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The Economic Viability of Associated Gas Investment in Iraq During the period (2012-2021)

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Abstract:

Purpose: Examine the feasibility of investing in and processing associated gas and the impact of increased investment in flaring associated gas on the Iraqi economy, in addition to knowing the quantities of gas produced, invested and burned in Iraq Also calculating the costs that Iraq loses due to gas flaring During the research period (2012-2021).

Theoretical framework: The research addresses the feasibility of investing in associated gas from oil and its impact on the Iraqi economy, given its abundant availability. The research problem revolves around whether Iraq can achieve self-sufficiency in gas production and whether it can reach the status of a natural gas exporting country in the coming years, as the Iraqi government aspires to achieve as soon as possible.

Design/methodology/approach: The available data on associated gas in Iraq during the period (2012-2021) were used to determine the volume of gas production, the amount burned, the volume of investment, and the material losses resulting from its burning.

Findings: The results show the importance of investing in gas in Iraq, as it represents an important resource that can be used to achieve self-sufficiency in energy, as gas represents a raw material for many industries such as petrochemicals, fertilizers, and others...

Research, Practical & Social implications: Iraq primarily relies on two main sources for its energy use و oil and natural gas, due to their abundant availability. Through these sources, electrical energy is generated, which is the main driver for all vital installations in Iraq.

Originality/value: We propose a future research agenda and highlight investment in associated gas and its impact on the Iraqi economy, in addition to providing realistic recommendations aimed at investing in associated gas, achieving economic goals, and reaching the appropriate global position considering the availability of this important resource.

Keywords: Associated gas, Gas investment, Natural gas, Renewable energy, Oil
JEL Classification: M10, M12, M15, M19.

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1. Introduction:

Fossil fuels especially oil and gas, constitute the majority of supplies to meet the increasing demand for energy, Fossil fuels are the world's primary source of energy generation Natural gas and oil are projected to satisfy a significant share of the global energy demand in 2040 (Saleh, 2016) ; (Vora et al., 2021) ; (Prasad et al., 2023). Although the renewable energy market is expanding, oil and gas will likely be a significant part of the energy infrastructure for the foreseeable future (Lee et al., 2022). As oil and gas drive the global economy, and in the absence of better alternatives, demand is expected to grow exponentially in the coming years (Niyazbekova et al., 2021). Crude oil and natural gas are components of petroleum in its liquid and gaseous forms (Sakib, 2021). It is the United States the world's largest natural gas producer, approximately 1.03 trillion cubic feet of natural gas was produced in 2019 (Pozzer et al., 2020) ; (Allen et al., 2021). At the international level, oil and gas companies have survived with poor demand and low prices, lately oil and gas prices have gone down, which could be a restriction to invest in the field (Jianu & Jianu, 2018). Global crash in prices slowed oil and gas production in 2015. Production surged again in the last several years (Kassotis et al., 2020). In the US, natural gas prices are low because the rapid growth of shale gas production has reduced imports, in Asia, historically high prices are weakening, Links to oil prices are looser because of uncertainty about demand (Mitchell et al., 2015). In January 2020, oil prices declined as the COVID-19 pandemic triggered a global slowdown in oil and natural gas consumption (Lyon et al., 2021). Petroleum deposits often have a gaseous component, commonly called Associated Petroleum Gas (APG) consisting mainly of methane and other short-chain hydrocarbons (Ali, 2020). Over the past years, the main issue of associated gas from oil has been widely discussed around the world. Associated gas can be both a valuable and hazardous material (Lipanov et al., 2020). Despite the importance of the gas associated with oil, it is considered a dangerous substance that pollutes the environment. For example, oil exploration, production, refining, and the spillage of part of the crude oil lead to the release of various organic and inorganic pollutants (Naithel & Al-Dakhili. M. O, 2016). The production of oil and natural gas is also associated with emissions of NOx and other air pollutants like volatile organic compounds and air toxics (Dix et al., 2020). In the United States, in 2017, more than half of gas production came from shale gas plays or was produced as associated gas from tight oil plays (Boak & Kleinberg, 2020). Irrational flaring of associated petroleum gas (APG) remains a big issue for oil industry. About 150 billion cubic meters of APG are burned annually in the world (Drozdov et al., 2021). Associated gas is found in fields or oil wells and is naturally or concurrently associated with oil when it is extracted, it appears in the form of wet gas, which contains a high percentage of moisture, and consists of a small amount of hydrogen sulfide gas, carbon dioxide, and other gases (Abdel Reda & Ahmed, 2018). A large proportion of natural gas comes associated with crude oil, and the necessary infrastructure to utilize these resources has become technologically different (Yaqoub & Abdul_Hussein, 2022). Associated gas is found dissolved in crude oil within oil reservoirs, where it is referred to as dissolved gas. When the oil is brought to the surface, the pressures it is subjected to within the earth decrease, and the gases are released, thus it is called associated gas (Ziara & Muhammad, 2016). Global flaring and venting of petroleum–associated gas is a significant source of greenhouse gas emissions and airborne contaminants that has proven difficult to mitigate over the years (Baker, 2018). Considering that associated gas in Iraq is rich in ethane, progress in its exploration and production could also contribute to a significant

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increase in petrochemical production, The methods Iraq uses to extract and use its gas will determine the overall process of reform and modernization (Semenova & Al-Dirawi, 2022). Associated gas constitutes the main source of natural gas, and it is the gas that cannot be controlled in its production since it accompanies the production of crude oil (Al-Jourani & Al-Abadi, 2024). The research addresses the feasibility of investing in associated gas from oil and its impact on the Iraqi economy, given its abundant availability. The research problem revolves around whether Iraq can achieve self-sufficiency in gas production and whether it can reach the status of a natural gas exporting country in the coming years, as the Iraqi government aspires to achieve as soon as possible. The importance of the study lies in its focus on evaluating the feasibility of investing in associated gas and its impact on the Iraqi economy. The aim is to gain a deeper understanding of the nature of investing in associated gas instead of flaring it, which causes environmental pollution, regional warming, diseases, and other negative effects. This, in turn, affects the overall economic movement. Optimally investing in both associated and free gas significantly contributes to achieving economic stability. The research aims to examine the feasibility of investing in and processing associated gas and the impact of increased investment in flaring associated gas on the Iraqi economy.

2. Literature Review and Hypothesis Development:

The results of the study conducted by (Hamed, 2016) indicate that flaring associated gas in Iraq reduces the risk of environmental pollution by 21%. However, it is not the best option. The best approach is to invest in utilizing it for energy production and chemical industries. The results of the study conducted by (Abdel-Aali & Dhuwai, 2017) indicated that natural gas in Iraq is divided into three main types: the first type is associated natural gas, which accounts for 71% and is associated with oil production in oil. The second type is free natural gas, which constitutes 19%, with its most prominent fields being Khormor, Jambur, Khusham Al-Ahmar, Jereybeka, Mansouriya, and Akkas. The third type is gas caps, which make up 10%, with the majority, around 90%, located in the oil fields in Maysan, Diyala, Hassan, and Jambur. The remaining 10% is found in gas fields in central Iraq, with natural gas exporting fields in the Sahnot field in Basra Governorate. (Jawda & Jaafar, 2018) indicate that Iraq's lack of appropriate technologies and equipment leads to the flaring of associated gas, resulting in significant pollution that affects various environmental elements in Iraq due to the large amounts of carbon oxides and other compounds emitted. A study indicated (Al-Saadi, 2020) Iraq has a total proven natural gas reserves of 7126 trillion cubic feet, but that the production volume of natural gas is 21853 million cubic meters, due to the percentage of waste and burning Which has reached 70% of the gas associated with the extraction of oil. In a study conducted by (Semenova & Al-Dirawi, 2022) entitled Economic Development of the Iraqi Gas Sector in Conjunction with the Oil Industry, The results indicated that Iraq consumes 93,344 million cubic feet of natural gas annually, and that Iraq produces 885,029.22 million cubic feet of natural gas annually (as of 2015) and ranks 33rd globally. The Washington Institute for Near East Policy indicates that losses resulting from the burning of natural gas in Iraq amount to $2.5 billion annually, it burns 10 times more gas than it imports, The Ministry of Electricity also stated that 85% of the country's power plants depend on natural gas. Iraq imports 40 million cubic feet daily. While it burns 30 million cubic feet per day, without counting the burning of free gas. The Ministry of Oil indicates that the quantities of associated gas produced reach 2,700 million standard cubic feet per day, of which the amount used is 1,500 million cubic feet per day. According to the National Oil Company, the value of gas burned for the period (2011-2015) amounted to 15 billion dollars (Al-Musawi, 2023). In their study titled "Investment in Associated Gas in Dhi Qar Governorate," (Al-Abadi & Al-Rikabi, 2023) highlighted the investment in associated gas and its development prospects. The study found that associated gas occupies an important position among global energy sources, as it represents the cornerstone and primary driver of the production process for the overall international economies.

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The study by (Hameed & Mohammed, 2023) indicates that Iraq ranks low among the countries that invest in and refine associated gas, and that Iraq relies solely on the production and export of crude oil. The study by (Abdel Kazem & Masokhor, 2024) indicates that Iraq relies on the production and export of oil for its economic resources, which is one of the fossil energy sources subject to depletion. Additionally, oil is one of the major environmental pollutants, both in terms of the extraction methods and the processes involved, as well as its usage after refining. The same applies to the flaring of associated gas, which causes pollution and environmental damage.

The research assumes that there is economic feasibility in investing in associated gas in Iraq, considering activating the oil investment policy, to achieve economic and social benefits that contribute to developing the economy.

3. Research Methodology:

This study followed the descriptive-analytical approach to assess the economic feasibility of investing in gas associated with oil in Iraq. The economic feasibility of associated gas investment in Iraq is a complex issue influenced by various economic, political, and technical factors. A robust methodology is necessary to assess these investments' potential returns and risks. This study differed from previous studies and literature; these current methodologies fill the research gap theoretically by anticipating what will become of gas separation processes**.**

For Future Foresight, the study identified the main factors affecting the associated gas investment, identifying the risks and economic costs resulting from the losses realized from the burning process**.**

Government data, statistics, and the attached table were used in the paragraphs of this study to derive the analysis and extract the study's results.

3.1 Research Tools:

The researchers relied on the use of the descriptive analytical approach to prove or disprove the research hypothesis based on the available data on associated gas in Iraq during the research period (2012-2021)

4. Results:

Iraq has significant reserves of natural gas, both free gas and associated gas from oil production. Free natural gas accounts for about 17%, while the associated gas constitutes 83% of the gas reserves. Geographically, 60% of the associated gas reserves are in southern Iraq, while 40% are found in central and northern Iraq. The regions with natural free gas fields are also present. Table (1) show the quantity of Iraqi natural gas reserves and its contribution to global reserves:

Table 1: show the quantity of Iraqi natural gas reserves and its contribution to global reserves during the period (2012-2021).

Years	Iraqi reserves (billion cubic meters)	Global reserve (billion cubic metres)	Ratio of Iraqi reserves to global reserves %
2012	3694	194891	1.89
2013	3980	196613	2.02
2014	3694	195905	1.88
2015	3694	196923	1.87
2016	3820	195892	1.95
2017	3744	197196	1.90
2018	3820	201651	1.89
2019	3820	205022	1.86
2020	3820	207197	1.84
2021	3714	206627	1.80

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Source : Prepared by the researcher based on the annual statistical reports of the Organization of Arab Petroleum Exporting Countries (OAPEC) for several years

Iraq's natural gas reserves were 3,170 billion cubic meters in 2008, rising to 3,694 billion cubic meters in 2012, and reaching 3,820 billion cubic meters in 2020. The highest proportion of Iraq's natural gas reserves to global reserves was recorded in 2016 at 1.95%. These increases in gas reserves are due to the intensification of exploration activities and field development resulting from licensing rounds, which in turn increased Iraq's contribution to global gas reserves. It is noted that gas reserves have followed a relatively stable upward trend due to the initiation of development and research work during the licensing rounds in the oil and gas sectors. Since the majority of Iraq's production is associated gas, it is linked with oil production and the discovery of new oil and gas wells. Therefore, the increase in gas reserves and the production of associated gas is due to the discovery of new natural gas areas and the exploration and development of oil wells, thereby increasing the proportion of Iraq's gas reserves in the global reserves. The production of associated natural gas began with the onset of oil production in Iraq. Initially, this gas was flared for disposal as the oil investment companies, which had a monopoly, claimed the lack of necessary technology to utilize this gas. They also argued against its utilization to prevent the emergence of a competitor to oil, which could potentially lower oil prices. However, in the 1970s, when the government took control of the oil sector and increased its focus on oil resources, there was slow development in production due to the circumstances Iraq faced and the damage inflicted on the Southern Gas Complex and gas compression stations during the 2003 events, leading to a decline in production capacity compared to previous levels. After signing the licensing round contracts aimed at improving the oil sector and increasing production rates, natural gas production increased alongside oil production. However, this was accompanied by an increase in flaring associated gas. Despite efforts to stop gas flaring, according to the World Bank's Zero Routine Flaring (ZRF) initiative launched in 2015.

which mandates oil-producing governments and companies to completely eliminate gas flaring by 2030 to protect the environment and climate and reduce carbon emissions, this has become a priority in government policy. The goal is to invest in gas to achieve self-sufficiency, reduce energy imports, and enhance energy security in Iraq.

Figure (1) shows the Iraqi natural gas reserves during the research period (2012-2021), where in 2013 Iraq achieved the highest amount of natural gas reserves, amounting to about (3980) billion cubic meters. While Iraq achieved the lowest amount of reserves during the years (2014-2015), amounting to (3694) billion cubic meters respectively.

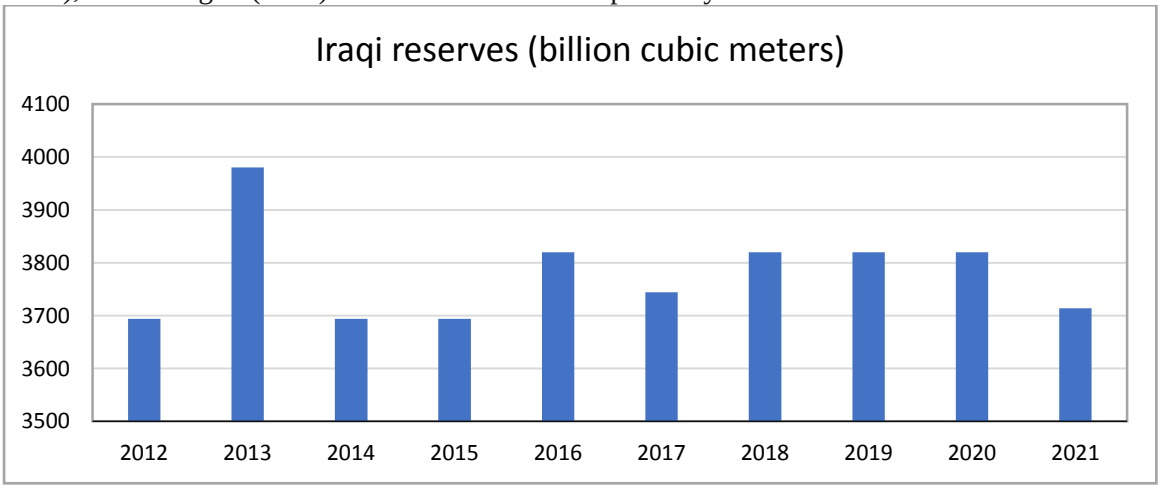

Figure (1) Iraq's natural gas reserves for the period (2012-2021)

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The following table (2) illustrates the quantities of gas produced, consumed, and flared :

Table 2: Quantity of gas produced, consumed, and burned during the period (2012-2021)

Years	Product Million cubic meters/day	Consumer Million cubic meters/day	Burnt Million cubic meters/day	Percentage of associated gas burned %
2012	20496	8520	11976	%58
2013	21386	8954	12432	%58
2014	22364	8981	13383	%60
2015	24513	8851	15662	%64
2016	29326	11612	17714	%60
2017	29870	13231	16639	%56
2018	31358	14522	16834	%54
2019	32699	15453	17258	%53
2020	28738	14812	14173	%48
2021	30275	15737	14548	%48

Source: Iraqi Statistical Collection (2022), Ministry of Planning, Iraq.

* The unit of measurement is one million standard cubic feet per day/mqm

* The percentage burned was calculated by dividing the amount of gas burned by the amount of gas produced and multiplying it by 100%.

It is observed that with the increase in extracted gas production and gas consumption, the amount of flared gas also increases, especially in recent years. In 2015, the highest percentage of flared gas was recorded. After this year, there was a gradual decrease in the flaring percentage despite an increase in production and consumption rates. The highest production level was reached in 2019, amounting to 32,699 million cubic meters, with a corresponding increase in flaring, reaching 17,258 million cubic meters, which is 53% of the total. Gas production then decreased in 2020 to 28,738 million cubic meters, and consumption decreased to 14,812 million cubic meters for the same year due to the COVID-19 pandemic. The flaring of associated gas significantly dropped to 14,173 million cubic meters, which is 48% of the flared gas. In 2021, production increased to 30,275 million cubic meters with a consumption rate of 15,737 million cubic meters due to increased use of gas in several fields. The amount of flared gas slightly decreased to 14,548 million cubic meters, maintaining the same flaring percentage of 48%, reflecting efforts to reduce gas flaring. The flaring of gas negatively impacts economic activity by deteriorating financial and economic conditions in general. This causes a shortage in energy levels, as is the case in Iraq, leading to the necessity of importing energy from neighboring countries, especially Iran, to cover the deficit. This results in the outflow of hard currency and places Iraq under the terms and conditions of the exporting country, causing a general increase in energy prices and significant economic losses for the government. The rising cost of energy importation creates pressure on the economic sector and a financial burden on the budget, in addition to the additional costs associated with addressing the environmental impacts of gas flaring, particularly water and air pollution and the health of living organisms. There are also financial costs in the health sector due to the diseases caused by pollution from gas flaring, especially affecting workers in the oil sector.

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Table 3: Material losses resulting from burning gas for the period (2012-2021)

Years	Quantity of thermal units of gas burned	Value of burned gas
2012	423.779	1542.556
2013	439.915	1601.290
2014	473.566	1723.783
2015	554.210	1522.557
2016	626.822	2281.633
2017	588.782	2143.169
2018	595.682	2168.285
2019	610.686	2222.898
2020	501.521	1825.538
2021	514.791	1873.840

Source: Prepared by the researcher based on the amount of gas burned annually.

• The number of thermal units was calculated by dividing the amount of gas burned by (28.26) cubic meters of gas, to give one million thermal units.

From Table (3), the number of thermal units from flared gas has increased over time due to the rise in oil production, leading to an increase in the volume of gas flaring. It reached its peak in 2016, with 626.822 thermal units valued at $2,281.633. Subsequently, the volume of flaring decreased in the following years due to efforts to reduce flaring, despite the increase in gas production. However, the flaring volume rose again in 2019 to 610.686 thermal units valued at $2,222.898. This increase was due to the rise in gas production. In 2020, the flaring volume declined to 501.521 thermal units valued at $1,825.538 due to the reduction in production caused by the COVID-19 pandemic and the economic contraction. In 2021, the flaring volume slightly increased to 514.791 thermal units valued at $1,873.840. These losses result in the wastage of millions of dollars, which could have added significant revenues to the general budget.

Iraq's gas has been and continues to be flared in large quantities. It is imperative to start contracting with foreign companies and leveraging international expertise to develop gas fields, reduce flaring, and increase national production. These contracts should have been executed in parallel with the first licensing rounds for developing oil fields. This approach would place Iraq in a better position, securing a distinguished place in the global gas markets. Iraq could have supplied Europe with gas through pipelines while achieving self-sufficiency by providing fuel for all power plants that currently rely on imported gas.

Although this step has been delayed due to political and security reasons and poor planning in managing oil and gas resources, the government aims to achieve it by the end of 2025. The focus is on developing the investment in associated gas because of its economic benefits. It might become an alternative to oil in the future, given the ongoing negotiations, consultations, and contracts with well-known international companies to develop all gas fields. Additionally, the establishment of gas separation plants and the increase in national gas production will enhance the economic returns. Iraq has large reserves and a promising future in the energy market through the optimal investment of these resources.

Accordingly, the investment in associated gas is viewed from three perspectives: the first is economic, providing resources and income to the state budget of about 2.5 billion dollars annually. The second perspective is social, as it would create many jobs for the unemployed if gas processing plants are established. The third perspective is environmental, considering the amount of carbon emitted into the atmosphere, estimated by Al-Khalifa at around 150 million tons. Flaring pollutes the air and warms the region, particularly the southern areas. The Integrated National Energy Strategy up to 2030 assumes that regional markets will be available for dry gas as much as Iraq produces, provided that the infrastructure is available and supplies can be ensured. The expected gas deficit in the Middle East region by 2030 will reach

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approximately 182 billion cubic meters, meaning that Iraq's future natural gas production will find export markets to absorb its products.

Iraq's current need for imported gas is 40 million cubic meters per day, equivalent to 1766 million standard cubic feet per day (MMSCFD). Current gas projects include the Nasiriyah Gas Investment Project with a capacity of 200 MMSCFD, the Halfaya Field Investment Project with a capacity of 300 MMSCFD, the Artawi Field Project in Basra Gas Company with a capacity of 400 MMSCFD, and the Artawi Field Project in South Gas Company with a capacity of 300 MMSCFD. Once these projects are completed, their combined production is expected to reach 1200 MMSCFD, achieving 80% of the country's self-sufficiency in gas.

Additionally, if the French company Total completes its project, it is anticipated to invest 600 MMSCFD, which will meet all local gas needs and cease imports from abroad. Furthermore, the investment in Mansuriya Gas with a capacity of 282 MMSCFD and Akkas Gas with a capacity of 388 MMSCFD will result in an export surplus of 670 MMSCFD, or 19 million cubic meters per day. This figure will increase with the investment in the Khashm Ahmar and Injana fields in Diyala, which have been allocated for investment under the fifth round, as well as the potential for additional associated gas investment that will rise with increased crude oil production in Iraq. Some studies indicate the presence of hundreds of high-potential oil and gas structures yet to be explored, with estimated potential gas reserves of around 332 trillion cubic feet.

Iraq can achieve self-sufficiency in gas production by launching projects to exploit associated gas, including a principles agreement with the French company Total to establish a complex for processing and utilizing associated gas with a capacity of 600 million standard cubic feet. Additionally, exploration projects in the Western Desert aim to increase natural gas reserves, and the development contract for the Mansuriya gas field by the Chinese company Sinopec within the sixth licensing round.

Saudi Arabia is considered one of the largest gas producing countries in the world. According to statistics in 2023, Saudi Arabia ranks sixth in the world with a gas reserve of 8.5 trillion cubic meters. The continued investment in gas has led to a direct increase in gas production over the years. This increase in production over the past decade is the result of the growing demand for the energy sector and the petrochemical sector. The following table shows the development of gas production in Saudi Arabia :

Table 4 : Development of Saudi gas production for the period (2012-2021).

Years	Natural gas production quantity (TJ)
2012	2773332
2013	2802839
2014	2911320
2015	2984103
2016	3105160
2017	3266096
2018	3312097
2019	3357724
2020	3378668
2021	3450928

Source : World Energy Balances.

It is noted from the table that gas production in Saudi Arabia has gradually developed from 2012 to 2021, and reached its highest level in 2021 at (3,450,928) terajoules due to the increase in investment in natural gas, thus increasing production as a result of the increase in demand for it to enter into many industries due to its great importance as a fuel or raw material, especially in the petrochemical industry. Since the petrochemical sector is of great importance and in line with the increase in gas production, several petrochemical companies were established, the most important of which is the Saudi Basic Industries Corporation (SABIC), which is a leading

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company in the petrochemical industry, in addition to the Saudi International Petrochemical Company (SABIC), which is one of the largest manufacturing companies, and others. Lately, Aramco has entered the petrochemical sector through joint projects with the American Dow Chemical Company, where they established Sadara Chemical Company, which is considered the first and main step for Aramco in making it an integrated energy and petrochemical company on the global level. Then, Aramco acquired 70% of SABIC after taking the share of the Saudi Public Investment Fund. The decision not to waste associated gas and the feasibility of investing in it coincides with the developments that have occurred in the field of petrochemicals, and the observation of the population growth within one decade from 25.8 million people to 33.7 million people, and thus gas flaring has become expensive, so gas has become used to meet local needs primarily and thus energy generation based on burning oil has been excluded. Based on the above, without the measures taken by Saudi Arabia and the establishment of joint investments between the Saudi government and Aramco and the establishment of the main gas network system that increased gas investment in the Kingdom, it contributed to diversifying revenues, getting rid of the electricity crisis that it suffered from for many years, developing the petrochemical industry and meeting local demand.

Norway has succeeded in extracting associated gas in a typical way. It has huge resources of associated natural gas and has taken innovative and effective measures to extract and exploit it, so that the associated gas industry is considered an important part of the Norwegian economy, and it is considered the third largest producer of natural gas in the world. Norway produces associated gas during oil extraction operations, and its extraction and refining technology is considered the most advanced in the world. One of the most important distinguishing features is its strong commitment to environmental conservation. Table (5) shows the volume of Norwegian gas production.

Table 5: Natural gas production volume in Norway

Years	Natural gas production volume in Norway
2012	4248924
2013	4248924
2014	4009361
2015	4308390
2016	4285793
2017	4568252
2018	4470284
2019	4223394
2020	4104679
2021	4220714

Source : World Energy Balances.

It is noted from Table (5) that the percentage of natural gas production in Norway has increased due to the increase in gas investment and the growth in global demand for it. In 2017, the amount of natural gas production reached (4,568,252) terajoules, which is the highest production amount recorded by Norway during the period 2012-2021, while the lowest production amount reached (4,009,361) terajoules as a result of Norway being exposed to an economic shock that caused a recession, especially in the oil sector when oil prices collapsed to more than half their value and the value of the currency decreased, but in the following year, the Norwegian economy recovered and gas production began to rise again as a result of the policies followed by Norway to overcome the crisis, and production quantities continued to increase due to the increase in global demand for energy, especially natural gas, in light of global crises. Norway has also set strict and stringent laws to protect the environment and reduce the negative impacts of the oil and gas industry through barrier membrane technology and pyrolysis processes, which helped separate gas from oil in an effective manner and at the lowest cost.

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It is worth mentioning that Norway is one of the major oil producing countries and owns offshore oil fields called the continental shelf. Oil exports for promotion reached about 44% of total exports for the year 2002, amounting to 24% of the gross domestic product. It is distinguished by adopting the best practices in oil production operations in addition to its great interest in protecting the environment, as it has reduced emissions resulting from burning gas associated with oil production and has become able to reconcile between large energy production and its leadership in the field of environmental conservation.

5. Discussion of the Results

5.1 The natural gas sector in Iraq is one of the most prominent energy sectors after oil, positioning itself as a key pillar supporting economic policy. Iraq ranks twelfth globally in terms of natural gas reserves, with an estimated 132 trillion cubic feet distributed across various regions. Of Iraq's total gas reserves, 70% is associated gas produced with oil, concentrated in central and southern Iraq, while 30% is free natural gas and dome gases. Iraq flares approximately 1,399 million standard cubic feet per day (MMSCFD), which is 46% of its gas production.

5.2 possessing vast natural gas reserves, Iraq produces quantities that do not match its potential. This discrepancy is due to the frequent halts in many gas production projects caused by ongoing wars and economic sanctions, which have directly impacted production operations. Given Iraq's large gas reserves, there is a significant opportunity for the country to export surplus natural gas to global markets after achieving self-sufficiency for its various uses, such as generating electricity and serving as a raw material in petrochemical plants.

5.3 The interconnection between the production of associated gas and oil production has made it difficult to control gas production, especially in the absence of specialized facilities for gas collection, processing, and storage. Additionally.

5.4 the outdated technology and lack of alignment with the latest technological advancements contribute to the wastage of gas through flaring or venting into the atmosphere.

Iraq's natural gas reserves have shown significant growth over the years, from 3,170 billion cubic meters in 2008 to 3,820 billion cubic meters in 2020.

5.5 Despite challenges, such as the damage to infrastructure during the 2003 events and the initial flaring of associated gas due to the lack of necessary technology and monopoly of oil investment companies, the government has taken steps to improve the situation. Efforts to curb gas flaring have been in line with the World Bank's Zero Routine Flaring (ZRF) initiative launched in 2015, which mandates the elimination of gas flaring by 2030 to protect the environment and reduce carbon emissions. This initiative has become a priority in government policy.

6. Conclusion:

It has been shown that Iraq produces quantities of natural gas that are not commensurate with the huge reserves it possesses. The reason is due to the continuous halting of many gas production projects as a result of Iraq being exposed to ongoing wars, international economic sanctions, and the lack of seriousness in making decisions regarding gas investment, which has directly affected the production process. Therefore, it is important to seek to combine efforts in order to achieve maximum benefit from the available quantities of gas associated with oil production to generate electricity, and to reduce environmental pollution resulting from the process of wasting gas, whether by burning it or venting it into the atmosphere. In addition to developing a plan to rehabilitate and develop the infrastructure of existing gas projects related to natural gas processing and planning to establish other gas investment projects in order to reduce gas waste, as well as developing appropriate strategic plans to develop gas wealth and work to exploit it optimally in a way that achieves national economic growth and thus achieves sustainable development.Also, using foreign expertise specialized in optimally investing associated gas in the field of generating electricity and training national cadres to manage gas projects.

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Authors Declaration:

Conflicts of Interest: None

-We Hereby Confirm That All The Figures and Tables In The Manuscript Are Mine and Ours. Besides, The Figures and Images, which are Not Mine, Have Been Permitted Republication and Attached to The Manuscript.

- Ethical Clearance: The Research Was Approved by The Local Ethical Committee in The University.

Reference :

Abdel-Aali, A. S., & Dhuwai, A. J. (2017). The future of the energy sector in Iraq in light of the energy strategy for the period. *Gulf Economic Journal*, *33*(33), 1–50.

Abdel Kazem, R. M., & Masokhor, A. H. (2024). Iraq and opportunities for transition towards a renewable and sustainable energy system. *Altorath University College Journal*, *1*(39), 198–207.

Abdel Reda, L. S., & Ahmed, J. T. (2018). Current and future prospects for Iraqi natural gas for the period 2000-2016. *Wasit Journal for the Human Sciences*, *14*(1), 83–116.

Al-Abadi, S. A. Z., & Al-Rikabi, H. S. (2023). Associated gas investment and development prospects in Dhi Qar Governorate. *Iraqi Journal of Human, Social and Scientific Research*, *3*(8), 1021–1036.

Ali, E. (2020). Modeling of Properties and SI Engine Pollution of Associated Petroleum Gas in Iraq. *Journal of Petroleum Research and Studies*, *10*(2), 1–16.

Al-Jourani, H. A. A., & Al-Abadi, S. A. S. (2024). A geographical analysis of extractive industries in Maysan Governorate for the period . *Maysan Research Journal*, *14*(28), 507–527.

Allen, D. T., Chen, Q., & Dunn, J. B. (2021). Consistent metrics needed for quantifying methane emissions from upstream oil and gas operations. *Environmental Science & Technology Letters*, *8*(4), 345–349.

Al-Musawi, M. J. R. (2023). The regional and international importance of natural gas in Iraq (a study in geopolitics). *Al-Qadisiyah Journal of Arts and Educational Sciences*, *23*(3), 377–396.

Al-Saadi, A. M. H. (2020). Future of Natural Gas in Iraq. *Ahl Al-Bait Jurnal*, *1*(27).

Baker, S. A. (2018). The possibility of using associated gases of the khabaz oil field in supporting the production of electrical energy. *Journal of Petroleum Research and Studies*, *8*(2), 92–105.

Boak, J., & Kleinberg, R. (2020). Shale gas, tight oil, shale oil and hydraulic fracturing. In *Future Energy* (pp. 67–95). Elsevier.

Dix, B., de Bruin, J., Roosenbrand, E., Vlemmix, T., Francoeur, C., Gorchov-Negron, A., McDonald, B., Zhizhin, M., Elvidge, C., & Veefkind, P. (2020). Nitrogen oxide emissions from US oil and gas production: Recent trends and source attribution. *Geophysical Research Letters*, *47*(1), e2019GL085866.

Drozdov, A., Gorbyleva, Y., Drozdov, N., & Gorelkina, E. (2021). Perspectives of application of simultaneous water and gas injection for utilizing associated petroleum gas and enhancing oil recovery in the Arctic fields. *IOP Conference Series: Earth and Environmental Science*, *678*(1), 012039.

Hamed. H. H. (2016). Study the Process of Energy Losses Resulting From Burning Associated Gas With Oil Production in Fields of North Oil Company (Khabaz and Jambor Fields). *Diyala Journal of Engineering Sciences*, *9*(3), 1–11.

Hameed, A. M., & Mohammed, I. A. (2023). The Possibility of maximizing the benefits of the exploitation of crude oil An analytical study of the reality of the oil sector in Iraq. *Journal of Administration and Economics*, *3*.

Jawda, D. R. N. H., & Jaafar, H. N. (2018). The Developmental Effects of Oil Industry in Iraq (Developmental of Oil Industry and Ist Reflection on Environment in Iraq). *Economic Sciences*, *13*(51).

Jianu, I., & Jianu, I. (2018). The share price and investment: Current footprints for future oil and gas industry performance. *Energies*, *11*(2), 448.

Kassotis, C. D., Harkness, J. S., Vo, P. H., Vu, D. C., Hoffman, K., Cinnamon, K. M., Cornelius-Green, J. N., Vengosh, A., Lin, C.-H., & Tillitt, D. E. (2020). Endocrine disrupting activities and geochemistry of water resources associated with unconventional oil and gas activity. *Science of the Total Environment*, *748*, 142236.

Lee, J., Sorensen, C., Lemery, J., Workman, C. F., Linstadt, H., & Bazilian, M. D. (2022). Managing upstream oil and gas emissions: A public health oriented approach. *Journal of Environmental Management*, *310*, 114766.

Lipanov, A., Leschev, A., Ovcharenko, P., Delgado Sobrino, D. R., Kolesnikova, L., & Sterkhov, K. (2020). Selection of optimal modes of obtaining broad fractions of light hydrocarbons from oil-associated gas at oil production sites. *Acta Montanistica Slovaca*, *25*(1).

Lyon, D. R., Hmiel, B., Gautam, R., Omara, M., Roberts, K. A., Barkley, Z. R., Davis, K. J., Miles, N. L., Monteiro, V. C., & Richardson, S. J. (2021). Concurrent variation in oil and gas methane emissions and oil price during the COVID-19 pandemic. *Atmospheric Chemistry and Physics*, *21*(9), 6605–6626.

Mitchell, J. V, Mitchell, B., & Marcel, V. (2015). *Oil and gas mismatches: finance, investment and climate policy*. Chatham House for the Royal Institute of International Affairs.

Naithel, I. H., & Al-Dakhili. M. O. (2016). Study of Crude oil spills and gas burning of accompanied natural gas on the environment of Nasiriyah oil field southern Iraq. *University of Thi-Qar Journal of Science*, *6*(1), 52–59.

Niyazbekova, S. U., Ivanova, O. S., Suleimenova, B., Yerzhanova, S. K., & Berstembayeva, R. K. (2021). Oil and gas investment opportunities for companies in modern conditions. *Socio-Economic Systems: Paradigms for the Future*, 669–676.

Pozzer, A., Schultz, M. G., & Helmig, D. (2020). Impact of US oil and natural gas emission increases on surface ozone is most pronounced in the central United States. *Environmental Science & Technology*, *54*(19), 12423–12433.

Prasad, S. K., Sangwai, J. S., & Byun, H.-S. (2023). A review of the supercritical CO2 fluid applications for improved oil and gas production and associated carbon storage. *Journal of CO2 Utilization*, *72*, 102479.

Sakib, S. M. (2021). The impact of oil and gas development on the landscape and surface in Nigeria. *Asian Pacific Journal of Environment and Cancer*.

Saleh, H. Y. (2016). Corrosion prevention approach for gas and oil refinery Tanks. *Journal of Petroleum Research and Studies*, *6*(1).

Semenova, T., & Al-Dirawi, A. (2022). Economic Development of the Iraqi Gas Sector in Conjunction with the Oil Industry. *Energies*, *15*(7), 2306.

Vora, M., Sanni, S., & Flage, R. (2021). An environmental risk assessment framework for enhanced oil recovery solutions from offshore oil and gas industry. *Environmental Impact Assessment Review*, *88*, 106512.

Yaqoub, F. A., & Abdul_Hussein, H. A. (2022). The Historical Development of Natural Gas Extraction and Production in Iraq (Basra Governorate) as a Model. *Nasaq*, *35*(8).

Ziara, R. H., & Muhammad, N. A. (2016). Future prospects for the natural gas industry in Iraq and available investment opportunities. *Journal of Economic and Administrative Sciences*, *22*(94), 406–427.