Assessment of oil and gas resources of northern Afghanistan and their impact on energy security in the country

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Abstract. Developing and utilization from hydrocarbon resources of northern Afghanistan is very important for ensuring the energy security and development of the least developed country in Asia. The estimation made by the USGS and Afghanistan geological survey revealed substantial oil and gas resources in the Amu Darya and Afghan-Tajik basins of northern Afghanistan that created an optimistically bright landscape for ensuring the energy availability and development of the country. This study evaluates the Amu Darya and Afghan-Tajik hydrocarbon basins and their development prospective. In 2020, field trips were arranged to Sheberghan and Sar-e-Pul oil and gas fields for collecting information, conducting interviews, and evaluating the infrastructures of oil and gas fields. The findings described that the infrastructures for producing oil and gas are old, poorly maintained, and have limited production capacity. There are serious obstacles, such as security problems, undeveloped infrastructures, and technical issues that are needed to be considered.

1. Introduction
The economic development of any country is directly related to the sustainable meeting of energy demands, especially oil and gas. Currently, oil and gas are the dominant sources of energy in the world, and countries with significant energy reserves not only have a stable and strong economy but also play an active role in international issues. Oil and gas reserves have been the main sources of economic development in the majority of the Gulf and North African states. Countries like The USA, Canada, Norway, Iran, Nigeria, The Russian Federation, and the CIS have also reached different stages of development largely due to their rich oil and gas reserves.

Afghanistan is situated along the energy corridor of Central and Southwest Asia with the vast endowment of natural resources including, rich hydrocarbon reserves [1-2]. The presence of hydrocarbon reserves is a panacea for Afghanistan, and the development of these resources can help the poorest country in Asia to resolve part of its economic problems, create work opportunities and take crucial steps toward reaching stability. Oil and gas resources in Afghanistan have been known for a long time, but they were exploited in limited quantities by the government and some influential warlord leaders [3]. Most of the oil and gas resources of Afghanistan are situated in the north of the country within the Amu Darya and the Afghan-Tajik basins, and it is believed that these basins are the continuation of the great oil and gas fields of Central Asia, which is situated in Turkmenistan, Uzbekistan and Iran [4].
According to intergovernmental agreements concluded between the Government of Afghanistan and the Soviet Union, from the second half of 1958, topographic and geological-geophysical surveys were conducted in the territory of northern Afghanistan to study the geological structure of this region and setting up exploratory drilling for oil and gas. As a result, from 1960-1983, several oil and gas fields were discovered in the northern provinces of Sheberghan, Sar-e-Pul, and Faryab [5].

Before the withdrawal of the Soviet troops in 1989, about the 80 percent of natural gas produced at the Sheberghan gas fields, was exporting to the Soviet Union, supporting the activities of the Northern fertilizer plant, the 36,000 kW thermal power station, and the textile factory in Mazar-e-Sharif [6]. In 2005, by using a series of Soviet's old charts, available data, and modern technics, the USGS conducted a comprehensive scientific survey for identifying minerals in Afghanistan [7]. The survey revealed that two northern basins of Amu-Darya and Afghan-Tajik could contain as much as 1.6 billion barrels of oil and 15.6 trillion cubic feet of natural gas respectively [8]. In 2011, the Afghan Ministry of Mines and Petroleum estimated that northern Afghanistan has about 1.95 billion barrels of undiscovered technically recoverable crude oil reserves and 16.2 trillion cubic feet of discovered natural gas reserves [9].

Afghanistan's development has been affected by decades of political turmoil and conflict. The country's economic growth, which was 9.3% between 2003 and 2014, fell to 2.9 percent in 2019 [10]. It was mainly influenced by the withdrawal of international forces, as assistance and activities related to their participation supported the period of economic expansion. The cutback in aid, accompanied by extensive corruption, created a gap in the Afghan economy and an overall catastrophe in the country.

2. Oil and gas basins of northern Afghanistan

The oil and gas resources of northern Afghanistan are accumulated in two prolificous geological basins of The Amu-Darya and Afghan-Tajik figure 1.
2.1. The Amu Darya (Amu River) oil and gas fields.

The Amu Darya basin is located in Faryab and Sar-e-Pul provinces in the northwest of Afghanistan. This basin is associated with the foredeep of the southeastern part of the Turan Plate, extending far beyond Afghanistan [11]. The part of the basin which is located in the Afghan territory extends from the north to the south. The northern part includes the North Afghan and Maimana basement protrusions, Daulatabad troughs, and the Kushkin uplift zone, whereas the south is limited by the outcropping of the basement in the mountain-folded structures of Afghanistan (table 1) [12].

| Table 1. The estimated mean volumes of undiscovered, technically recoverable, conventional oil and gas resources for the Amu Darya basin province. |
|------------------------------------------------|
| **Crude oil** | 942 million barrel |
| Natural gas | 52 025 billion cubic feet |
| Associated and dissolved natural gas | 2 321 billion cubic feet |
| Non-associated natural gas | 49 704 billion cubic feet |
| Natural gas liquids | 582 million barrel |
| Natural gas liquids in oil accumulation | 55 million barrel |
| Total liquids in non associated gas accumulation | 527 million barrel |

2.2. Afghan-Tajik oil and gas fields.

The Afghan-Tajik basin is located in the north and northeast of Afghanistan and is extended to Turkmenistan and Tajikistan. This region extends along with the northern and northeastern parts of the country from Takhar to the Jawzjan provinces. From the east, it reaches to the Hindu Kush mountain, in the west and north to the Amu Darya, and in the south to The Alborz mountains [13]. The Afghan-Tajik basin has formed by the northward protrusion of the Pamir-Badakhshan block that began in the late Oligocene and continuing to the present [14]. The Afghan-Tajik basin has significant potential for the accumulation of crude oil, as the basin, is situated in the area with Cretaceous-Paleocene carbonate reservoir rocks that are associated with thrust faulting and folding of northern regions of Afghanistan (table 2) [15].

| Table 2. The estimated mean volumes of undiscovered, technically recoverable, conventional oil and gas resources for the Afghan-Tajik basin province. |
|------------------------------------------------|
| **Crude oil** | 996 million barrel |
| Natural gas | 7 072 billion cubic feet |
| Associated and dissolved natural gas | 225 billion cubic feet |
| Non-associated natural gas | 8 847 billion cubic feet |
| Natural gas liquids | 85 million barrel |
| Natural gas liquids in oil accumulation | 4 million barrel |
| Total liquids in non associated gas accumulation | 81 million barrel |

3. Methods

The main objective of this paper is to evaluate the potential and challenges of developing oil and gas resources of northern Afghanistan and their impact on the economic development and stability of the country. This paper is designed based on:

- Area observation
- Interviews were conducted with relevant government officials, academics of Kabul, Polytechnic, Balkh, and Jawzjan universities, experts, and representatives of private companies who linked with this study.
• Analysis of relevant data obtained from the Afghan Ministry of Mines and Petroleum, Soviet sources, USGS, the World Bank, Afghanistan Geological Survey, Sheberghan oil and gas authority, and Northern oil and gas authority.

4. Discussion

4.1. Afghanistan’s energy status.
Afghanistan's energy comprises both renewable (hydro, solar, wind) and non-renewable (natural gas, petroleum, coal, wood, charcoal). In 2019, wood comprised nearly half (44%) of Afghanistan's energy consumption, while oil and gas comprised almost (8%) and (17%) of Afghanistan’s energy consumption basket [15]. Oil is widely used in transportation and power generation sectors, whereas gas for heating and cooking purposes. In the last two decades, Afghanistan’s energy consumption has increased tremendously, mainly due to population growth and changing life patterns (figure 2).

![Afghanistan’s energy consumption pattern](image)

**Figure 2.** Afghanistan’s energy consumption pattern 2019 (designed based on NSIA data).

4.2. Afghanistan’s oil and gas production, consumption, and imports.
Afghanistan’s oil and gas consumption has been increasing steadily for the past two decades, and it is expected to have a similar trend in the future. The country is a net importer of oil and gas, as it produces only 5% of its total domestic need figure 3. Since 2017, natural gas and crude oil production have decreased significantly due to the country's instability and disputes with contracted companies, while the import has increased.

Afghanistan needs almost 4.5 million tons of oil and 656 thousand tons of natural gas annually, which is mostly imported from Russia, Iran, and Central Asian countries. Importing oil, gas, and electricity costs about 1.85 to 2.5 billion dollars for Afghanistan every year that is roughly 20-25 percent of the country’s total imports. In 2019, Afghanistan’s import reached 7.4 billion dollars, in which petroleum and electricity shared 24 percent of the total import (figure 4).

4.3. Development potentials and economic impact.
Despite having substantial untapped minerals and hydrocarbon reserves that are estimated to worth more than 3 trillion dollars, Afghanistan is still the poorest country in Asia and one of the poorest in the world. The Afghan economy is extensively dependent on foreign aids and, every year needs around 10.1 billion dollars for expenditure. Considering the current trend that Afghanistan’s revenue barely reaches 2.5 billion dollars per year, about 7 billion dollars of aid is needed annually to grow the country’s economy and ensure the national budget. On the other hand, Afghanistan has an annual population growth rate of 2.3, which indicates that there will be more demand for oil and gas in the future. The assessment of the current population growth rate and energy consumption models reveals that by 2050, Afghanistan will have an estimated population of 59.8 million and will need to nearly 18 million tons of oil and gas (figure 5).
Figure 3. Afghanistan’s oil and gas consumption and imports from 2009-2018 (designed based on NSIA data).

Figure 4. Oil and gas production in the Amu Darya and Afghan-Tajik basins between 2012-2019 (designed based on NSIA data).

Figure 5. Afghanistan’s estimated population growth and demand pattern for oil and gas from 2020-2050.
The development and utilization of natural resources, especially oil and gas resources of northern Afghanistan, is the key to improving the Afghan economy, decreasing dependency on international aid, and reducing energy imports. In the best scenario, through a proper 5-8 years of planning and investment, production of gas from the Sheberghan fields can meet the domestic necessities of the country, while in long term, it can be exported and ensure up to 50 percent of the public budget. It has been estimated that producing 12,328 tons of natural gas per day, can meet domestic demand, and Afghanistan will be able to save at least $ 800 million per year.

Moreover, considering the current oil price that is around 50 dollars a barrel, an output of 65,000 barrels per day that can be produced in Qashqari and Angot fields, would ensure Afghanistan’s domestic oil demand and save about 1.15 billion dollars per year. Increasing the output to 125,000 barrels per day would earn Afghanistan 2.25 billion dollars, which is roughly 10 percent of the country's gross domestic product of 22 billion dollars in 2019.

4.4. Challenges.

The area observation and conducted interviews in northern basins have indicated that insecurity is the most challenging barrier against the development and utilization of oil and gas resources of Northern Afghanistan (table 3).

Table 3. The main barriers against the development and utilization of oil and gas resources of the Amu Darya and Afghan-Tajik basins.

| Administrative barriers                                      | Technical barriers                       |
|-------------------------------------------------------------|-----------------------------------------|
| Insecurity                                                  | Poorly-maintained and limited infrastructures |
| Corruption                                                  | Lack of skilled workforce               |
| Weak government performance in managing contracts           | Lack of refineries and storage tanks    |
| Lack of reliable data                                        | Transportation cost and restrictions    |

5. Conclusion

The Amu Darya and Afghan-Tajik oil and gas resources can sufficiently meet Afghanistan’s domestic demand. However, the basins have not developed, and the production level is limited due to different problems, such as insecurity, worn-out infrastructure, and corruption. Although the Afghan government has tried to exploit these resources by attracting international investors and internal private companies, it failed to achieve desirable results mainly due to the lack of experience in managing big projects and security instability. There are two potential scenarios for the future of the oil and gas resources of northern Afghanistan:

- If the Afghan government can guarantee the security of any potential big projects, have proper planning to deal with extensive corruption, and invest in infrastructures and capacity building, it will be able to attract high scale international investors and therefore, extensively exploit from its hydrocarbon reserves.
- By considering the current scenario, production in the Amu Darya and Afghan-Tajik basins is expected to be stagnant or very limited for a minimum of 3 to 5 years, as the majority of exploration operations have been postponed. The failure of national projects means that the country's infrastructure will not develop, and Afghanistan without infrastructure wills more likely experience economic problems and remains dependent on international aids for a long time.

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