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Assessing Gas Losses and Implementing Effective Prevention Strategies in Mining Areas of the Northern Part of Afghanistan

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Abstract

Methane gas is one of the cheapest and cleanest energy sources in the world. It is used for heating homes, generating electricity, and in various industries and manufacturers. Since the middle of the 20th century, with the rise of mechanical engineering, the development of gas exploration, production, and use of these energy sources in various areas has also increased and acquired a special position. This study focuses on the study and analysis of the problems related to gas production processes, gas losses in mining areas in the northern part of Afghanistan, and ways to prevent the occurrence of such problems. For this purpose, data on the gas production volumes and the gas waste generated technically and during consumption are collected and analyzed. In addition, different sales prices for gas to different industries and current technical methods for gas production are evaluated. The methodology of this scientific research is based on a combination of fieldwork and library research, as well as data collected through field visits to the Shakarak, Jarqadoque, Khwaja Gogerdak, and Yatim-Taq mines. The study evaluates different gas extraction methods and collects data from different layers during gas production. Gas transportation and consumption areas and sectors are also visited to collect data on consumption rates and compare them with production rates. The research highlights significant gas losses during production and distribution and highlights the need for improved engineering practices and efficient management. Implementing these measures can improve gas utilization, reduce waste, and contribute to Afghanistan's economic growth. This comprehensive approach ensures that the study provides an in-depth and reliable analysis of the gas industry and its potential for improvement.

Keywords: Natural Gas, Bottom Hole Pressure (BHP), Pipeline, Compressor, Well testing.

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1. Introduction

Methane gas is one of the most cost-effective and clean energy sources in the world. It is used for heating homes, generating electricity, and in various industrial sectors and manufacturers. Since the mid-20th century, as machine industries have grown, the use of natural gas (methane) has also increased. [5], [6], [8]

From 1960 up to now, the development of gas exploration, extraction, and use of these energy sources in different fields, has increased and gained a special position.

The northern part of Afghanistan has two oil and gas basins and is rich in large reserves of natural gas. The gas extracted from these mines is utilized in various industries, including power generation, production of chemical fertilizers for agriculture, transportation fuels, heating homes, bats, brick-making, and gypsum production plants, etc. Using these energy resources helps in electricity generation, making business opportunities, and development of industrial factories in the city of Sheberghan. In addition, it also helps reduce prices of imported energy, foods, and improves life quality of the residents of the Sheberghan city. [4], [9], [11], [13]

The northern part of Afghanistan has large gas reserves that are both explored and unexplored. A comprehensive exploration and production strategy will ensure the extraction of oil and gas and utilize it effectively. As we know, these resources can contribute to strengthening the economy of the country and ensure the independence of the energy sector. In addition, managing these resources responsibly can help to save the natural beauty of the country. This will also reduce the risk of cutting trees and destruction of forests. It requires the implementation of environmentally responsible practices and compliance with established regulations and standards in the oil and gas production sector. [1], [5], [7], [13]

In Jawzjan province, approximately 145-150 $\times 10^9$ m^3 of gas were discovered in eight gas fields, of which around 73 $\times 10^9$ m^3 were extracted. At present, around 670,000 to 700,000 m^3 of gas (0.244 $\times$ 109 m^3 per year) are extracted from the Khwaja Gogerdak, Yatimtaq, Jarqadoque, and Shakarak gas fields in 24 hours. The average annual income from these minefields for the Afghan government is about 1.2 billion Afn. However, the total income of the Ministry of Mines and Petroleum of Afghanistan is approximately 14 billion Afn per year, which represents 5% of the national budget. The natural gas (methane) produced by the Afghan Gas Enterprise is sold at various prices by the Mazar-e-Shareif Fertilizer and Electricity Plant, the Bayat Power Plant, the Afghan Compressed Natural Gas (CNG) industry, the people of Jawzjan province, and the private sector. It should be noted that a significant portion of this gas is wasted in the non-technical extraction process (well testing and water production from wells) and distribution route (no installation of gas meters at distribution points) and different selling prices. This research paper focuses on efforts to prevent these losses. [1], [9], [11]

The use of environmentally friendly and cost-effective energy sources, such as natural gas (methane) for heating homes, fueling machinery, and producing a different kind of industrial products, has gained significant attention worldwide. Methane gas has the potential to protect the environment and reduce production costs. The extraction of gas from mines in the northern part of Afghanistan, and its efficient use will help to strengthen the economy of the country and resolve the energy needs of industries. Additionally,

chemical fertilizers for agriculture can also be produced from this gas and will help to increase agricultural production in the country. According to the information of the Ministry of Commerce and Industry of Afghanistan, about 5 million tons of fuel are imported from neighboring countries annually. In addition, over $350 million of electricity is imported from neighboring countries. Whereas less than 30 % of the country's population has access to electricity. Furthermore, most industries are on the verge of bankruptcy due to a lack of essential energy. The extraction of metallic mines such as iron, copper, and construction materials has not been developed because of the scarcity of materials for energy production. Therefore, extraction, purification, and rational use of natural gas (methane) make it possible to produce a large quantity of electricity and chemical fertilizers, which will help to increase agricultural production and make us self-sufficient to some extent. Finally, the extraction and purification of methane gas will promote industrial development and will be able to create job opportunities in the country. [4], [9], [10], [12]

Exploration, technical extraction, and reasonable use of gas energy in the north of the country will contribute to strengthening and developing a favorable industry, creating enterprises, creating a balance between exports and imports, preventing monetary imbalances, and, finally, strengthening the national economic base. Strengthening the national economy will lead to political stability in the country, will reduce dissatisfaction caused by unemployment and poverty in the society, and will lead to political stability and industrial development. At present, much of the country's gas is wasted in the process of non-technical extraction, transportation, non-standard distribution, and sales at different prices. Investigation of these wastes and ways to prevent them constitutes the importance of the subject. [9], [10], [11], [15]

2. Research Literature

From 1346 to 1370, 2.5×10^9 m^3 of gas extracted from mining areas of the northern part of Afghanistan was exported to the former Soviet Union, and less than 0.5×10^9 m^3 were used in the Fertilizer and Electricity Factory of Balkh province, as well as in the city of Sheberghan.

The Jarqadoque gas field's wells were conserved after 1370, when the export of gas to the Soviet Union was stopped, and the needs of the Fertilizer and Electricity Factories were obtained through the extraction of gas from the Khwaja Gogerdak mining field. After the decrease in gas in the Khwaja Gogerdak mining field, the Jarqadoque wells were re-used. Although the flow rate from these wells was extremely low this time. Besides the Fertilizer and Electricity Factories of Balkh province, this gas was distributed to the cities of Sheberghan, Aqcha, and Khwaja Duko districts. [6]

When the gas in these two fields was low, Well No. 2 of the Shakarak gas field was put into service in 1390, which had a flow of 90,000 m^3/24 hours and rescued the abovementioned factories from collapse. [1], [5], [8], [9], [16]

At the end of 2019, when the construction plan of Bayat Power and Ghazanfar Group electricity production factory was designed, and the gas needs of Fertilizer and Electricity Factories of Balkh, and Jawzjan provinces could not be satisfied by Khwaja Gogerdak, Jarqadoque and Shakarak gas fields, gas refinery and gathering point No. 3 were built in

Yatim Taq field, worth $40 M (million US dollars). In addition, 5 more gas extraction wells were put into service in the Yatim Taq gas field (by extracting 500,000 m^3/24 hours) from the Gaterif productive layer, which currently supplies the required gas for the consumption areas.

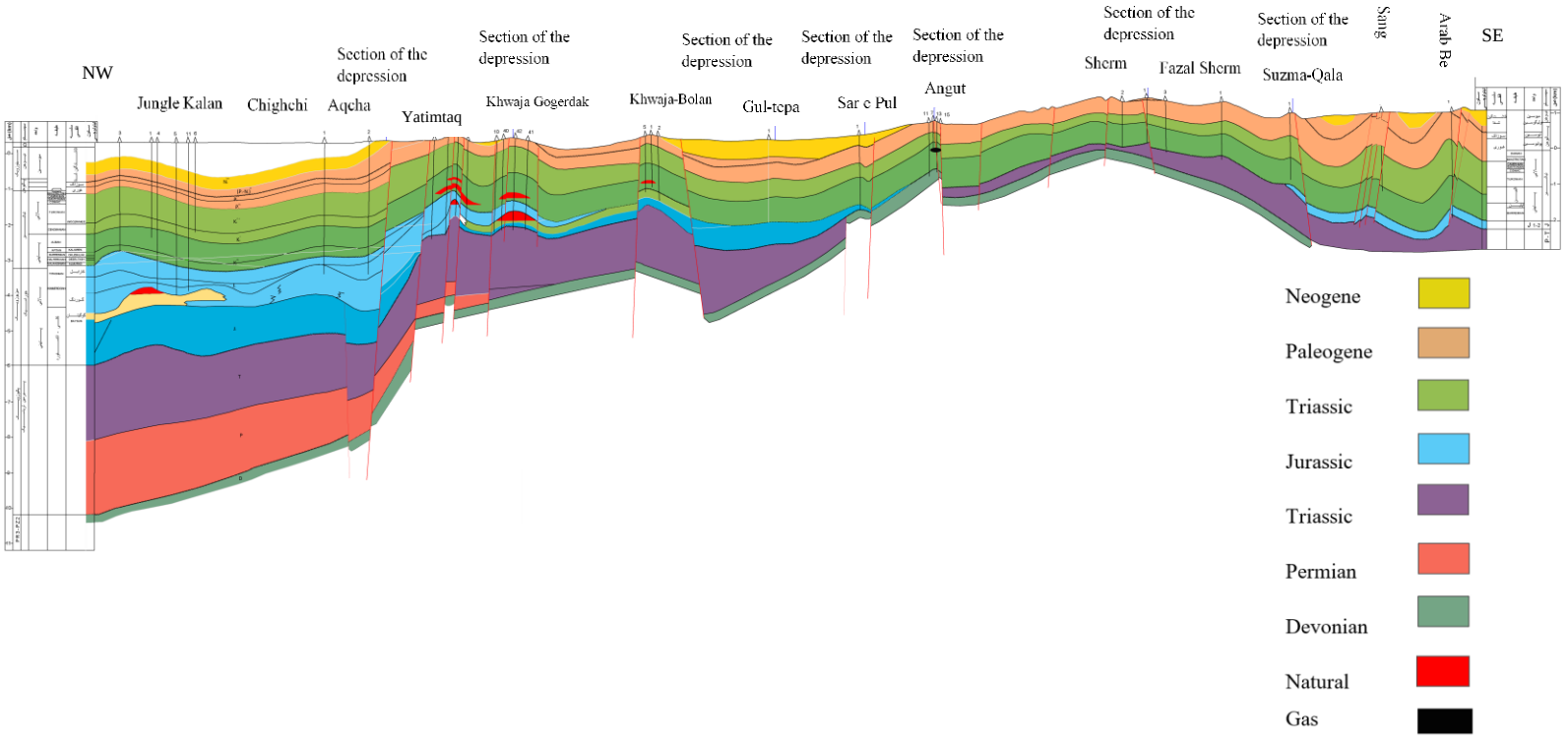


Fig. 1. Strati-graphic cross section of the northern part of Afghanistan

3. Research Methods

The methodology of this scientific research is based on a combination of fieldwork and library research, as well as data collected through field visits to Shakarak, Jarqadoque, Khwaja Gogerdak, and Yatim Taq Mines. The study assesses different gas extraction methods and collects data while extracting gas from different layers, as well as visits the gas transportation and consumption areas and sectors to collect data on its consumption rates and compare it to production rates. Based on this analysis, the study aims to identify gas waste in the distance between production and consumption and to provide reasonable methods to reduce it. Additionally, the research focuses on collecting field data on the use of non-technical gas extraction methods, evaluating gas waste resulting from technical factors in gasification and supply to production institutions, investigating revenue collection problems, and providing scientific evaluations of these issues and solutions to prevent them. Lastly, this comprehensive approach ensures that the study provides an in-depth and reliable analysis of the gas industry and its potential for improvement. [1], [4], [8], [14]

4. Research Goals:

This study focuses on the investigation and analysis of the problems associated with gas extraction processes, gas losses in mining areas of the Northern part of Afghanistan, and ways to prevent such problems. [9], [10], [11] For this, data on gas extraction amounts, and gas waste resulting from technical and gasification reasons are collected and analyzed. Additionally, different sales prices for gas to various sectors and present technical methods for gas extraction are evaluated. By addressing these research issues, this study seeks to contribute to the development of effective and sustainable gas extraction strategies to prevent gas waste and promote its reasonable use. Additionally, the following are discussed:

1. Investigating the problems and waste of gas due to non-technical extraction methods.
2. Collecting the data of the amount of gas extraction and comparing it with the amount of consumption.
3. Finding the amount of gas waste in the distance between production and consumption.
4. Collecting the amount of gas sales and its prices to different organizations.
5. Investigating the factors of gas wastes in the distribution path.
6. Analyzes of gas sales prices and standardization of sales prices to various consumer organizations.
7. Proper collection of gas revenues, ways to prevent its wastes, and its reasonable use for the development of gas production and refining processes for long-term supporting of the markets in the county. [9], [10], [11]

5. Addressing the Challenges of Gas Wastes in Mining Areas of the northern part of Afghanistan

The gas extraction process is presently being carried out from the productive layers of Gaterif of Shakarak, Aptian, Albian, and Gaterif of Jarqadoque, Gaterif of Yatim Taq, and Gaterif of Khwaja Gogerdak mining fields. Approximately 50,000 to 70,000 m^3/24 hours of sweet gas is extracted from the Shakarak mining field and transported to the Khwaja Gogerdak factory with a pipeline. Later, this gas is accompanied by gas from the mining fields of Khwaja Gogerdak and Yatim Taq and is transported to the Fertilizer and Electricity Factory of Mazar-e-Sharif, Balkh province to produce urea chemical fertilizer (agricultural white chemical fertilizer) and electricity. To date, three wells have been drilled in the Shakarak mining field, and only well No. 2 has been drilled within the gas contour. The gas of the Gaterif layer in this area is 98% pure methane and does not require refining. Approximately 350×10^6 m^3/24 hours gas has been extracted from well No. 2 since 2010. [1], [5], [9], [17]

Currently, gas extraction is taking place from four (4) mining fields in the northern part of Afghanistan, which are consist of: Over 50,000 m^3/24 hours from the Gaterif productive layer of Shakarak mining field; about 58,000 m^3/24 hours from Albian and Aptian productive layers of Jarqadoque, approximately 41,000 m^3/24 hours from Albian, Aptian and Gaterif productive layers of Khwaja Gogerdak, and finally, more than 500,000 to 570,000 m^3/24 hours from the Gaterif productive layer of the Yatim Taq mining field. From this, the Bayat Natural Gas Power Plant receives 270,000-250,000 m^3/hours of gas, while Fertilizer and Electricity Factories in Balkh province receive 350,000 - 370,000 m^3/24 hours.

Furthermore, 10,000 m^3/24 hours of methane gas are distributed from the Jarqadoque minefield, Jawzjan province by the Afghan Compressed Natural Gas (CNG) industry to the private transportation sector, 48,000 m^3/24 hours to bathrooms, bakeries, and houses in Sheberghan city, Aqcha and Khwaja-Du-Koh districts of Jawzjan province, etc. The lack of gas consumption meters in bathrooms, bakeries, houses, and other locations has resulted in approximately 16,000 m^3 of gas going unaccounted for every 24 hours. Additionally, non-technical extraction methods, gas uses for water discharge from the bottom of wells, and well-testing processes also contribute to the loss of gas.

Table 1. Amount of extracted gas in 24 hours (m3/24 hours) from Shakarak, Jarqadoque, Yatim Taq, and Khwaja Gogerdak mining areas.

No	Areas	Amount of extracted gas m3/24 hours	Total amount of extracted gas m3/24 hours
1	Shakarak	50,000-70,000	65,000-70,000
2	Jarqadoque	58,000	
3	Yatim Taq	50,000-57,000	
4	Khwaja Gogerdak	41,000	

Currently, a private entrepreneur named Sadeq Group has imported liquefied natural gas (LNG) production equipment to the country. This group has been assigned the gas fields of Shakarak and Khwaja Burhan by the Afghan Gas for Production to produce LNG. The

gas from these fields is 98% pure methane, and it does not require purification. If methane gas is converted to LNG gas, 32 tons or 53×10^3 m^3 of gas can be transported in tankers without any problem to big cities like Kabul and Jalalabad.

Importing this technology will enable big cities to obtain clean and inexpensive energy from the country's resources. In addition, the currency will not leave the country, and there will be equilibrium in the country's exports and imports. In addition, the Ministry of Mines and Petroleum has a plan to supply gas to major cities in the north of the country, such as Mazar-e-Sharif, Sheberghan, and Maimena, through a pipeline, which is considered a good and reasonable move.

Bayat Power, an electricity production factory, purchases 250,000 to 270,000 m^3 of gas from Afghan Gas Company for $15,500 (5.6 Afn/$m^3$, 9.3 Afn/kg) in 24 hours, and sells 40 MWh of electricity generated from this gas to the Breshna Company for $80,000 (7.5 Afghani/kilowatt-hours). It means that this company is making more than five times interest in this deal. On the other hand, if the Bayat Power plant fails to produce electricity due to problems, it will continue to receive its revenues from the Breshna company based on the contract. From our point of view, such contracts should be done based on international standards and it would be better to re-examine this issue.

As per the contract, Bayat Power acquires 1000 m3 of gas from the Afghan Gas Company for $78. According to the contract, a cubic meter (1 m3) of gas must produce 38.56 megajoules (38.5 MJ/m3) of energy. Due to its unrefined nature, the gas extracted from the Yatim Taq gas field produces 36.75 MJ/m3 of energy. Bayat Power only pays 62 dollars (5580) per 1000 m3. This gas is being extracted from the Gaterif productive layer (the geological reserve of Gaterif is 5.9 × 109 m3 and its extractable reserve is 5.2 × 109 m3). Bayat Power requires a gas pressure of 60 atm and a gas temperature of 38 C^o degrees.

1BTU: The amount of heat that can melt a ton of ice. 1MJ=1031 BTU

The use of Siemens equipment, which is a German enables Bayat Power to produce one megawatt (1 MW) of electricity from 7,000 m^3 of gas or 4,200 kg of methane in 24 hours. Mazar-e-Sharif Fertilizer and Electricity plant buys approximately 350,000 to 370,000 m^3 of gas per day from Afghan Gas Company (per cubic meter costs 4 Afn, and per kg 6.66 Afn). It uses 75,000 m^3 of gas to produce agricultural chemical fertilizer, and more than 275,000 m^3 of it to produce 14.5 MWh (megawatt hour) of electricity. To produce one kilowatt of electricity in 24 hours, this factory consumes about 20,000 to 21,000 m^3 of gas. Although Fertilizer and Electricity plants buy per cubic meter or (0.6 kg) of gas for four Afn from Afghan Gas Enterprise (almost for free), they still owe a B Afn to the Afghan Gas Enterprise.

On the other hand, the Mazar-e-Sharif fertilizer and power plant has already been used over six times its lifetime and is unusable in today's modern machinery. This means that the Bayat Power Factory machinery uses 7,000 m^3 of gas, while Mazar e Sharif's Fertilizer and Electricity factory uses 20,000 to 21,000 m^3 of gas to produce 1 MW of electricity in 24 hours. As a result, the Fertilizer Factory in Mazar-e-Sharif uses three times more gas than the Bayat Power Factory for the same task. Here, the use of old and obsolete

machinery is the cause of the irresponsible use of clean and cheap energy sources (natural gas). We believe that the activity of the Fertilizer and Electricity Plant of Mazar e Sharif should not be permitted to continue under the pretext that, it is a government factory and 1600 personnel work in it. The gas compression device (CNG) is capable of purifying and obtaining 18,000 to 24,000 m^3 of gas every day, but now it buys about 1000 m^3 of gas from Afghan gas enterprise (20 Afn/kg). It is distributed to cars in Sheberghan city after purifying it from hydrogen sulfide (H_2S) and compressing it. [2], [3], [4], [5], [7], [18]

Small vehicles (e.g. Corolla) can travel 18 to 20 km with one kg of natural gas (methane), but if the car's load is high or the wind is blowing against it, it can travel about 15 km with a single kg of gas. With one liter of petrol, it can travel only up to 10 kilometers. One kg of compressed natural gas was provided to 50 Afghans by the CNG engine on 30/03/2023. A Corolla car uses approximately 6 kg of compressed natural gas (CNG) for 100 km. By using 300 Afn, these cars can cover 100 kilometers using this gas. Whereas this distance is traveled with 10 liters of petroleum. If a liter of petroleum costs 70 Afn, it would cover 100 km with a consumption of 700 Afn. CNG gas consumption is less than half the amount of petroleum. It should be noted that compressed natural gas (CNG) is more environmentally friendly than petroleum. On the other hand, natural gas (methane), which is a pure gas, is better for use than LPG and petroleum. If CNG gas is used, automotive machinery will last for a long time. According to the statements above, CNG should be utilized in private transportation because it reduces environmental pollution and is more affordable than other fuels. This work can help us prevent the import of fuel from foreign countries, which will lead to economic improvement in the country. [2], [8], [10]

In addition, prudent utilization of the country's energy resources. To produce 1 megawatt of electricity, fertilizers and Electricity factories in Mazar e Sharif use 21000 m^3 of gas in 24 hours. Bayat Power uses 7000 m^3 of gas in 24 hours to produce the same amount of electricity using the equipment of Siemens, a renowned German company. Comparatively, advanced countries use new technology, they consume 4500 m^3 of gas in 24 hours generate a single megawatt of electricity generate a single megawatt of electricity. Based on the data, it is evident that the electricity production segment of the Fertilizer and Electricity Factory in Mazar-e-Sharif is significantly wasting valuable and clean natural energy sources. Consequently, we recommend an immediate suspension of its operations until new technological machinery can be implemented.

The Afghan gas company wastes approximately 16,000 m^3 or (9,600 kg) of gas in 24 hours, so it cannot collect its revenues. The reason for this waste is the absence of gas consumption meters (flow meters) in houses, bathrooms, and bakeries. Additionally, a significant amount of gas is wasted during well testing, like testing well No. 2 of Shakarak gas mine and removing water from the bottom of wells in the Khwaja Gogerdak and Jarqadoque fields.

To precisely determine the absolute free flow, the Shakarak Gas Field No. 2 well was tested for two hours. During this time, 4166 m3 of gas was discharged into the atmosphere through a choke with a specific diameter of 10 mm.

$50000/24=20.82 \times 2= 4166\ m^3$

They conducted this process for the second time under various dimeters of choke accordingly 12 mm, 14 mm, 22 mm, 24 mm, and finally 26 mm, and released about 15,000 m3 of gas into the air. To determine the proper flow rate and manage the extraction process properly, this process is repeated twice a year.

In order to extract gas from the Khwaja Gogerdak and Jarqadoque gas fields, where the extraction of gas from the Gaterif layer is almost finished and the wells have become watery, a chemical substance known as Sulfanole (H_2OS) is added to the wells so that the water turns into foam and its density decreases. This foam is then released into the atmosphere. This method makes it possible to extract gas by removing water from the bottom of the wells. Instead of conducting geophysical investigations, stabilizing wells, and banning aquifer intervals, water is taken off the bottom of wells by releasing gas into the atmosphere. By doing this, the air becomes polluted on one side and the amount of gas waste increases on the other. [2], [3], [5], [7], [19]

The Gaterif layer of the Yatim Taq gas field has a current extractable reserve of 5.3. This gas is composed of 0.43% hydrogen sulfide gas (H_2S). The newly constructed sulfur separation plant in the Yatim Taq area can purify 0.9% of hydrogen sulfide (H_2S) from the gas. There is also a plan to build another refinery facility in this area in the future, which will be capable of purifying one million 106 m3 of gas from hydrogen sulfide.

Bayat Power offers one kilowatt of electricity for 7.5 Afn to Berishna company. Bayat Power purchases 7,000 m3 of gas from Afghan Gas Company for 39,060 Afn to produce 1 megawatt (1MW) of electricity in 24 hours and sells the same amount of electricity to Breshna Company for 180,000 Afghans within 24 hours.

1 MW =1000 KW = $1000 \times 24 \times 7.5 = 180000$ Afn.

The advantages they obtain from the price they sell are 4.6 times higher.

In 2022, the revenue generated by the Ministry of Mines and Petroleum of Afghanistan was approximately 14 billion Afg or about 5% of the Afghan government's budget. Afghan Gas Company made a significant contribution to this revenue. They have received 1.2 billion Afn from gas extraction, and 3.5 billion from the extraction of oil from the Qashqari oil field.

Table 2. The amount of gas extracted from the mining fields

No	Name of the area	The amount of gas transferred to different sectors, m^3/24 hours	Debit/Amount of produced gas	Gas sales price	Electricity's selling price
1	Bayat Power Plant	250000-270000	40MW/hour	1000 m^3/62$	**7.5 Afn/ KW**
2	Mazar Sharif fertilizer and electricity factory	370000-350000	75,000 m^3 of gas to produce 108-100 Tons of chemical fertilizers 275,000 m^3 of gas to produce 14.5 MW/hour of electricity	1000 m^3/4000 Afn	**For the factory's internal use, only a small amount of gas is sold to the residents of Balkh.**
3	CNG Station	10000	10,000 m^3 supply of compressed gas	1Kg/20 Afn	**1 Kg/50 Afn**
4	Gas consumption in the private sector	48000	Baking raw bricks, bread, chalk, and cooking food	1 Kg/10 Afn	

6. Discussion

There are huge reserves of gas in the northern part of Afghanistan, and gas extraction has been ongoing since 1967 to date. From 1967 to 1991, the annual gas extraction amount of gas was approximately 3×10^9 m^3. Since 1991, when the exportation of gas to the former Soviet Union ceased (about 2.5×10^9 m^3annually), a small portion of gas extraction continues to meet the energy requirements of the Fertilizer and Electricity Plant and the residence of Sheberghan province. [1], [9], [11]

Gas extraction is currently taking place to keep the Mazar-e-Sharif Fertilizer and Electricity Factories and Bayat Power Plants running, to meet the energy needs of the private sector (bathrooms, bakeries, plaster production factories, etc.) and the needs of residents of Sheberghan City. The daily gas extraction is currently around 670,000 to 700,000 m^3 and the annual extraction is 0.255 billion m^3.

The extraction, distribution, and contracts made with the private sector have various problems and do not meet the standards. In addition, a significant amount of gas is lost because of non-technical extraction, distribution, and sale to the private sector with no meters, and the contracts that are made in favor of the private sector. For example, the 60-year-old Mazar e Sharif Fertilizer and Power plant produces 14 MWh of electricity per day from 275,000 m^3 of gas (to generate one megawatt hour of electricity in 24 hours, 210,000 m^3 or 12,600 kgs gas is required). The Bayat Power factory, which utilizes Siemens-Germany's new technology, produces 40 MWh of electricity per day with 250,000 m^3 of gas (7000 m3 or 4200 kgs of gas is required to generate the same amount of electricity). [2], [5], [6], [10]

Comparing the gas consumption in the Fertilizer and Electricity factory and Bayat Power, the Fertilizer and Electricity plant wastes about 71.54 Mm3 or 43,000 tons of gas annually because of the use of old technology. In addition, gas is sold at low prices at Fertilizer and Electricity plants in Mazar-e-Sharif, Bayat Power, and the private sector. For example, 1,000 m^3 of gas is sold to the Mazar-e-Sharif Fertilizer and Power plant for 4,000 Afn (6.6 Afn per kg). to Bayat Power for 5,580 Afn (9.3 Afn per kg), to the residents of Sheberghan city for 6,000 Afn (per kg for 10 Afn), and to production sectors (bakeries, chalk production factories, etc.) for 10,000 Afn (16.6 Afn per kg), and finally to (CNG) devices for 20 Afn per kg. The selling price of Afghan Gas Company is extremely low compared to the market price of 70 Afn per kg of gas. If there were not such a large amount of gas waste in various extraction and distribution processes and if the prices were not so low. Finally, if gas were sold for 50 Afn per kg, the Afghan Gas Company could earn revenue of seven B six hundred million and fifty-five thousand 7.6×10^9 Afn. instead of the current 1.2 B Afn from the annual gas sales. This means that the Afghan Gas Company or the government loses about $646{,}50 \times 10^7$ Afn or $218.5 million annually. If the revenues from this amount of gas were not lost, it would be easy to carry out many research, exploration, and extraction projects in the northern part of Afghanistan. [4], [5], [8], [10], [11], [20]

7. Results

The statements above can lead to the following conclusions and suggestions:

1. At present, there are around 670,000 to 700,000 m^3 of gas extracted from the gas fields, of which 58,000 m^3 is delivered to Sheberghan and its surrounding areas within 24 hours. The Bayat Power factory receives about 70,000 m^3, while the Fertilizer and Electricity factories receive 370,000 m^3, and 16,000 m^3 are wasted.
2. Afghan Gas Company sells gas to Fertilizer and Electricity plants at extremely low prices, i.e., 6.5 Afn per kg of gas, which is about 11 times cheaper than the current price of gas in the country's market. We suggest that this issue should be reconsidered.
3. The utilization of gas as a clean and affordable energy source has led to the development of industry, electricity production, business, and raising the standard of living and welfare of the residents of Jawzjan province.
4. The Fertilizer and Electricity factories' electricity production department is equipped with outdated equipment that has lasted more than seven times its lifespan, and it consumes about 21,000 m^3 of gas for one-megawatt hour of electricity. With the use of modern and new technology machinery, $5\text{-}7 \times 10^3$ m^3 gas can be used to generate this much electricity. Therefore, the activity of the electricity production department of the Fertilizer and Electricity plant of Mazar e Sharif must stop until new technological equipment is installed.
5. It is important to revise the price of selling gas to Bayat Power's electricity production factory, which costs 9.3 Afn per kg of gas. It is important to take this price seriously as it is 7.5% lower than the price of gas in the country's market.
6. The cost of gas selling to the private sector and residents of Sheberghan City, Aqcha, and Khwaja Duko districts is also exceptionally low compared to the country's market. It is our suggestion to revise these prices as well.

7. Installing meters for homes and production sectors that use this gas is essential to determine the consumption amount of each person.
8. To reduce waste and gas release into the air, it is important to use devices as much as possible during testing wells.
9. It is necessary to use a technical method to remove water from the wells, as a significant amount of gas is wasted, and the environment is polluted on the other hand. The first step in solving this problem is to identify the water-bearing interval of the wells through geophysical studies. After blocking or insulating the aqueous intervals with cement solution, the gas intervals should be drilled or perforated.

Table 3. Results of the works done in this article

Period	Daily Gas Extraction Rate	Annual Gas Extraction Rate	Usage	Gas Prices (per 1,000 m^3)	Potential Revenue	Gas Wastage Amount
1967-1991	-	3×10^9 m^3	Export to Soviet Union (2.5×10^9 m^3 annually)	-	-	-
1991-Present	670,000 - 700,000 m^3	0.255 billion m^3	Fertilizer and Electricity Plant, Sheberghan residents	Mazar-e-Sharif Fertilizer and Power: 4,000 Afn; Bayat Power: 5,580 Afn; Sheberghan residents: 6,000 Afn; Production sectors: 10,000 Afn; CNG devices: 20 Afn	7.6×10^9 Afn (potential) vs. 1.2 B Afn (current)	Non-technical extraction, distribution, and sale; old technology in plants
Mazar-e-Sharif Plant	-	-	14 MWh/day of electricity from 275,000 m^3 of gas	-	-	71.54 Mm^3 or 43,000 tons annually wasted due to old technology
Bayat Power Plant	-	-	40 MWh/day of electricity from 250,000 m^3 of gas	-	-	-
Gas Price Comparison	-	-	-	Market price: 70 Afn/kg; Potential price: 50 Afn/kg	-	-

Revenue Loss	-	-	-	-	646.5 × 10^7 Afn or $218.5 million annually	-
Gas Consumption Efficiency	-	-	Bayat Power: 7,000 m^3 of gas for 1 MW electricity; Mazar-e-Sharif: 20,000 - 21,000 m^3 of gas for 1 MW electricity	-	-	Mazar-e-Sharif uses three times more gas than Bayat Power due to old machinery
Gas Wastage Amount	-	-	-	-	-	16,000 m^3/day wastes due to lack of meters and non-technical extraction method; 15,000 m^3 releases during well testing
Revenue Contribution	-	-	Afghan Gas Company contributed 1.2 billion Afn from gas extraction to the Ministry of Mines and Petroleum's 14 billion Afn revenue in 2022	-	-	-

8. Conclusion

Natural gas is considered one of the cost-effective and cleanest energy sources and has been used increasingly since the middle of the 20th century. The northern part of Afghanistan is rich in natural gas reserves and plays a crucial role in various industries, including power generation, chemical fertilizer production, and heating industries.

The focus of this study is to analyze gas production processes, identify significant gas losses during production and distribution, and evaluate current technical methods and sales prices.

Fieldwork and data collection from the study areas highlighted the inefficiency of current production and distribution practices. The study highlighted the need for improved technical practices and efficient management to reduce gas waste and increase economic growth.

The results show that efficient extraction and use of natural gas can make a significant contribution to the Afghan economy by reducing dependence on imported energy, reducing production costs, and creating employment opportunities. In addition, the environmental benefits of using natural gas, such as reducing greenhouse gas emissions, were highlighted.

The study also found significant gas losses due to non-technical extraction methods, lack of gas consumption meters, and inefficient management practices. Addressing these challenges through modern technologies and efficient management practices is critical to maximizing the benefits of natural gas and supporting the country's economic development.

Bayat Power's contract with Afghan Gas Company highlights the economic potential of natural gas but also highlights the need for contracts to meet international standards to ensure fairness and sustainability. In contrast, the aging machinery at the Mazar-e-Sharif Fertilizer and Electricity Plant results in inefficient gas usage, highlighting the need for modernization to eliminate waste and optimize resource utilization.

In addition, the study found that advanced countries use significantly less gas compared to the outdated machines in Mazar-e-Sharif to produce the same amount of electricity. This highlights the urgent need for technological improvements to ensure judicious use of the country's energy resources. The Afghan gas company is also facing significant gas losses due to a lack of gas consumption meters and inefficient well-testing procedures. Addressing these issues is critical to reducing waste and improving revenue collection.

Finally, the study provides a comprehensive analysis of the natural gas industry in northern Afghanistan and identifies both potential and challenges. The results highlight the importance of adopting modern technologies and efficient management practices to maximize the benefits of natural gas and support the country's economic development.

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