One of the solutions is international marketing to sell this product. The second solution is to increase the share of liquefied petroleum gas in the petrochemical industry, and the ultimate solution is to increase its share in the transportation fuel basket, which should be done with technical and safety considerations in mind [28, 33].

ii. Increase in heavy petroleum products such as furnace oil

Due to international environmental agreements and the need to adhere to energy carrier standards, heavy petroleum products,

Table 4. The energy exports in the lazy scenario by 2020-2025.

		2020	2021	2022	2023	2024	2025
The heavy	Total	47,927	29,153	42,815	48,298	56,213	60,274
	Company	7,587	5,580	8,426	10,103	11,986	13,066
The lazy	Total	49,409	27,672	42,563	47,876	55,618	62,639
	Company	7,802	5,365	8,390	10,042	11,967	12,582
The Turbo	Total	51,233	29,471	46,930	55,079	65,540	77,622
	Company	8,066	5,626	9,023	11,086	13,406	15,581
The dark	Total	44,093	26,821	39,390	44,434	51,716	59,274

such as furnace oil, have lost their international customers and domestic consumption and are a problem for the country. In domestic consumption, for example, by replacing natural gas instead of furnace oil in the power sector, large quantities of furnace oil surplus are generated [33]. At the international level as well, by requiring cargo ships to comply with fuel standards, furnace oil with current quality cannot be used, and a solution must be considered to increase its quality. The formic acid value progress of the heavy oil can be taken into account as a suitable solution in this matter [27, 34]. *iii. Financial Relations of Government and Iranian Oil Company*

According to the government's policy of reducing crude oil exports and increasing domestic consumption, the oil revenues of the National Iranian Oil Company will decline significantly [34]. Crude oil must be consumed by refineries in the country so that they can increase the value-added and generate revenue by producing petroleum products to offset oil revenues domestically. Therefore, the National Iranian Oil Company needs to establish transparent financial relationships with refineries to finance some of its costs [30, 35, 36].

4. CONCLUSIONS

Long term overview over the current status of the energy industry in Iran shows that Iran's most common path over the energy sector is much more likely to the undesirable Shell's Scramble and WEC's Hard-Rock Scenarios, which are considered as the environmentally and economically weak performed scenarios. Considering this trend over the world's current status in the energy field, to achieving the optimal status (blueprints, modern jazz, and ER), there is a necessity for the nations to gather together and take more severe actions, modifying environmentalist policies and plans of decarbonization of the Iranian energy and share technologies with each other. This causes that every nation can successfully perform these united policies and plans. The mentioned facts note that scenario planning's attractiveness is rapidly growing among the policymakers. The major companies and political officials in the world are now using them to make better decisions. This illustrates the importance of this paper, which used one of the novel scenario planning methods to propose an outlook of different possible futures in the term of Iranian energy progress plan for 2020-2025. The main importance of this method is that it shows the feedback of the country's energy system to each decision and uncertainties in that field. This research suggests that this method be implemented in different sectors of the Iranian economy and before every important decision which is made by the governmental officials. Briefly, this method helps the decision-makers to see the consequences of their decisions before it is decided.

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