Economic Development of the Iraqi Gas Sector in Conjunction with the Oil Industry

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Abstract: The relevance of this article is due, on the one hand, to the importance of the oil and gas industry in the development of Iraq and, on the other hand, the inability to enhance the existing capacities of the gas industry due to both serious systemic internal causes and external problems. The objective of this article is to study the prospects of the gas industry in conjunction with the oil industry, and develop a strategy for their development based on the forecasting of future scenarios. In the article, the research methods used included a systematic analysis of economic, social and cultural conditions, considering the history of Iraq, including a review of statistical data and a variety of sources. The article proposes a method for choosing the industry development strategy on the basis of an analytical hierarchy process, based on an algorithm of iterative processes using an analysis of hierarchies. To clarify the actors’ policies and strategic goals and to find the optimal solution, repeated iterations of the choice of strategy have been proposed. The strategies were divided into alternative strategies for future scenarios, which were evaluated in actions as able to achieve the goals by determining the consistency ratio and the consistency index. As a result of the study, we can highlight the analysis of the centralized system of oil and gas resources’ management that has developed in Iraq, which has a complicated “top-down” delegation of decisions and responsibility, with decisions made at the political level and resources distributed from above, which precludes individual industries from performing their functions, and also limits the effective implementation of strategic development priorities. The development factors for the gas industry in Iraq were identified and systematized with a rationale for the direction of the industry’s strategic development. Groups of factors were identified: market-affecting determinants of the development of the gas industry, as well as other considerations that may, to a lesser extent, affect the development of Iraq’s gas industry and the oil and gas complex as a whole. The results, assessing the significance of the actors’ goals, can be taken as a basis for development strategies for the oil and gas industry, to improve the contract system of the gas industry in conjunction with the oil industry.

Keywords: energy security; oil and gas industry; gas infrastructure; investments; contract system; state regulation; resource base; development strategy

1. Introduction
1.1. Rationale and Purpose of the Study

In Iraq, the energy sector is one of the pillars of economic growth, since it is the main means of meeting the energy needs of the state and directly contributes to satisfying the requirements of the sustainable economic development plans. Gas is the only alternative to generating basic electricity needs, enabling a stable electricity grid to operate without renewable energy sources. Creating an efficient oil and gas complex will allow for the local industry to grow and improve in efficiency [1]. It is important to strengthen the trade balance by developing exports to foreign markets and streamlining imports on a sustainable basis, which meets the consumer needs of a growing population and the requirements of the country’s ambitious development plans [2].
However, despite the significant reserves of gas, in addition to oil, in Iraq, this sector of the economy has not gained proper momentum [3]. This is partly due to a number of internal problems, since central state traditions, inadequate measures of transparency, lack of readiness and determination on the part of citizens, political control over bureaucratic structures, information channels and indicators of performance and implementation controlled by the government remain points of concern, hindering effective public administration in the MENA region. In addition, constant military conflicts, the lack of a clear system of responsibility for ongoing activities limit the development of Iraq, as well as its gas industry [4].

This article aims to study the features that distinguish the functioning of the Iraqi gas industry, considering the prevailing socio-economic conditions, historical trends, proposals for the development of the contract system and strategic management of the oil and gas industry, as well as work out a method to help choose a strategy for the development of the oil and gas industry, considering the changing external environment.

The structure of this article is determined by the use of a logical algorithm to achieve the research goal by solving the following tasks. First, the existing conditions for the development of the oil and gas industry were studied, considering the results of an assessment of its capabilities. Methods for studying the prospects and limitations of the economic development of the Iraqi gas industry have been described. Directions for the development of the contract system have been developed, since imperfections in the existing system currently provide serious limitations. The determinants and factors of the modernization of the oil and gas infrastructure, which underlie the choice of strategy for the development of the gas industry in Iraq, have been determined.

To achieve this goal, we carried out the following: an analysis of statistical data on the development of socio-economic facilities, as well as indicators of issues of concern and limitations to the functioning of the Iraqi gas industry; the development tendencies in the gas and oil industry were systematized, and determined the long- and short-term direction of the industry’s strategic development; an approach was developed to optimize the income of participants in an investment contract based on the theory of contracts; a methodical approach was used to choose a strategy for the development of the gas industry using an analysis of hierarchies, including levels such as focus and factors, as well as actors, actors’ goals and strategies; calculations were made to help choose a strategy for the development of the gas industry in Iraq based on the developed hierarchical model.

1.2. Literature Review

Iraq is one of the most oil-dependent countries in the world. Over the last decade, oil revenues accounted for more than 99% of exports, 85% of the state budget and 42% of the GDP [5]. This over-reliance on oil makes the country unstable in terms of macroeconomics, while the inflexibility of the budget severely limits fiscal space and any opportunity for counter-cyclical policies. Despite the fact that economic situation in Iraq is gradually improving as international oil markets recover, that recovery also comes with serious risks from structural bottlenecks, including constraints on public investment management that have impacted government disbursement, as well as a greater dependence of state banks and the central bank on the state. These problems are exacerbated by unstable political conditions, a weak healthcare system, and rampant corruption, which continue to cause unrest throughout the country [4].

Iraq is now at a crossroads. Nearly two decades after the 2003 war, the country remains fragile in practice, facing growing political instability, social unrest, and a deepening gap between the state and citizens. In the midst of a series of crises (including falling oil prices, the COVID-19 pandemic, and recent protests), in addition to the accumulated consequences of weak economic policies, a lack of reforms, and failure to fight corruption, the country’s economy is facing serious problems [6].

The long-term low gross domestic product (GDP), lack of work opportunities and poor service provisions are among the most important risks to the country’s long-term growth
and limit its opportunities to utilize the potential of the gas industry [7]. The gas industry in Iraq is facing many long-standing problems associated with an internal systemic crisis, i.e., the low standard of living, and the severe instability and conflict in Iraq, which are fueled by a strong dependence on the natural resources sector. These hinder the country’s progress towards reforms and economic growth [6]. Sensitive areas include the need to provide technical and technological support [8,9] and innovative development [10,11].

As we can see, the development of the Iraqi economy is accompanied by complex processes that handicap the ability to plan the development of the gas sector. This determines the significance of developing a strategic planning method. The achievements made by the school of strategic planning most strongly emphasize the need for active strategic planning, and the inclusion of this process in the form of regulatory, formalized methods of development planning, while the evolutionary school and the resource school avoid formulating regulatory principles of development management, with an emphasis on explaining the context of changes in strategy.

The theoretical basis of long-term planning is based on the belief that there is only one strategy that corresponds to the situation and the forecast of changes in the environment, and the task is to build this strategy and implement it perfectly. The forecasts were based on the assumption that the past can be extended into the future using extrapolation or the use of expert knowledge (Delphi method). It soon became clear that forecasts based on the assumption of linear changes are rarely successful in practice. It is appropriate to recall the method of forecasting the future, i.e., the method of scenarios. The impetus for their implementation was the economic shocks caused by the oil crisis, which compromised traditional methods of strategic planning. The improvement in scenario planning led to the development and implementation of three types of scenario methods, namely, the school of intuitive logic, trend impact analysis, and analysis of the cross-impact of the scenario input data [12,13].

The scenario-planning method is evolving as people become more aware that the environment is becoming more unpredictable. This method is used to predict an environment that is neither deterministic nor chaotic, but changes in a measurable way. This method of strategic planning is unique in that it openly acknowledges people’s inability to anticipate changes in their environment and offers a meaningful way to deal with uncertainty. The use of scenarios has transformed the process of building a plan from a one-time episodic activity into a continuous learning process [14,15].

The specific nature of modern scenarios leads to the analysis of a large number of options in a wide range of possible changes. This makes it possible to consider almost all possible changes in the forecast, except for catastrophic ones. Even unlikely changes find their place in unexpected scenarios. The usefulness of scenario methods depends not only on the range of changes in the external environment that are considered in the scenarios, but also on linking the methodology to develop alternative scenarios and the method of their implementation [16]. However, strategic planning methods that have already been employed cannot always be used under high turbulence in the environment, which can be observed in emerging economies, e.g., Iraq. For the Iraqi gas industry, a more flexible rule, which can implement multiple strategies simultaneously, should be applied.

The analysis of the studied issues showed that, at present, there is no unified approach to developing a strategy for the oil and gas industry, considering the turbulence of the external environment, which indicates the need to form a methodology for choosing priority strategies, considering the systematization of the functioning factors of the Iraqi gas industry and substantiating its priorities.

2. Methodology
2.1. Research Techniques for the Prospects and Constraints of Economic Development of the Iraqi Gas Industry

The following research methods were used in this paper: a systematic analysis of economic, social and cultural conditions, considering the history of Iraq, and including a
review of the statistical data and a variety of sources. An inductive approach was taken, conducting a comprehensive review of previous studies related to the study’s subject to ascertain the development of concepts related to the Iraqi gas industry and its capabilities in the prevailing conditions in the country. A deductive approach was taken when analyzing research variables to clarify the role of government regulation in achieving sustainable development in the gas industry. An important method is the analysis of secondary data characterizing the current state of the oil and gas industry.

The study was based on the state statistics data for Iraq, in the field of the development of the gas industry and the socio-economic sphere, as well as the laws and regulations of Iraq in the regulation of mineral resource potential. We also looked at theoretical and methodological research into the issues under study, as well as periodicals and Internet resources.

2.2. Methods of Choice of the Industry Development Based on the Analytical Hierarchy Methods

The article proposes a step-by-step calculation scheme for choosing a strategy for the development of the Iraqi gas industry, based on the method developed by the author of the article, i.e., the process of analytical hierarchy. The article argues that strategic planning for the development of the oil and gas industry, as part of regional sectoral planning, should be carried out by analyzing hierarchies and include analytics, strategy and mechanism. Dominant-type hierarchies are characterized by the following criteria:

Building a hierarchy of the direct process by superimposing the current state or problem onto a possible or logical future (cause-and-effect relationship).

Building a hierarchy of the reverse process through a process management policy to achieve a result (event–effect relationship).

A hierarchical model for choosing a development strategy for the gas industry, using the hierarchy analysis method, includes the following:

- Goal (focus), with varying results in the forecasting process;
- Factors influencing the achievement and accomplishment of the goal (political, social, economic, environmental, technical and technological);
- Actors driving the processes in the system (Council of Ministers of Iraq, Ministry of Oil, Ministry of Energy, state gas companies, state oil companies, public–private oil and gas enterprises, private oil and gas enterprises);
- Goals of the actors;
- Contrasting (alternative) strategies [14].
- The process of analytical hierarchy is based on the iterative process algorithm, using the hierarchy analysis method. Repeated processes are envisaged to clarify the actors’ policies and strategic goals, and to find the optimal solution. The strategies were divided into alternative scenarios for the future, which were evaluated as actions to achieve goals. It is important to determine the consistency relationship.

- Summarizing each column of judgments;
- Multiplying the sum of the first column by the value of the first component in the normalized priority vector; multiplying the sum of the second column and beyond;

1. Summarizing the obtained numbers, obtaining the value $\lambda_{\text{max}}$;

In addition, the consistency index was calculated: ($HC$) [15]:

$$HC = (\lambda_{\text{max}} - n) / (n - 1)$$

(1)

where $n$ is the number of compared elements.

We determined the consistency ratio (OC) by dividing the $HC$ by the random consistency number of the matrix of the same order.

The study uses a direct and reverse process of strategic planning. Repeated processes are envisaged to use secondary data to confirm the results of the study, clarify the actors’ policies and strategic goals, and find the optimal solution. The figure shows the algorithm of iterative strategic planning processes to develop the gas industry using the hierarchy.
analysis method. Planning, as an iterative process, combines forward and reverse processes to achieve results.

The direct process hierarchy projects the present state of the issue into the most probable or logical future. The reverse process hierarchy defines the management policies needed to achieve the desired future. In the process of strategic planning for the development of the gas industry, it is advised to use both types of hierarchies. Planning is an iterative process that combines direct and reverse processes to turn the probable into the desired reality. Figure 1 shows the algorithm of iterative strategic planning processes for the development of the gas industry.

**Figure 1.** Algorithm for iterative strategic planning processes for the development of the gas industry.

In this study, to choose a strategy, calculations were made according to the first direct process. If it is necessary to refine the strategy and use secondary data, calculations should be made for the first reverse process, and also, if required, for the second direct process. The presented methodology allows for this.

The method is based on the algorithm of iterative processes using the hierarchy analysis method. Repeated processes are envisaged to clarify the actors’ policies and strategic goals, and to find the optimal solution. When considering these strategies, we
single out alternative strategies for future scenarios, which are evaluated in the actions taken to achieve goals.

The future strategic approach is hypothetically determined by the forecast and assumptions regarding the relationship between current and expected future changes. However, opinions should be based on logical conclusions, and not go beyond sense boundaries, resource restrictions, time and technological limits.

There are three types of strategy:
- The research type explores changes from the present to the future, considering the logical sequence of events;
- The preliminary type explores the future state and determines the initial components in the present to identify the influence and process needed to achieve the goal. It is divided into the regulatory type, which determines a set of goals, and the way to achieve these goals;
- The contrast type explores a combination of the first two, characterized by both desired and achievable results. It forms a generalized type of strategy, while maintaining the priorities of both. This typology allows for the direct process to be managed until the last iteration process, and the desired result achieved.

3. Results

3.1. Assessment of Capabilities of Development of the Iraqi Oil and Gas Industry

The current state of the Iraqi gas industry is characterized by the following trends [5,17,18]:

1. Iraq consumes 93,344 million cubic feet of natural gas per year, as of 2017.
2. Iraq ranks 92nd in the world in natural gas consumption, accounting for about 0.1% of the total world consumption of 132,290,211 million cubic feet.
3. Iraq consumes 2486 cubic feet of natural gas per capita per year (with a population of 37,552,781 in 2017), or 7 cubic feet per capita per day.
4. Iraq produces 885,029.22 million cubic feet of natural gas per year (as of 2015), ranking 33rd in the world.
5. Iraq does not export natural gas.

According to analytical forecasts, over the next decade, commercial gas production in Iraq will increase to about 50 billion m$^3$ [18]. Considering that Iraqi-associated gas is rich in ethane, progress in its exploration and production could also contribute to a significant increase in petrochemical production. The methods Iraq uses to extract and use its gas will determine the overall process of reform and modernization.

About three quarters of Iraq’s natural gas reserves are associated with oil. Most of this associated natural gas is concentrated in supergiant fields in the south of the country [19]. In 2019, Iraq produced 378 billion cubic feet of dry natural gas.

In 2019, Iraq consumed 636 billion cubic feet of dry natural gas, most of which was used by the electricity sector. According to the World Bank, Iraq flared 632 billion cubic feet of natural gas in 2019 [19], ranking second in the world in natural gas flaring, after Russia. Natural gas is flared due to insufficient pipeline capacity and other medium-flow infrastructure used to transport natural gas from production areas. Figure 2 presents data on the extraction and flaring of natural gas in Iraq.
The public sector can no longer provide this labor force with jobs, as it could during the period of high oil prices, so it is important to develop a robust private sector and attract foreign direct investment, which is destined to become a powerful engine of growth and social development, which will benefit all Iraqis and be based on a fair distribution of wealth and equality between generations [23]. The country has not yet fully recovered [22]. Subsequent political reforms must follow a coherent policy of economic and social development, which will benefit all Iraqis and be based on a fair distribution of wealth and equality between generations [23]. The country has not benefited from unsustainable profits, inefficient state-owned enterprises, and commitment to short-term consumption in a bloated public sector. As a result, Iraq’s macro-economy remains very fragile and urgently needs to be addressed, as a sound fiscal and monetary system is critical to the country’s stability.

The heavy dependence on electricity and gas imported from Iran to supply local power plants is another problem for the Iraqi economy. Iraq is experiencing a deep energy crisis with power shortages that have persisted for decades due to blockades and successive wars. For example, Iraq produces 19,000 megawatts of electricity, while representatives of the electricity sector argue that the real need is over 30,000 megawatts. The unstable relations between the countries for many years have resulted in frequent power cuts, especially in summer, when temperatures sometimes exceed 50 degrees Celsius. The Iraqi authorities are continuing negotiations with the countries of the Persian Gulf, led by Saudi Arabia, regarding the import of electricity through the connection between its energy system and the system of the Persian Gulf [24].

In addition, the country faces the challenge of creating jobs for a rapidly growing number of young people. The development of the gas industry provides an opportunity to diversify the economy, but this structural change will take many years, and immediate action is needed to integrate the rapidly increasing young labor force into the labor market. The public sector can no longer provide this labor force with jobs, as it could during the period of high oil prices, so it is important to develop a robust private sector and attract foreign direct investment, which is destined to become a powerful engine of growth and job creation [25].

The most challenging obstacles to the development of the gas industry in Iraq are as follows [2,3,6]:

- The need to conduct a variety of administrative proceedings to obtain the necessary permits, approvals and opinions;
- Complex and lengthy administrative and legal procedures;

Figure 2. Natural gas recovery and flaring in Iraq, billion cubic meters [19–21].

![Natural gas recovery and flaring in Iraq, billion cubic meters](image-url)
• Division of competencies within the above administrative and legal procedures between various state authorities and local self-government;
• Vague provisions and doubts regarding their interpretation, as well as excessively frequent changes in legal status;
• The issue of accessing energy enterprises for the real properties to be invested in;
• Lengthy legal proceedings.

3.2. Development of the Contract System

As we can see, one of the obstacles in the industry is state regulation. Thus, in 2017–2018, the Council of Ministers resolutions (No. 423 and No. 50) were adopted regarding the market regulation for natural, associated and liquefied gas, as well as the conversion of gas into electricity. The resolutions envisage the establishment of a gas pipeline company, holding of tenders to implement contracts for gas production and processing, the development of infrastructure facilities for gas processing, etc. Investors buy gas from the Ministry of Oil at agreed prices, sell it to companies that convert gas into electricity, and export gas. However, there is still no law in Iraq that lays the foundations for subsoil use, since the political groups in the country fail to agree on the legal boundaries of foreign companies in Iraq and the distribution of oil revenues. Each investment contract is considered on an individual basis. This leads to reduced competition, monopolization of the industry and corruption in contract procedures.

Oil and gas contracts represent relationships between oil- and gas-producing countries and international companies operating in the exploration and production of oil or gas. Such contracts are used if the owner of the subsoil lacks financial or material and technological resources.

The following types of oil and gas contracts exist:
- Term Service Contracts (TSC);
- Production Sharing Contracts (PSC);
- Franchising contracts;
- Hybrid contracts.

Franchising and hybrid contracts are used less often.

A feasibility study of investments in the use of associated gas and production of free gas is discussed below. A diagram of financial transactions that occur when investing in associated gas, and the income from oil and associated gas, are shown in Figures 3 and 4. In Figure 5, a situation with associated gas flaring is shown. The diagrams were compiled using Reference [26].

Let us calculate the losses of the Iraqi economy in the absence of investment in the area. For the calculation, let us assume that Iraqi oil production per day amounts to 50 thousand barrels per day. The APG produced will amount to 850 thousand m$^3$; the selling price will be 75 USD/bbl; the cost of associated gas production will be 56 USD/thousand cubic meters; the price of imported gas will be 280 USD per thousand m$^3$ of natural gas. The production of 50 thousand barrels of oil under standard conditions will yield about 850 thousand m$^3$ of natural gas [26].

The calculations economically substantiate the expediency of investing in gas and using gas associated with oil operations, instead of importing natural gas from abroad. It should be noted that Iraq relies on oil to fund more than 95% of its budget [26].
Figure 3. Diagram of financial transactions when investing in associated gas.
Figure 4. Financial return when investing in associated gas.
Figure 5. Financial return on oil revenues without investing in associated gas, importing it from abroad instead.

Oil revenues account for 95% of the Iraqi budget. Accordingly,

\[
\text{State revenue of Iraq} = \frac{\text{oil revenues}}{95} \times 100
\]

\[
\text{State revenue of Iraq} = \frac{3,289,375 \text{ $}}{95} \times 100
\]

State revenue of Iraq = 3,462,500(100%) $

Costs of importing gas from abroad = 238,000 $

Costs of associated gas production = 47,600 $

Costs of importing gas : \( \frac{238,000 \text{ $}}{3,462,500 \text{ $}} = 0.06 \)
Costs of associated gas production: \[\frac{47,600 \text{ $}}{3,462,500 \text{ $}} = 0.01\]

The difference between the cost of gas production and imported gas = 190,400 $.

Percentage of losses for the Iraqi economy in the absence of investments in associated gas:
\[\frac{190,400 \text{ $}}{3,462,500 \text{ $}} = 0.05.\]

Thus, Iraq will lose 6% of its total national revenue if it does not invest in associated gas and depends on gas that is imported from abroad; however, if Iraq invests in associated gas, this will provide 5% of state revenue, which reduces losses from 6% to 1%. It is worth noting that Iraq produces more than 4 million barrels of oil per day and flares more than 55% of the associated petroleum gas. The economic feasibility of developing investments in associated gas can also be confirmed on the basis of the following analytical data. Iraq imports natural gas from abroad (to generate electricity) at a price of 245–350 US dollars per thousand m\(^3\), while obtaining natural gas from APG costs the Iraqi government 35–105 US dollars per thousand m\(^3\). The conclusions from the studies and calculations are as follows:

1. It is necessary to continue and expand oil exploration to increase oil reserves, increase the oil production limit and increase associated gas production within the OPEC oil-production limits, as well as increasing oil reserves through the development of fields in all regions of Iraq.
2. It is necessary to continue joint projects with major international gas companies to increase the exploration and development of free gas to meet the local demand and export opportunities for gas, as well as the possibility of developing natural gas in the western region of Iraq.
3. Increasing the production of gas and its derivatives will promote the development of relevant industries that intensively use clean energy, with a preference for investment in the private and joint sectors.
4. The natural gas system, the pricing of household gas and the gas used for transportation should be properly developed, and the number of filling stations, which is dependent on the supply of natural gas, should be increased, as this is environmentally friendly.
5. Petrochemical plants should mainly develop to meet local needs and other export-oriented industries; export-oriented industries, such as petrochemicals, must be located in the same area, close to Basra, due to ports, geographic location and infrastructure size.
6. The natural gas service sector, including local and international companies, should be encouraged through investment contracts that are acceptable to all investors, namely through profit-sharing in service contracts and production-sharing contracts, so that more international companies are present in Iraq.

A typical formula for calculating economic rent (\(ER\)), as a starting point for evaluating a particular section of an oil or gas field, may look like this:

\[
ER \equiv \sum_{t=1}^{n} \left[ \frac{Po \times Pr(L - rt) - Lt - Jt}{(L - I)^t} \right] - w
\]

where:

- \(ER\): Economic rent.
- \(n\): Time horizon.
- \(t\): Year.
- \(Po\): Expected price of oil and gas, USD per barrel.
- \(Pr\): Expected oil and gas production, barrel/year.
- \(rt\): Royalty, %.
- \(Lt\): Expected income tax, USD/year.
- \(Jt\): Expected production costs, USD/year.
- \(w\): Expected well-drilling costs, USD.
- \(I\): Discount rate.
Studies show the need to base the calculation of the cost of production reductions in the oil and gas fields, within the framework of technical service contracts. Then, we can find the production reduction factor using the following mathematical formula:

\[
Re - \text{Factor} = \frac{\text{Actual production}}{\text{Reduced production}} \times 100\% \tag{3}
\]

where “Re – Factor” is a production reduction factor.

The formula for cash income from oil and gas technical service contracts might look like this:

\[
\Gamma_D = P_0 \times Pr - P \times (RF \times PF \times ReF) \times (1 - GP) \times (1 - Lt) \times Pr - (C \times Pr) \\
\Pi_D = P \times (RF \times PF \times ReF) \times (1 - GP) \times (1 - Lt) \times Pr + C \times Pr \tag{4}
\]

where:

- \(\Gamma_D\) – state share (SS);
- \(\Pi_D\) – contractor share (CS);
- \(GP\) – state partner;
- \(P_0\) – expected price of oil and gas;
- \(Pr\) – expected production of oil and gas;
- \(Lt\) – expected profit tax;
- \(P\) – profit;
- \(RF\) (R-Factor) – recovery factor = \((\text{Total income})/\text{(Total costs)} \times 100\%\)
- \(PF\) (P-Factor) – production factor = \((\text{Actual production})/\text{(Planned production)} \times 100\%\)
- \(ReF\) (Re-Factor) – production reduction factor = \((\text{Actual production})/\text{(Reduced production)} \times 100\%\)
- \(C\) – costs of oil and gas production.

We believe that it is necessary to introduce changes to the legislation, and to consolidate the transformation of existing oil and gas agreements into service contract. This is the key challenge in the development of the Iraqi gas industry. A service contract will allow the investor some discretion: under previous contracts, profits were distributed on the basis of the declared discrete value, and the use of service contracts implies the use of ad valorem rates (i.e., rates per cent) of the initial values. This approach seems more economically feasible, since its use to conclude contracts for the development of oil and gas fields will ensure higher revenues while reducing production costs.

The details of this approach are provided in Figure 6.

When selling a given volume of commercial gas for a certain period of time, the company receives 100% of the sales revenue. According to the terms of the applicable service contract, 50% of the received revenue is paid to the government as royalties. The balance of the revenue is divided into reimbursements of the production costs incurred by the contractor when developing the asset, and profits.
We shall now calculate the practical application of this technique. We will consider this approach by using an example (Figure 7).

It has been revealed that the provisions offered by Iraqi legislation when regulating the construction process are not in line with the specifics of the implementation of linear investments. Linear facilities, such as gas infrastructure, are largely located in regional areas. Subsequently, such investments are associated with the need to carry out administrative procedures with the state authorities and local governments, which often not only do not cooperate with each other to efficiently obtain the appropriate permits, but compete with each other, leading to conflicting goals. This situation is largely due to the fragmentation of individual competencies between bodies that solve highly specialized tasks, and the lack of a single decision-making center that plays a decisive role in the investment process for linear investments.
It should be noted that public administration authorities are aware of the problems associated with the administrative and legal barriers that impede the implementation of linear investments. One measure to improve the energy security of the country could be legislative measures, aiming to remove investment barriers, particularly in the area of major investments in infrastructure (warehouses, CNG infrastructure, gas compressor stations, etc.).

Furthermore, attempts should be made to introduce legislative solutions that would contribute to the expansion of the energy infrastructure. These form main stages of the administrative and legal procedures that are necessary to invest in infrastructure. As part of the investment process, there are several main stages of the administrative and legal procedures that a company will face when planning to develop a linear infrastructure. First of all, they must determine in which facility they will invest. This calls for agreement with local governments and their inclusion in local plans (local territorial development plans). The foreseen infrastructure, as a rule, will only partly pass through areas that are covered by local plans, while other areas will remain uncovered. This necessitates a separate decision on the facilities in which to invest.
Additional infrastructure facilities for the distribution of gas in Iraq will be needed to connect regions with new gas sources, or gas-supply sources, to areas where production is expected to increase. Not all areas will need an extensive transmission network; connecting new investments to the existing network may be enough. As mentioned earlier, each new infrastructure investment will largely depend on the economic viability of the project. Therefore, it is not surprising that long-term contracts will ensure greater predictability and allow for long-term planning.

It should be mentioned that a foreign company will not want to build a new transmission infrastructure unless provided with two important elements. First of all, the reliability of the supply of raw materials is worth noting; this can only be guaranteed by a long-term sales contract. In addition, this allows for companies to begin the process of raising funds, and manage portfolios of investments. Secondly, the sale of purchased and shipped raw materials should be ensured. In this case, the best option is to search for major customers, which could be a large industrial (chemical) plant or a power plant equipped with gas units. In this context, a long-term gas purchase agreement should also be considered to ensure economic viability and full utilization of infrastructure facilities [4]. It is necessary to apply advanced methods of managing oil and gas companies [27,28]. It is also necessary to monitor the problems of taxation [29], the employment of efficient technologies [30–32], and the application of modern geophysical methods [33].

In addition, market competition for unconventional gas production (the issue of exploration concessions to many entities) should contribute to greater diversification of supplies and, as a result, the possibility of Iraq being engaged as a supplier by, for example, EU countries. The search for new sources of natural gas supplies, in response to the forecasted growth in the consumption of this raw material, will entail the need to expand another important element of the gas infrastructure, viz. underground gas storage facilities. The country’s energy security in the field of gas is associated with the availability of sufficient gas reserves that could be employed in crisis situations (in case of sudden interruptions in gas supplies from abroad, an unexpected increase in demand caused by weather conditions, etc.). Thus, the predicted growth in gas consumption requires a proportional increase in storage capacity.

The conducted analysis identified the factors that influence the development of the oil and gas industry’s infrastructure in Iraq. Unfortunately, most factors on which the development of gas infrastructure depends are unknown (uncertain). These are variables, which may manifest themselves in the future; today, we can only predict their possible impact. Therefore, the factors that affect the development of the Iraqi gas industry can be divided into two groups.

Determinants of infrastructure development, which have significant impact on the market:

1. Growth/decrease in GDP, which, in an era of economy based on the energy produced from natural resources, is crucial to the reported demand for energy, and, therefore, for natural gas; the growing demand for natural gas requires an expansion of the infrastructure that supplies raw materials to end consumers;
2. The priorities of the state’s energy policy, which determines strategic energy sectors and has a decisive influence on the distribution of the investment funds required for new infrastructure; the decision to build a nuclear power plant may decrease the inflow of funds to investments in gas infrastructure (the reverse trend is observed in Germany, with natural gas becoming an alternative to the foreseen closure of nuclear power plants);
3. An increase in electricity demand associated with economic growth; the construction of gas-fired power units can not only meet the increased demand for electricity, but also allow for a flexible coverage of short-term electricity shortages, for example, in summer (gas can be turned on and off very quickly);
4. The industrial exploitation of unconventional gas resources could significantly change the energy mix in Iraq; connecting new gas sources to the transport network would
be a huge investment project, and the possible consequences associated with falling natural gas prices could lead to the creation of new gas-based power units; in the long term, if natural gas resources turn out to be extremely large, it will be possible to export gas (in the traditional form or as CNG);

5. National legislation, including mineral tax provisions that may determine the profitability of exploiting energy resources, in addition, restrictions related to international climate obligations (Kyoto Protocol) or plans to reduce greenhouse gas emissions into the atmosphere. It is also necessary to take into account the existing methods of regulating the markets of natural monopolies [34].

Other considerations that may have a lesser impact on the development of the Iraqi gas industry in the future:

1. Development of the potentially vast market for cars and trucks fueled by compressed natural gas (CNG), which, however, requires the developed infrastructure (many filling stations to accommodate CNG filling), due to low prices for this type of gas, this infrastructure is currently being developed quite intensively, e.g., in the United States;

2. Population growth, which, although not a direct cause of the development of the gas market and infrastructure, nevertheless contributes to its increased economic activity, which has a direct impact on GDP growth (potentially increasing gas consumption);

3. Growth in industrial output, which can contribute, albeit to a lesser extent than GDP growth, to the expansion of infrastructure (although it should be noted that, in developed countries, less energy-intensive services dominate the formation of GDP);

4. High prices for crude oil or coal, which may affect the decisions of individual and commercial consumers regarding their heating method (switching to gas heating);

5. Ambient temperature, and its possible increase with climate change (regardless of the causative factors), as well as population decline, will also have an indirect impact on infrastructure development, affecting the GDP trend (although, as mentioned earlier, it may have a minor impact on the decrease in demand for gas for heating purposes);

6. An increase in gas production costs associated, on the one hand, with the previously mentioned, more restrictive regulation of hydraulic fracturing technologies, and, on the other hand, with the possible exploitation of increasingly less-accessible fields, which will lead to the need to search for alternative energy sources;

7. Exploitation of unconventional crude oil resources (oil sands or oil shale), which, paradoxically, can jeopardize investment in gas infrastructure by causing oil prices to fall worldwide (the same mechanism that led to the shale gas boom in the US is employed);

8. Technologies that increase energy efficiency and lead to more pro-environmental consumer behavior; in extreme cases, such measures can hinder the development of the gas industry, as they contribute to the more efficient use of raw materials. In the long-term, a technological revolution can be envisaged, resulting in the search for an alternative source of energy (fossil fuel) and independence from the current fossil-fuel infrastructure.

3.3. Choice of the Development Strategy for the Iraq Gas Industry

The following is a step-by-step calculation scheme for choosing a strategy to develop of the Iraqi gas industry:

At stage 1, the influence of different factors on the functioning and development of the gas industry should be determined. After working through the problem in terms of a hierarchy, it is necessary to evaluate the criteria and the alternatives. Using an analysis of hierarchies, elements should be compared in pairs, and their impact on the overall characteristics of the process should also be collated. We consider paired comparisons in matrix form [15].

A set of local priorities is formed based on a group of paired comparison matrices, expressing the set’s influence on the unit element of the adjacent level from above, for which the set of vectors is calculated. Then, the result is to be normalized to one, thus obtaining a priority vector. One matrix of pair-changes describes the second level as a matrix of dominance.
The factors are compared pairwise, assessing their impact on the innovative development of the region. Once the criteria (alternative factors) have been determined, the consistency of the local criteria should be assessed. The consistency index provides information about the degree of change in numerical and ordinal consistency. If the deviation exceeds the established limits, the calculations in the matrix should be rechecked.

Calculations are based on the fact that, when selling a given volume of commercial gas for a certain period of time, the company will receive 100% of the sales revenue. Based on the terms of the applicable service contract, 50% of the received revenue is paid to the government in the form of royalties. The rest of the proceeds are divided into two directions: reimbursement of the production costs incurred by the contractor in the process of developing the asset, and profits. The production costs depend on the individual characteristics of the field and are regulated by a number of factors, which include, among other things, the regional factor, the complexity of field development, and hazardous working conditions. However, this value cannot exceed 40% of the revenue, since further increases will mean that participation in this project is economically unjustified. According to the terms of the contract, 75% of the profits will be deducted by the Iraqi Oil Ministry, and the remaining 25% will be sold as follows: 25% of the balance (i.e., from 25%) falls to the state partner company, and 75% of the balance is received by the contractor. The contractor’s profit is subject to income tax at the level of 35%.

In the hierarchy analysis method, elements are compared in pairs, and their impact on the overall process characteristics is also compared. Table 1 presents the results of an assessment of these factors’ impact on the development of the Iraqi gas industry. Let us consider pairwise comparisons as a matrix.

Table 1. Results of assessing factors’ impact on the development of the Iraqi gas industry.

| Indicators | Factors | Political | Social | Economic | Environmental | Technical and Process | Normalized Priority Vector Estimates |
|------------|---------|-----------|--------|----------|---------------|-----------------------|------------------------------------|
|            |         | 0.306     | 0.055  | 0.348    | 0.126         | 0.165                 |                                    |
| λ<sub>max</sub> | 5.692 |            |        |          |               |                       | OC=15.4%                           |

Let us consider the sequence used to obtain the calculation results presented in Table 1. This technique was also used to obtain results at other stages; please review auxiliary Table 2.

Table 2. Pairwise Comparison Matrix of Factors Affecting the Functioning and Development of the Iraqi Gas Industry.

| Factors       | Political | Social | Economic | Environmental | Technical and Process | Eigen Vector | Normalized Priority Vector Estimates |
|---------------|-----------|--------|----------|---------------|-----------------------|--------------|-------------------------------------|
| Political     | 1         | 5      | 1/3      | 3             | 3                     | 2.47         | 0.306                               |
| Social        | 1/5       | 1      | 1/3      | 3             | 1/3                   | 0.44         | 0.055                               |
| Economic      | 3         | 3      | 1        | 4             | 3                     | 2.8          | 0.348                               |
| Environmental | 1/3       | 3      | 1/4      | 1             | 1/2                   | 1.017        | 0.126                               |
| Technical and process | 1/3 | 3     | 1/3      | 2             | 1                     | 1.333        | 0.165                               |
|               | 4.866     | 15     | 2.249    | 10.333        | 7.833                  | 8.06         |                                     |

To make a pairwise comparison of the factors’ influence on the development of the Iraqi gas industry, the following scale was used: 1—equal significance; 3—moderate superiority
of one factor over another; 5—significant superiority; 9—very strong superiority; 2, 4, 6, 8—intermediate judgments.

The first line was obtained as follows. The influence of political and social factors were compared: political factors predominated over social ones (the number 5). The reciprocal value (1/5) was entered in the symmetrical position of the matrix. For Iraq, political factors were less strong than economic ones. The estimate was 1/3; the inverse number were entered into the symmetrical position of the matrix, that is, 3. The estimates were obtained by qualified experts in the field, with scientific doctorates. Other factors were assessed in a similar way. To ensure the reliability of the expert survey, indicators of the consistency index (IC) and the consistency ratio (OC) were calculated. The consistency index provides information about the degree of violation of numerical and ordinal consistency. Lack of consistency was a limiting factor. The value of the consistency ratio should not exceed 20%.

Calculation in columnar form “Eigen Vector”
Political: \((1 + 5 + 0.333 + 3 + 3):5 = 2.47\)
Social: \((0.2 + 1 + 0.333 + 0.333 + 0.333):5 = 0.44\)
Political: \((3 + 3 + 1 + 4 + 3):5 = 2.8\)
Environmental: \((0.333 + 3 + 0.25 + 1 + 0.5):5 = 1.017\)
Technical and process: \((0.333 + 3 + 0.333 + 2 + 1):5 = 1.333\)

Calculation in columnar form “Normalized Priority Vector Estimates”
Economic: \(2.47:8.06 = 0.306\)
Social: \(0.44:8.06 = 0.055\)
Political: \(2.8:8.06 = 0.348\)
Environmental: \(1.017:8.06 = 0.126\)
Technical and process: \(1.333:8.06 = 0.165\)

The consistency index is calculated as follows. First, each column of judgments is summed, then the sum of the first column is multiplied by the value of the first component of the normalized priority vector. The sum of the second column is multiplied by the second component, and so on. Then, the resulting numbers are summed. Thus, one can obtain the value denoted as \(\lambda_{\text{max}}\):

\[
\lambda_{\text{max}} = 4.866 \times 0.306 + 15 \times 0.055 + 2.249 \times 0.348 + 10.333 \times 0.126 + 7.833 \times 0.165 = 5.692
\]

For an inversely symmetric matrix \(\lambda_{\text{max}} \geq n\) is always followed.

The consistency index can be found using the formula: \(IC = (\lambda_{\text{max}} - n)/(n - 1)\), where \(n\) is the number of compared components.

\[
IC = (5.692 - 5)/4 = 0.173.
\]

A table of average consistency for random matrices of different orders is given below, as Table 3.

Table 3. Table of average consistencies.

| Order of matrix | 1   | 2   | 3   | 4   | 5   | 6   | 7   | 8   | 9   | 10  |
|-----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Random consistency | 0   | 0   | 0.58| 0.90| 1.12| 1.24| 1.32| 1.41| 1.45| 1.49|

To obtain the consistency ratio (OC), let us divide the IC by a number corresponding to the random consistency of the matrix of the same order:

\[
OC = IC/1.12 \times 100\% = 15.4\% \text{ (not exceeding 20%)}.
\]
The final calculations by factors are presented in Table 1. Table 4 shows the results of an assessment of the importance of the actors’ goals. For the Council of Ministers of Iraq, the most important goal when building a strategy for the development of the gas industry is the construction of infrastructure for the gas industry—the value of the normalized priority vector estimate is 0.478. The total estimates of the goals are 1 (0.350 + 0.478 + 0.172 = 1). The results of the assessment of the objectives of the Iraqi Ministry of Oil, the Ministry of Energy, and the state gas and oil companies, both public–private and private oil and gas enterprises, are interpreted in a similar way.

At stage 2, it is necessary to determine actors’ degree of influence on factors. At stage 3, the importance of all seven goals of the actors should be determined. These are compared in pairs. The result is priority vectors that reflect the ordering of weights and goals. The results of the actors’ assessment are summarized in Table 4.

At stage 4, a synthesis of priorities should be determined, starting from the second level. The local priorities are multiplied by the priority of the top-level criterion and summed for each element of the impact criterion.

Let us determine the degree of actors’ influence on factors by multiplying the matrix of vectors of the third level of actors’ priorities by the vector of priorities from the second level in Table 5.

### Table 4. Results of the estimation of the importance of actors’ goals.

| Goals                                           | Council of Ministers of Iraq | Oil Ministry | Ministry of Energy | National Gas Companies | National Oil Companies | Public-Private Oil and Gas Companies | Private Oil and Gas Companies |
|-------------------------------------------------|------------------------------|--------------|--------------------|------------------------|------------------------|-------------------------------------|-------------------------------|
| Creation of favorable conditions for the development of the country’s economy. | 0.350                        |              |                    |                        |                        |                                     |                               |
| Development of the gas industry’s infrastructure. |                              | 0.478        |                    |                        |                        |                                     |                               |
| Sustainable use of the resource potential.      |                              |              | 0.172              |                        |                        |                                     |                               |
| \( \lambda_{\text{max}} \)                      | 3.965                        |              |                    |                        |                        |                                     |                               |
| \( \text{OC} \)                                  | 14.1%                        |              |                    |                        |                        |                                     |                               |
| Ensuring sustainable functioning and development of the oil and gas industry. |                              |              |                    | 0.297                  |                        |                                     |                               |
| Development of the gas industry in Iraq.        |                              |              |                    | 0.208                  |                        |                                     |                               |
| Sustainable use of associated gas.              |                              |              |                    | 0.151                  |                        |                                     |                               |
| Development of free gas fields.                 |                              |              |                    | 0.156                  |                        |                                     |                               |
| Employment of modern technologies in the gas industry. |                              |              |                    | 0.065                  |                        |                                     |                               |
| Full satisfaction of the needs of the industry and population in terms of gas resources. |                              |              |                    | 0.123                  |                        |                                     |                               |
| \( \lambda_{\text{max}} \)                      | 6.84                         |              |                    |                        |                        |                                     |                               |
| \( \text{OC} \)                                  | 17.2%                        |              |                    |                        |                        |                                     |                               |
| 1. Increasing the economic efficiency of the production, transmission and distribution of electricity. |                              |              |                    |                        |                        |                                     | 0.458                        |
Table 4. Cont.

| Goals                                                                 | Council of Ministers of Iraq | Oil Ministry | Ministry of Energy | Actors National Gas Companies | National Oil Companies | Public-Private Oil and Gas Companies | Private Oil and Gas Companies |
|-----------------------------------------------------------------------|------------------------------|-------------|--------------------|------------------------------|------------------------|--------------------------------------|------------------------------|
| 2. Ensuring an uninterrupted power supply to the country’s economy.   |                              |             |                    |                              |                        |                                      |                              |
|                                                                      |                              |             |                    |                              |                        |                                      |                              |
| 3. Maximum utilization of the potential of the Iraqi gas industry and the use of a modern power supply. |                              |             |                    |                              |                        |                                      |                              |
|                                                                      |                              |             |                    |                              |                        |                                      |                              |
| \( \lambda_{\text{max}} \)                                          | 3.252                       |             |                    |                              |                        |                                      |                              |
| OC                                                                   | 14.1%                       |             |                    |                              |                        |                                      |                              |
| 1. Development of infrastructure for the use of free and associated gas. |                              |             |                    |                              |                        |                                      |                              |
| 2. Increasing profits through the introduction of new technology.     |                              |             |                    |                              |                        |                                      |                              |
| 3. Exploration of free gas fields.                                    |                              |             |                    |                              |                        |                                      |                              |
| \( \lambda_{\text{max}} \)                                          | 3.119                       |             |                    |                              |                        |                                      |                              |
| OC                                                                   | 15.1%                       |             |                    |                              |                        |                                      |                              |
| Development of infrastructure for gas production.                    |                              |             |                    |                              |                        |                                      |                              |
| Increase in the share of exports.                                    |                              |             |                    |                              |                        |                                      |                              |
| \( \lambda_{\text{max}} \)                                          | 3.053                       |             |                    |                              |                        |                                      |                              |
| OC                                                                   | 11.5%                       |             |                    |                              |                        |                                      |                              |
| Utilization of associated gas                                        |                              |             |                    |                              |                        |                                      |                              |
| Development of infrastructure for gas production.                    |                              |             |                    |                              |                        |                                      |                              |
| Increase in the share of exports.                                    |                              |             |                    |                              |                        |                                      |                              |
| \( \lambda_{\text{max}} \)                                          | 4.216                       |             |                    |                              |                        |                                      |                              |
| OC                                                                   | 11.5%                       |             |                    |                              |                        |                                      |                              |
| 1. Introduction of new technologies for natural gas production.      |                              |             |                    |                              |                        |                                      |                              |
| 2. Exploration of oil and associated gas fields.                     |                              |             |                    |                              |                        |                                      |                              |
| 3. Improving the environmental safety of the work.                   |                              |             |                    |                              |                        |                                      |                              |
| 4. Development of ports for the export of oil and gas.               |                              |             |                    |                              |                        |                                      |                              |
| \( \lambda_{\text{max}} \)                                          |                              |             |                    |                              |                        |                                      |                              |
| OC                                                                   |                              |             |                    |                              |                        |                                      |                              |
| 1. Increasing the rate of utilization of oil and gas reserves.       |                              |             |                    |                              |                        |                                      |                              |
| 2. Use of advanced international experience.                         |                              |             |                    |                              |                        |                                      |                              |
| 3. Improving the qualifications of personnel.                       |                              |             |                    |                              |                        |                                      |                              |
| \( \lambda_{\text{max}} \)                                          | 3.278                       |             |                    |                              |                        |                                      |                              |
| OC                                                                   | 14.5%                       |             |                    |                              |                        |                                      |                              |
Table 5. Results of the influence of actors on actors.

| Actors                                | Calculation                                      |
|---------------------------------------|--------------------------------------------------|
| Council of Ministers of Iraq          | 0.246 × [0.350 0.478 0.172] = [0.086 0.118 0.042] |
| Oil Ministry                          | 0.208 × [0.297 0.208 0.151 0.156 0.065 0.123] = [0.062 0.043 0.031 0.032 0.014 0.026] |
| Ministry of Energy                    | 0.176 × [0.458 0.218 0.324] = [0.081 0.038 0.057] |
| National gas companies                | 0.118 × [0.521 0.115 0.364] = [0.061 0.014 0.043] |
| National oil companies                | 0.133 × [0.421 0.346 0.233] = [0.056 0.046 0.031] |
| Public–private oil and gas companies  | 0.092 × [0.259 0.386 0.107 0.248] = [0.024 0.036 0.010 0.023] |
| Private oil and gas companies         | 0.029 × [0.491 0.125 0.384] = [0.014 0.004 0.011] |

The calculation is based on the fact that, when selling one barrel of oil at a price of 75 USD/bbl, the sales revenues will be 75 USD. Half of the proceeds (37.5 USD) are paid to the government in the form of royalties. The second half is distributed as follows: production costs in this field are 8 USD/bbl, with the retained earnings of 29.5 USD.

According to the terms of the contract, 75% of the retained earnings (22,125 USD) fell on the Iraqi Ministry of Oil, and the remainder was distributed between the state partner company and the contractor in the following ratio: 25% of the balance (≈1844 USD) fell on the state partner, and 75% of the balance (≈5,531 US dollars) on the contractor. The contractor’s profits were subject to a 35% income tax (≈1936 USD). As a result, the income distribution looks like this:

- The state—61,561 USD (37.5 + 22,125 + 1,936);
- Government partner—1,844 USD;
- Contractor—11,595 USD (8 + 3,595).

Let us consider the results of the analysis:

(1) For the Council of Ministers of Iraq, the main goal is to form the infrastructure of the gas industry as a prerequisite for the effective development of the national economy;
(2) For the Oil Ministry, the main goal is ensuring the sustainable functioning and development of the oil and gas industry;
(3) For the Ministry of Energy, the main goal is to increase the economic efficiency of the production, transmission and distribution of electricity;
(4) For national gas companies, the main goal is the development of an infrastructure for the utilization of free and associated gas;
(5) For national oil companies, the main goal is the use of associated gas;
(6) For public–private oil and gas companies, the main goal is the exploration of oil and associated gas fields;
For private oil and gas companies, the main goal is to increase the utilization of oil and gas reserves.

The normalized vector is then applied to obtain weights for the development strategies for the Iraqi gas industry. By normalizing the weights of the goals with maximum values, we obtain the resulting vector of the goal weights. At stage 5, the development strategies’ degree of influence on the actors’ goals should be determined. Let us consider five contract investment strategies within the hierarchical model for the development of the Iraqi gas industry:

1. Investing in associated gas, stopping the use of oil to generate energy and electricity.
2. Investing in associated gas, fully meeting the needs of the industry regarding this type of resource, and refusing to import gas from abroad.
3. Investing in free gas and stopping the import of electricity from abroad.
4. Free basic investments and operations, and investments in petrochemical projects.
5. Investing in natural gas (both associated and free), making arrangements for the exportation of operations with natural gas. The weights of the strategies were formed in the dominance matrices using goals; the results of paired comparisons are presented in Table 6.

Table 6. Calculation results for the assessment of influence of the chosen strategy on the achievement of actors’ goals.

| Strategies                                                                 | Development of the Gas Industry Infrastructure | Ensuring Sustainable Operation of the Oil and Gas Industry | Increasing the Economic Efficiency of Production, Transmission of Electricity | Development of Infrastructure for the Utilization of Free and Associated Gas | Utilization of Associated Gas | Exploration of Oil and Associated Gas Fields | Increasing the Degree of Utilization of Oil and Gas Reserves |
|---------------------------------------------------------------------------|-----------------------------------------------|----------------------------------------------------------|-----------------------------------------------------------------------------|-------------------------------------------------------------------------|----------------------------|-----------------------------------------------|------------------------------------------------------------|
| Investing in associated gas, stopping the use of oil for energy and electricity generation. | 0.265                                         | 0.226                                                    | 0.218                                                                       | 0.248                                                                   | 0.239                     | 0.248                                        | 0.211                                                      |
| Investing in associated gas, fully meeting the needs of the industry regarding this type of resource, refusing to import gas from abroad. | 0.290                                         | 0.241                                                    | 0.251                                                                       | 0.358                                                                   | 0.372                     | 0.275                                        | 0.237                                                      |
| Investing in free gas and stopping the import of electricity from abroad.   | 0.120                                         | 0.179                                                    | 0.194                                                                       | 0.110                                                                   | 0.123                     | 0.163                                        | 0.184                                                      |
| Free basic investment and operation, and investing in petrochemical projects. | 0.238                                         | 0.198                                                    | 0.204                                                                       | 0.175                                                                   | 0.164                     | 0.218                                        | 0.196                                                      |
| Investing in natural gas (both associated and free), making arrangements for export operations with natural gas. | 0.087                                         | 0.156                                                    | 0.133                                                                       | 0.109                                                                   | 0.102                     | 0.096                                        | 0.172                                                      |
| \( \lambda_{\text{max}} \) | 5.860                                         | 5.232                                                    | 5.184                                                                       | 5.122                                                                   | 5.844                     | 5.782                                        | 5.386                                                      |
| OC                          | 12.8%                                         | 14.86%                                                   | 14.92%                                                                      | 18.23%                                                                  | 16.98%                     | 15.77%                                       | 16.44%                                                      |

Stage 6 is the determination of the necessary strategy for the development of the Iraqi gas industry. When multiplying the matrix by the vector of goal weights, the remarkable thing is that the largest share is accounted for by the second strategy, i.e., investing in associated gas, independently meeting the needs of the Iraqi industry regarding this type of resource, and refusing to import gas from abroad.

Thus, in summary:

1. Iraq possesses large natural gas resources, which can be used to increase clean energy use via greater investments in free gas fields and associated gas processing.
2. A promising investment image should be developed to attract foreign investment by reducing bureaucracy and increasing the share of profits, so that the return relationship
between owner and investor is straight. This would mean that profits increase together, instead of without the other party.

3. The investment strategies for natural gas production in Iraq are as follows: the first step is to invest in the processing of associated gas in oil fields; the second step is to invest in free gas fields, since the investment costs of associated gas are lower because it directly depends on the infrastructure of oil fields.

4. Discussion

4.1. The Necessity of Developing a Gas Industry Infrastructure

In Iraq, the oil and gas industry is mainly controlled by the public sector, which could be the reason for the limited international investment in Iraqi oil and gas, and the underuse of modern technology to develop resources in the oil and gas industry. This statement is confirmed by the macroeconomic indicators in the country. Thus, in 2017, Iraq’s GDP growth slowed to 1.1% [5]. This was due to civil unrest, reduced consumption and investment in a sluggish oil market. Iraq’s economy is described as state-owned. It is dominated by the oil sector, which accounts for about 85% of government revenue. Iraq has made slow progress in enacting legislation and creating institutions for investor-friendly economic reforms. However, the antiquated infrastructure, inadequate public services, shortage of skilled labor, and outdated laws deter investment and growth in the private (non-oil) sector. Although the Iraqi Government managed to tame inflation as early as 2006, living standards are rising very slowly. In Iraq, salaries are almost ten times lower than in Sweden or Germany; one out of eight citizens are not even employed [5].

Most of Iraq’s socio-economic indicators lag behind upper-middle-income countries. Despite the abundant natural resources that allowed Iraq to reach the level of upper-middle-income countries, institutions and socio-economic results vary in different areas [35]. Some of the development indicators are comparable to fragile, low-income countries. The country has one of the lowest female labor force participation rates, low levels of human and physical capital, and deteriorating business activity. Iraq shows a fairly high level of gross national income per capita compared with some other countries (Figure 8).

![Comparison of the gross national income per capita in a number of countries](image-url)

Figure 8. Comparison of the gross national income per capita in a number of countries, in US dollars [5].
According to recent World Bank data for 2019, Iraq’s gross national income per capita was 4545 USD per year (378.75 USD per month). For comparison, in Sweden, this figure was 43,998 USD (3666.5) and, in Germany, 39,093 USD (3257.75). In the Euro area, this figure was 4545 USD per year (378.75 USD per month). For comparison, in Sweden, this figure (Figure 10).

Iraq also has one of the highest unemployment rates among the considered states (Figure 9).

![Comparison of the unemployment rates in a number of countries](image)

**Figure 9.** Comparison of the unemployment rates in a number of countries, % [5].

According to the World Bank, in 2020, the unemployment rate (as a percentage of the total population) in Iraq was 13.7%. For comparison, in Sweden, this figure was 8.4%, 4.3% in Germany, and 8.2% in the Euro area.

Iraq’s economy also suffers from a lack of profound reforms, which may lead to increased difficulties in achieving sustainable and fair growth and maintaining the standard of living in the near future. Frequent conflicts in an expectedly unstable resource economy impede sustainable prosperity. The recent conflicts in Iraq have resulted in heavy economic and social costs. In 2018, GDP per capita in the country was about 18–21% lower than it would have been if not for the conflict that began in 2014 [5].

Two-thirds of the Iraqi economy is funded by oil production. According to various estimates, Iraq has approximately 141 billion barrels of oil, which makes it one of the largest reserves in the world [18]. The existing oil fields are widely dispersed throughout the fields in the south of the country and are currently the most productive ones. Iraq also possesses significant gas reserves, usually accompanying oil reserves. A significant amount of this gas is unused, but can be exported or used to provide a significant and sustainable source of energy for the production of electricity, helping to develop a new manufacturing industry.

According to the 2020 Statistical Review of World Energy, the total proven gas reserves were estimated at 125 trillion cubic feet or 6923 trillion cubic meters, which is about 2% of the world’s total natural gas reserves. This makes the country rank 12th place in the world (Figure 10).

Figure 3 shows that Iraq holds 1.6% of the world’s gas reserves. Iraq’s proven reserves are 1194.7 times its annual consumption. This means that the country has approximately 1195 years of gas remaining (at current consumption levels and excluding unproved reserves) (Figure 11).
Figure 10. Share of the Iraq’s proven gas reserves of total global reserves of natural gas in 2020, % [36].

As we can see, the proven gas reserves are very large, but their production is impossible at present. This is due to an underdeveloped infrastructure; therefore, the development of the Iraqi gas industry necessitates the expansion of the gas infrastructure. It is advisable
that geological exploration occurs in parallel with the development of the appropriate infrastructure, i.e., the main and distribution gas pipelines, as well as underground gas storage facilities. The largest number of new gas pipelines will be laid in the northwest and in the center of the country, where the most promising fields are located. Investments should ensure the transportation of natural gas to consumers. In addition, gas distribution pipelines are critical to allow for the distribution of gas from fields. The gas industry can have a heavy impact on the general development of the territory’s infrastructure. At the same time, new trends be considered when developing the infrastructure, particularly trends related to digital technologies [37].

It should also be noted that, where the construction of gas pipelines is impractical, installations for liquefying gas may be constructed to transport CNG in cryogenic tanks. In this way, the development of the gas industry provides an opportunity to modernize the gas infrastructure and logistics of gas supplies. This expansion is an important factor supporting the sustainable development of Iraq’s territories, by contributing to socio-economic development and meeting the current and future demand for natural gas.

It is important to improve the quality and safety of citizens’ lives in the territory in which investments are made, as well as increase the income of the local government. The development of the gas industry affects the development of the economy at three levels: through direct impacts (job creation, income from mining), indirect impacts on sectors serving the gas-production sector (jobs, income from work, and income from mining), and “downstream impact” (on consumers, through the reduced consumption of natural gas).

4.2. How the Territory Will Benefit

Direct economic benefits for the territory can also be identified. The analysis clearly shows that the presence of a gas mine, gas pipeline or underground gas storage contributes to an increase in the well-being of the local community, since the average income of those living in the area is usually several percentage points higher than in other, similar regions without this infrastructure. Expanding this infrastructure also contributes to the creation of new jobs, which is absolutely better for the residents. The exploration and production of gas will create new jobs in the exploration, extraction, production, and distribution of this feedstock.

Additional jobs will be indirectly created in companies providing services to the shale gas sector. Even if new gas infrastructure-related employment conditions are created for professionals from other regions of the country, they will also provide an “added value” to the catering and hospitality sector, since, as these services are used, they will be further developed. New jobs will naturally be created in these industries, in accordance with the industry trends.

The development of the gas pipeline network can not only improve the investment attractiveness of the territory, but also the national energy security. From the perspective of residents, investing in the expansion of the gas network will allow for connections to this network and conclude gas consumption agreements. Therefore, an increase in gas supply to certain regions of the country will be conducive to improvements in quality of life.

Investments in gas infrastructure are associated with certain inconveniences to residents. This is why mutual understanding and cooperation are so crucial. It is in the interests of energy companies to build the best possible relationships with residents and ensure their long term interests, thus contributing to the sustainable development of the region. Gas resources are a major driver for the development of the gas industry, which will ultimately provide specific economic benefits to the municipalities in which the gas infrastructure will be developed, and provide residents with access to cheaper gas, increasing their competitive advantage compared to other regions in the country. It is necessary to look for ways to sustainably develop the territory. At the same time, international experience in the development of unique and complex territories should be analyzed [38–40]. It is important to consider the system of environmental, socio-economic and innovation indicators [41], to assess the risks of projects [42].
The expansion of the gas infrastructure and the consequent increase in the country’s gas supply will improve national energy security and contribute to the development of an integrated energy market. The prospects for the development of the natural gas sector in Iraq, particularly in the context of the possible development of unconventional deposits, mean that developing a gas infrastructure so that it can meet the challenges associated with both increased production and the growing demand for gas should be a priority. Undoubtedly, the Iraqi gas infrastructure requires significant investment costs. These will contribute to both the expansion of gas systems, and the modernization of existing gas pipelines. Significant areas of the country are currently deprived of access to gas networks, and the existing infrastructure only allows natural gas to be imported into Iraq from the east. Therefore, in the coming years, energy companies in the gas sector will have to start a series of investments aimed at significantly expanding the gas system.

Thanks to technological progress, the construction of gas pipelines is not very time-consuming or difficult. The most complex and time-consuming step in infrastructure investments is currently the formal and legal procedures, i.e., the stage preceding the construction work. It should be highlighted that the gas infrastructure aims to meet the needs of local communities and contributes to the acceleration of the national economy. Therefore, investments in the development of gas networks should be classified as public investments, which would justify restrictions of individuals’ rights, if necessary.

4.3. Development of the Contract System

The natural gas service sector, including local and international companies, should be encouraged through investment contracts [43] that are acceptable to all investors, namely, profit-sharing in service contracts and production-sharing contracts so that more international companies are present in Iraq.

The authors propose considering the conversion of existing oil and gas contracts into service contracts as a priority in the development of the Iraqi gas industry. Service contracts will allow the investor some discretion: under previous contracts, profits were distributed on the basis of the declared discrete value, and the use of service contracts implies the use of ad valorem rates (i.e., rates per cent) of the initial values. This approach is more economically feasible, since its use in concluding contracts for the development of oil and gas fields will allow for higher revenues to be reached while reducing production costs at the national level. When selling a given volume of commercial gas for a certain period of time, the company will receive 100% of the sales revenue.

The investment process could be significantly accelerated if even relatively small changes were introduced, particularly in relation to the administrative procedures related to obtaining environmental decisions. The proposed changes may include clarifications and limitations to the reported environmental impact of the project, clarification of the deadline for the administrative procedures before a decision is issued on the state of the environment, or restriction of the rights of environmental organizations. In addition, it seems reasonable to authorize the investor to simultaneously submit applications for decisions on environmental conditions and decisions on development conditions and land development. It is advisable to study developments in the field of innovative environmental strategies [44].

4.4. Strategic Management of the Oil and Gas Industry

A methodical approach is proposed, which allows for the most rational strategy for the development of the gas industry to be chosen. For Iraq, at this stage, the study proposes the optimal strategy, which aims to invest in associated gas, which can independently fully meet the needs of the Iraqi industry regarding this type of resource, and refusing to import gas from abroad.

In terms of the innovation development strategy, the Iraqi oil and gas industry may benefit from the transformation of gas into liquids. To obtain a competitive advantage, Iraq needs to use the huge reserves of the Norther field. In this context, the process of converting natural gas to liquid fuels contains environmental advantages. Liquid petroleum has low
concentrations of sulfur and aromatics and a high octane rating. Proponents of gas-to-liquids emphasize that this approach is an excellent diversification strategy, as liquids require no additional investment in infrastructure, while liquefied natural gas requires the provision of specialized tankers, the processing of liquefied natural gas into conventional gas and the provision of storage.

5. Conclusions

The studies show that Iraq will lose 6% of its national total revenue if it does not invest in associated gas and depends on gas that is imported from abroad, while investments in associated gas will increase government revenue by 5%. It is worth noting that Iraq produces more than 4 million barrels of oil per day and flares more than 55% of its associated petroleum gas. The below analytical data can also confirm the economic feasibility of investments in associated gas. Natural gas is imported to Iraq from abroad (to generate electricity) at a price of 245–350 US dollars per thousand m$^3$, while obtaining natural gas from associated petroleum gas costs the Iraqi government 35–105 US dollars per thousand m$^3$. The conclusions follow from these calculations.

1. It is necessary to continue to expand oil exploration to increase oil reserves, and increase the oil output and associated gas output within the limits of OPEC oil production; oil reserves can be increased through the development of fields in all regions of Iraq.

2. It is necessary to continue joint projects with major international gas companies to increase the exploration and development of free gas to meet local demand and export opportunities for gas, as well as the possibility of developing natural gas in the western region of Iraq.

3. An increase in production gas and its derivatives will promote the development of relevant clean energy-intensive industries, with a preference for investment in private and joint sectors.

4. The natural gas system, pricing of household gas and gas for transportation should be properly developed.

5. Petrochemical plants should mainly be developed to meet local needs and other export-oriented industries; export-oriented industries such as petrochemicals and others must be in an area close to Basra due to its ports, geographic location and infrastructure size.

6. The natural gas service sector, including local and international companies, should be encouraged through investment contracts that are most acceptable to all investors, namely profit-sharing in service contracts and production-sharing contracts, so that more international companies are present in Iraq.

Since most of Iraq’s natural gas is associated with oil, periods of weak oil demand and tight OPEC quotas have hampered the development of many gas-dependent industries. Since Iraq cannot ensure economic growth based only on the level of its domestic market demand, the country’s focus on gas exports can be considered an available future option.

The study is limited by a number of factors, such as the lack of actual data on the development of the oil and gas industry in the last two years, which did not allow for consideration of the impact of the pandemic on the activities of the oil and gas industry. It is advisable to consider the possibility of adjusting the proposed recommendations, considering the latest changes in Iraq’s economy, as a future research area. To this effect, it is recommended to further refine the strategy within the framework of the methodological approach discussed in the article, according to the reverse and second direct processes.

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