P-ISSN 2664-0422	Pakistan Social Sciences Review	July-September 2023, Vol. 7, No. 3
O-ISSN 2664-0430	http://doi.org/10.35484/pssr.2023(7-III)101	[1236-1251]

Pakistan Social Sciences Review
www.pssr.org.pk

RESEARCH PAPER

Challenges and Prospects in Exploiting Oil and Gas Resources in KP: Critical Review of Government Policies in the Light of Best International Practices since 2005 and Policy Options

[1] Dr. Zahir Shah, [2] Dr. Jamal Shah and [3] Muhammad Ishaq

1. Professor of Political Science Abdul Wali Khan University Mardan, KP, Pakistan
2. Assistant Professor of Political Science Abdul Wali Khan University Mardan, KP, Pakistan

***Corresponding Author:** zahirshah@awkum.edu.pk

Abstract

This study explores the prospects and challenges of oil and gas exploitation in Khyber Pakhtunkhwa (KP), Pakistan, and to assess the effectiveness of existing government policies. Energy plays a vital role in socio-economic development and modern human activities. Pakistan faces a persistent energy crisis, with heavy reliance on costly imports of oil and gas. Utilizing domestic energy resources is essential for long-term sustainability. This is a library-based study employing descriptive, analytical, and explanatory approaches. It primarily uses secondary data sources to evaluate the energy potential of KP. The findings reveal that KP holds significant oil and gas reserves, offering viable opportunities for energy development. However, multiple challenges—including policy gaps and infrastructural limitations—impede full exploitation. The study suggests revisiting and strengthening government policies, improving infrastructure, and fostering public-private partnerships to enhance the sustainable and efficient use of KP's energy resources.

Key Words Oil and Gas, Oil Exploration, Exploration and Production, OGDCL, KPOGCL, Upstream E&P Sector, Downstream E&P Sector

Introduction

Energy is considered as a decisive component of the economy of a nation. Industry, transportation, infrastructure, information technology, agriculture, and home usage all rely on it. Nuclear power and renewable energy are the world's most rapidly expanding energy sources. However, fossil fuels will remain the dominant source of energy for the global economy and through 2040 fossil fuels will provide almost 80% of global energy, with natural gas being the fastest-growing fossil fuel (IEO, 2020). Recognizing the importance of energy, global energy demand has been gradually increasing, with global energy consumption predicted to rise by 56% between 2010 and 2040. Energy consumption would be more than double by the middle of this century.

Pakistan is an energy-deficient state, with its energy demand likely to rise at an ACGR of 4.37 to 6.09% in the coming years and is anticipated to be between 116 and 148 MTOE by 2022 (Rehman and Deyuan, 2018). Currently, the country is experiencing a significant demand-supply mismatch. Due to the depletion of current gas resources, demand for natural gas will rise to 13.27 BCFD over the next 15 years, compared to domestic supply of 2.17 BCFD, resulting in a massive deficit of nearly 11 BCFD by 2025 (Rehman and Deyuan, 2018). During the 1980s, indigenous energy sources satisfied roughly 86% of energy demand, with imports filling the remaining 14%. The demand-supply imbalance has been increasing since then, reaching about 47% by the end of 2000 (Valasai et al., 2016; 2017). Currently, indigenous gas meets 48% of energy demands, with oil imports accounting for 32%, power for 13%, and coal for 7% (Rehman and Deyuan, 2018). According to estimates, Pakistan spent about 60% of her entire foreign exchange

on buying fossil fuels in 2013. The country imported over 308.9 MBPD of oil, while domestic output was just about 63MBPD . The country's gas demand and supply status has shifted from surplus to deficit and since 2006 the country is in a shortfall phase . The country has enormous potential for oil and gas E&P. As of June 30, 2019, the country's oil reserves were 568 million US barrels while gas reserves were 21.45 TCF. The "Kohat and Potwar Basin" and the "Lower and Middle Indus Basin" of the country have accounted for about 96% of the total exploratory wells. In the provinces of Baluchistan, Punjab, and KP, vast swaths of land remain undiscovered (Hussain and Hussain, 2014).

Although Pakistan has never had a natural gas surplus, it has made policy mistakes in the past by making gas a chief energy source and allocating it to various key sectors of the economy (commercial industry, homes, transportation, and electricity). Furthermore, natural gas price did not follow the principles of scarcity and efficient usage. It was grossly over-allocated, under-priced, and grossly mismanaged . These policy mistakes have led to the country's present gas crisis. The country is now experiencing a serious gas shortage. To address the country's rising energy deficit, particularly reduction in gas supply, the government of Pakistan pursues a variety of solutions to alleviate the country's energy constraints. For example, a short-term remedy has been proposed in gas allocation and load management. And it was for this purpose that the Natural Gas Allocation and Management Policy, 2005 was created. The most obvious and short-term answer is to rationalize existing energy consumption. Gas sectoral allocations must be re-examined with caution and logic. The proposed gas pipeline projects, particularly the Iran-Pakistan gas pipeline, are the mid-term answer. Exploration of indigenous oil and gas resources is the long-term answer to the country's energy crisis where the country can benefit by exploiting its own natural resource potential. The main objectives of this study are to examine the prospects of exploiting oil and gas resources in KP and to identify and explain challenges to it. This study also aims to critically review government policies in the light of best international practices since 2005 and to suggest some policy options and recommendations to the government of KP.

Masood, Ali (2013) in his article "Pakistan's Gas Crisis due to Gas Theft &Unaccounted for Gas (UFG)" has discussed the gas crisis in Pakistan and has provided the strategies how the crisis can be avoided. But he has only mentioned the crisis situation without going in to the recommendations and prospects for energy resource exploitation in the country. Moreover, his study in related to the whole of Pakistan. This study tries to cover that gap. Its focus is KP and put forwards some policy recommendations for how energy resources can be optimally exploit.

Douggar (1995) in his article "Energy Situation in Pakistan: Options and Issues" has fully highlighted the energy situation in Pakistan. He has given some workable policy options and has highlighted the main issues in the energy sector of Pakistan. Again, this study has the whole of the country as its focus. It has not mentioned the prospects of energy exploitation in KP.

Similarly, Hussaain and Hussain (2014) in their article "Natural Gas Allocation and Management in Pakistan: Issues and Actors" have given an overview of the gas allocation and management in Pakistan. They have given a detailed assessment of the various issues and actors involved in the gas sector. But their main focus is on the gas allocation and management side. they have not mentioned the issues of oil. Moreover, their study is related to the whole of Pakistan. The present study tries to cover that gap. Its focus is KP and put forwards some policy recommendations for how energy resources can be optimally exploit.

In what follows I give a brief discussion of prospects of oil and gas exploration in Pakistan and KP in Section 1. The section shows that the region is endowed with several natural wonders as well as vast oil and gas reserves. If these hydrocarbon resources are harnessed, they will have a variety of benefits, including reduced imports, improved balance of payments, saving billions of dollars in foreign exchange, hundreds of thousands of direct and indirect jobs, sustainable development, infrastructure development, and improved life indices of masses. Section 2 mentions some of the most important challenges to gas and oil exploitation in KP. Section 3 concludes the paper and suggests some policy recommendations.

Prospects of Oil and Gas exploration in Pakistan and Khyber Pakhtunkhwa

The Government of Pakistan established the Oil and Gas Development Company Limited (OGDCL) in the 1960s, which has been trying to exploit gas and oil deposits within the country. Following the 1973 oil crisis, both OGDCL and private sector made several significant discoveries. The upstream (Exploration and Production), oil downstream, gas downstream, and power sectors make up Pakistan's energy business. Oil refining and marketing are two subsets of the downstream oil business.

Upstream E&P Sector: E&P sector of Pakistan consists of a mix of domestic and foreign firms (till June 2019 there were 24 active companies). The seismic activities have risen. In 2019, around 37 exploration wells and 67 appraisal/development wells were drilled. The mean gas and oil production in 2019 was 3,936 MMCFD and 89,030 BPD respectively, while the remaining recoverable gas and oil reserves were21.45 TCF and 568 MMBBL respectively. OGDCL is the country's largest E&P firm, accounting for 29.2%and 45.3%share of total yearly gas and oil production respectively. MOL (Magyar Olaj), a Hungarian international oil and gas company, is the country's biggest private and second-largest oil producer, with a 24% production share. PPL (Pakistan Petroleum Limited), a pioneer in Pakistani E&P, is the country's second-largest gas producer, with a 19.3% production share. MPCL, Eni, UEP etc. are the other big companies in the countries .

Downstream Sector: The downstream sector is composed of six oil refining firms (ARL, PRL, PARCO, BYCO, Enar and NRL) and 30 public and private Oil Marketing Companies. PSO, a government-owned company, is the country's major oil marketing company. PAPCO, ISGS and APL are the country's three oil pipeline businesses. Oil is stored by Oil Marketing Companies. In addition, the country has two oil terminals managed by KPT and FOTCO, as well as one SPM operated by Byco. Two government-controlled utilities (SNGPL and SSGC) supplying gas to the vast majority of the people while a small supply network is controlled and managed by gas producers or bulk customers for direct supplies .

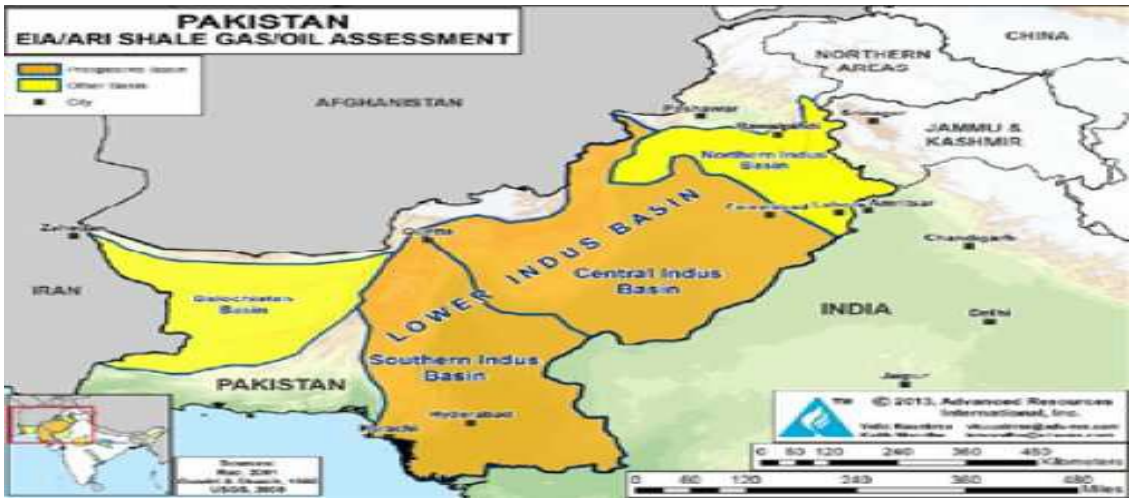
Oil and Gas Exploration History of Pakistan and KP

In 1866, the first well was drilled at Kundal in district Mianwali, Punjab, signaling the start of Pakistan's E&P activity. The first oil discovery was made between 1885 and 1892 in Khattan (Balochistan), with thirteen wells yielding barely 25,000 barrels. However, Attock Oil Company's drilling of the Khaur-1 well in 1915 was the first commercial success. Between 1915 and 1954, about 400 shallow wells were drilled in the Khaur field, resulting in three more oil fields. This economic success ushered in a new age of E&P in the Potwar Basin, resulting in the discovery of 3 oil fields. Sui gas field, the first and largest natural gas field in Pakistan, was discovered in 1952 and commercial production began in 1955, changing the whole picture. The first oilfield in Pakistan was discovered in 1964, and commercial production started in 1967. Latter on local firms (Pakistan Petroleum Limited-PPL) and Oil & Gas Development Company Limited

(OGDCL)) as well as foreign firms (OMV, Union Texas, BHP, Premier, ENI, Petronas, Tullow Oil etc.) found oil and gas reserves in lower Sindh in the 1990s. Thereafter, commercial gas and oil discoveries were made in KP by MOL and OGDCL. PPL began exploration efforts in KP by drilling the Pezu-1 well in 1968, the Marwat-1 well in 1970, and the Kundi X-1 well in 1995. Several prominent domestic E&P firms, such as MPCL and OGDCL as well as international firms such as Petro Canada and MOL flocked to KP to conduct exploration efforts. In 1999, OGDCL (Chanda-1 well- Shakardara) achieved the first oil and gas discovery after overcoming several obstacles. KP became the new commercial avenue for E&P firms after OGDCL discovered oil and gas there.MOL Pakistan marked its first discovery in 2001 in a well named Manzalai in Tal block. Multiple appraisals and development wells were drilled in these two blocks with significant results since then (Hussain, 2013).

Prospects of Oil and Gas Development in Pakistan

About 850 exploratory wells have been drilled in Pakistan's sedimentary basins since independence, spanning an area of 827, 268 km² (16 offshore and 834 onshore). Till September 2012, 271 gas and oil fields (209 gas and gas/ condensate and 62 oil) had been discovered across Pakistan's different basins, resulting in a drilling density of 2.44 wells per 1,000 km² and a 1:3.2 success rate. Despite having a lower drilling density than the world average of 10 wells per 1,000 km², Pakistan's success rate compares favorably to the international success rate of 1:10 (Tirmizi, 2011). Pakistan's shale oil and gas development is seen as critical in meeting the country's energy needs. Pakistan's current yearly conventional fuel usage is around 150 million barrels of oil and 1.6 TCF of natural gas . Pakistan relies heavily on gas and oil to generate power, with gas and oil accounting for around 47% and 30% of total generation respectively (Hussain 2013). Pakistan now has a gas deficit of 1400 MCF per day, resulting in a daily power shortfall of 5000-6000 MW. In terms of oil demand, Pakistan is currently in much more dire straits. At a cost of $12 billion per year, 75% of oil is imported. By 2022, oil imports are anticipated to reach 122 million metric tons (Hussain, 2013), resulting in a $ 40-50 billion increase in the oil bill. Pakistan has 227 billion barrels of shale oil deposits, with 9.1 billion barrels recoverable with latest technology. Pakistan also has 586 TCF of shale gas, of which 105 TCF can be recovered. Due to the high expense of shale gas and oil development and the high degree of technological knowledge required, $1.5 billion is required for exploring 500 wells . The majority of Pakistan's shale gas and oil reserves are found in the lower Indus basin, mostly in Sembar and Ranikot, primarily in lower Punjab and upper Sindh, with vast reserve in KP. The Central Indus Basin and Southern Indus Basin, as well as the significant Northern Indus Basin and Balochistan Basin are all potential basins. The shale gas basins are seen in the map below .



Prospects of Oil and Gas Exploitation in KP

KP is located in Zones I and I (F), which are oil and gas-rich zones. This region is endowed with several natural wonders as well as vast oil and gas reserves. If these hydrocarbon resources are harnessed, they will have a variety of benefits, including reduced imports, improved balance of payments, saving billions of dollars in foreign exchange, hundreds of thousands of direct and indirect jobs, sustainable development through E&P companies' CSR (Corporate Social Responsibilities) activities, infrastructure development, and improved life indices of masses. Oil and gas are the lifeblood of all economies, and KP hydrocarbon resources may help the federal and provincial governments achieve their goals. The discovery of KP's indigenous oil and gas resources has opened up new opportunities for economic growth in the province, as seen by recent discoveries in the Nashpa, Tal, Baratai and Kohat Blocks, and additional discoveries are expected in the future years.

Article 172 of Pakistan's constitution contains the constitutional provisions for gas and oil exploration and exploitation. The 18th constitutional amendment has brought a substantial change in provincial control over gas and oil reserves. Article 172(3) of the constitution said that "Subject to the existing commitments and obligations, mineral oil and natural gas within the province or the territorial waters adjacent thereto shall vest jointly and equally in that province and the federal government". Article 172(3) has been moved to Article 172 in the 18th Amendment so that it may be read with 172(1) and 172(2). Article 172(1) says that "Any property which has no rightful owner shall, if located in a province, vest in the government of that province, and in every other case, in the federal government". The provinces' ownership of oil and gas is clearly established in Article 172(1) and the province is currently the recipient of the royalties.

KP has recently emerged as Pakistan's newest and most exciting geological frontier. The potential is tremendous and so is the success. KP now produces over 55% of the country's total oil, 15% of its total gas, and 25% of its high-value LPG. KP has established itself as a major oil and gas E&P hub which has a recoverable potential of 1.1 billion barrels of oil, 16 TCF of gas, and 550 tons of LPG per day. Oil output is expected to be 200,000 barrels per day and gas production is expected to be 2000 MCF per day in 2025. The potential of KP in term of oil and gas production has been given in Table 1 and 2 below.

Table 1
Total Pakistan & KP Crude Oil Production (BPD) from 2010 to 2017

No	Total Production	2010	2011	2012	2013	2014	2015	Jan 2017
1	Total Pakistan	64948	65866	67140	76277	81516	84167	97243
2	Khyber Pakhtunkhwa	14528	21489	25944	30812	41078	43150	53322
3	Khyber Pakhtunkhwa %	22	33	39	40	50	51	55

Table 2
Potential of Oil and as in KP

Production	Units	2013	Jan 2017	2018	2025
Crude Oil	Barrels Per day (BPD)	30,000	53, 322	94,000	200,000
Gas	Million Cubic Feet per day (MMCFD)	330	443	970	2,000
LPG	Tons per Day (TPD)	10	550	1500	3,000

KP has established a Technical Laboratory on Commercial basis to enhance E&P activities in the province. It has also established an "Energy Apex Committee (EAC)", under its Chief Minister. This high-powered committee works out any kinks in the system.KP Oil & Gas Company Ltd (KPOGCL) was established in February 2013 by the provincial government as a corporate entity following the 18th Constitutional

Amendment to Pakistan's constitution to assist investors in geophysical and geological studies, feasibilities, seismic data collection, well planning, drilling, completion and production (KPOGCL, n. d., 23). It is tasked with not only carrying out oil and gas E&P activities, but also attracting more foreign and local E&P companies by providing them with the necessary logistics and technological support, paving the way for fast-track E&P activities in KP. As KP patronizes KPOGCL, it may serve as an efficient liaison between E&P firms and all other government departments. As a result, KPOGCL is essentially doing "One Window Operations", acts as a "Provincial Holding Company" under the Petroleum Policy of 2012, and serves as a facilitator for various national and international E&P firms operating in KP. Furthermore, KPOGCL is investing in the acquisition of technical equipments, including drilling rigs and seismic recorders for data gathering, all with the goal of lowering Pakistan's energy deficit. KPOGCL is committed to use its own resources and collaborate with other local and international E&P firms to explore and develop the province's undiscovered oil and gas resources (KPOGCL, n. d., 20).

Huge oil and gas reserves have been discovered in the province's southern strip, encompassing the districts of Karak, Kohat, and Hangu. The KP government, through KPOGCL, has inked memorandums of understanding with Russian firm ROSGEO, American firm Hycarbex, and Canadian firm Tallahassee to promote E&P activities and to entice foreign oil corporations to operate in the province. Presently 14 NOCs/IOCs E&P companies are working in KP which has the potential for significant new discoveries, notably in the Kohat Basin, which has become the center of attention following recent discoveries by MOL and OGDCL.

The KP government has taken steps at the federal level to modify Petroleum Policy 2012, including adding Zone-I (F) for newly merged districts. The major goal of proposing the new Zone-I (F) was to speed up exploration efforts in already awarded Blocks as well as future Blocks in order to unlock the merged districts' significant hydrocarbon potential. It might play a critical role in boosting national and international investor trust in upstream, midstream, and downstream industries in the merged districts which have not been fully explored. The KP government has begun exploratory efforts in merged districts in order to improve the socioeconomic conditions of disadvantaged areas, with the goal of attracting investors for numerous projects to exploit hydrocarbon resources. KP has devised a viable plan for marketing and diversifying its portfolio in order to increase the oil and gas industry.

It is important to note that the majority of KP remains unexplored, particularly in the newly merged districts, where high-impact discoveries are expected in the near future, boosting the province's hydrocarbon reserves base to around 8 TCF in the settled (3 TCF) and newly merged districts (5 TCF). In the KP Province, 12 national and international E&P firms are now active in 25 different exploration blocks. The province produces around 440 MMCFD of gas, but only consumes about 270 MMCFD. Despite generating more gas than required, KP customers do not have access to it, resulting in significant deforestation, particularly in the hilly Malakand and Hazara Divisions.

The KP Province has substantial indigenous production and potential oil and gas resources to fulfill residential demand. To meet future energy demand, E&P companies working in the province have set goals of drilling exploratory wells in 15 highly prospective Blocks in merged districts, resulting in total estimated gas production of 700-800 MMCFD in 2030 and beyond, which would meet KP's energy demand.

The most recent Petroleum Policy-2012 gives significant incentives with substantial profits to investors. Pakistan is divided into three onshore zones. KP is in Zone-1, which has the highest well head price compared to Zones II and III. Given the

high drilling success rate of 1:2.8, the E&P companies are encouraged to invest in KP. Because the global average is 1:10 and Pakistan's is 1:3.5, the province presents a low-risk potential for gas and oil exploration. In 2034 crude oil production in KP will reach 251905 BPD while gas will touch 2656 MMCFD. KP has many oil and gas rich blocks/spots for example:

a. **Lakki Block:** The Infra-Cambrian to Miocene rocks of the Kohat-Bannu Basin have confirmed and viable petroleum. Lakki Block (3270-9) covers 1084.87 km2 of area and is divided into three districts of KP: Lakki Marwat (63.48%), Karak (14.33%), and Bannu (22.19%). This Block lies in Prospective Zone-I. The Block is deemed propective based on nearby discoveries in the Kohat-Bannu basin, such as Mela Chanda, Maramzai, Nashpa, Mamikhel and Makori. The Block is located about 200 km southwest of Peshawar and 300 km southwest of Islamabad. From Peshawar, Karak, Bannu and Lakki Marwat, it is easily accessible by a network of motorways and concrete roads (KPOGCL, n. d., 28).

b. **DIK Exploration Block:** DIK East Block is a 446 km² block in KP's D.I Khan (100%) district and lies in Prospective Zone-I. DIK East Block is regarded as prospective based on nearby discoveries in the Kohat-Bannu basin, such as Mela Chanda, Maramzai, Nashpa, Mamikhel and Makori. The Block lies around 300 km south-west of Peshawar and 500 km south-west of Islamabad. It is accessible through the Indus Highway, which has modern amenities owing to neighboring oil and gas E&P activities/discoveries (KPOGCL, n. d., 42).

c. **DIK West Block:** DIK West Block covers 300 km²of area and is located in KP's D.I Khan (88.55%) and FR DI Khan districts (11.45%) and lies in Prospective Zone-II. DIK West Block is regarded prospectivebased on nearby discoveries in the Kohat-Bannu basin, such as Mela Chanda, Maramzai, Nashpa, Mamikhel and Makori. The Block lies around 300 km south-west of Peshawar and 500 km south-west of Islamabad. It is accessible through the Indus Highway (KPOGCL, n. d., 51).

d. **Nowshera Block :** The Nowshera Block covers 2,136 km²of area and is split between the districts of Mardan (53.83%), Swabi (38.48%), Buner (4.05%), Nowshera (3.17%), and Charsadda (0.47%) and lies in Prospective Zone-I. Nowshera Block is regarded prospective based on nearby discoveries in the Kohat-Bannu basin, such as Mela Chanda, Maramzai, Nashpa, Mamikhel and Makori. The Block lies around 60 km north-east of Peshawar and 300 km north-west of Islamabad. It is easily accessible by a network of highways and roads from the districts of Mardan, Peshawar, Charsadda and Nowshera (KPOGCL, n. d., 61).

e. **Miran Block:** Miran Block has 1064.3 km²of area and is located in KP's North Waziristan (85.63%) and Kurram (14.37%) districts and lies in Prospective Zone-I. Miran Block is regarded prospective based on nearby discoveries in the Kohat-Bannu basin, such as Mela Chanda, Maramzai, Nashpa, Mamikhel and Makori.The Block is about 270 km south-southwest of Peshawar and 400 km southwest of Islamabad. Due to the present boom of oil and gas discoveries in the neighboring districts, it is easily accessible by a network of highways roads from District Peshawar, Kohat, Karak, and Bannu, where modern facilities are available (KPOGCL, n. d., 70).

f. **Khushal Block:** The 417 km² Khushal Block is located in the districts of Tank (39.56%), Lakki Marwat (30.45%), and D.I Khan (29.97%) in KP and lies in Prospective Zone-I.Miran Block is regarded prospective based on nearby discoveries in the Kohat-Bannu basin, such as Mela Chanda, Maramzai, Nashpa, Mamikhel and Makori.Because the Khushal Block is close to MOL and OGDCL's Tal and Nashpa Blocks, both of which are very prolific (producing) blocks, and because active gas

seepages occur surrounding the block. As a result, there is a good chance that substantial discoveries will be made in the Khushal Block. Both oil and gas discoveries are expected there. The Block is around 350 km southwest of Islamabad and 250 km southwest of Peshawar. From Kohat, Peshawar, Karak, Lakki Marwat and Bannu, it is easily accessible by a network of motorways and concrete roads (KPOGCL, n. d., 79).

g. Charsadda Block: The Charsadda Block covers 2,436 km^2 of area and is split between the districts of Charsadda (38%), Peshawar (22.07%), Nowshera (7.55%), Mardan (4.63%), Khyber (26%), Mohmand (0.85%), and Malakand (0.9%) and lies in Prospective Zone-I. Charsadda Block is believed to be prospective based on nearby discoveries in the Kohat-Bannu basin, such as Mela Chanda, Maramzai, Nashpa, Mamikhel and Makori.The Block is around 30 km north of Peshawar and 200 km northwest of Islamabad. It is easily accessible by a network of highways from the districts of Peshawar, Mardan, Charsadda, and Nowshera (KPOGCL, n. d., 88).

Silent Features of these Block

a. These Blocks are located in the well-known Kohat-Bannu Basins, which now provide 55% of Pakistan's total oil production;

b. The first refinery is being built in the Kohat area, which will lower the time and cost of transportation and time to market the crude oil, paving the way for a reduction in the per barrel cost of production, since transportation presently accounts for 50% of E&P companies' Opex. Moreover, trucking expenses are about $2.75 per barrel, while estimated oil treatment and processing costs are $2.08. In terms of Opex vs. Production, the cost per BOE for other E&P firms operating is $6;

c. The overall drilling success ratio is 1:2.8;

d. When reservoir reserves are taken into account, the IRR is predicted to be in the range of 35-40%;

e. For foreigners working in the province, KPOGCL provides full proof security, as well as essential security clearances and logistical assistance .

Investment Opportunity in These Blocks

KPOGCL invites both national and international E&P companies to join as joint venture partners, andplans to farm out its 49% working interest to leading E&P companies to help KPOGCL with geophysical, geological and engineering studies, as well as the initial drilling of exploratory wells and subsequent production set-up.Work program on Lakki Block has already been started since September 2016 while for DIK East, DIK West, Nowshera, Miran, Khushal and Charsadda Blocks it has started in 2017 leading to the drilling activities in 2018-19. Full program cost (Capex) for Lakki, DIK East, DIK West, Nowshera, Miran, Khushal and Charsadda Blocks is estimated as US$ 55, 41, 40, 42, 45, 49 and 47 million respectively (KPOGCL, n. d.,28, 42, 51, 61, 70, 79, 88).

The province's law and order situation has greatly improved. Because of the federal and provincial governments' tireless efforts, national and international oil firms' confidence has grown, and several E&P companies are currently working in KP. Local and foreign investors benefit from a safe and secure law and order environment. Expats

routinely travel to KP to work and supervise their E&P operations. One of KPOGCL's responsibilities is security and logistics coordination. To provide proper security, the following major actions have been adopted.

a. The Energy Apex Committee chaired by the KP's Chief Minister;

b. Energy Security Steering Committee (ESSC) chaired by Home Secretary;

c. Security Clearance from Ministry of Interior, Board of Investment, Home Department and Security Risk Analysis;

d. Provide security coverage to foreigners and local official of the E&P companies operating in the province .

Challenges to Oil and Gas Exploitation in KP

The oil and gas sector not only in KP but also in Pakistan is faced with numerous challenges. These challenges need serious attention and will/determination on the part of the government to be addressed and taken seriously. The most important challenges are mentioned here which if given serious attention for addressal will usher in to an age of prosperity not only for KP but for the whole of Pakistan. The absence of government commitment has been the most significant obstacle to achieving KP's gas and oil potential. As of April 2017, gas and oil exploration was underway in 361,218.72 km^2 of the country's total sedimentary area of 827,268 km^2. Despite this, just 27,710 km^2 of KP have been explored. This means that only 27% of KP's land has been searched for oil and gas since independence. KP alone has a recoverable potential of 2 billion barrels of oil and 46 TCF of gas but the lack of commitment on the part of governmental authorities has been the most formidable hurdle.

This lack of attention on the part of the government may be due to inadequate financial potency required to boost the sector. Exploration and exploitation of oil and gas is highly capital intensive. Heavy and modern technology is required in this sector. There is technological gap that necessitate capital and human resource investments. The technology used in the quarrying and processing subsectors is old and is unable to create standardized and uniform quality goods for both home and export markets. Similarly, oil and gas trapped in shale strata are difficult to extract because of their poor permeability, which means that even if a well is drilled, oil and gas will not flow into it (Suan, Tan, and Wu, 2012). Because oil and gas are firmly bound in shale, extraction requires sophisticated equipment. Shale may be found between 6000 and 8000 feet below ground level. The soil layer is 50 feet deep, the aquifer is 50-800 feet deep, the limestone/sandstone is 800-6000 feet deep, and the shale is 6000-8000 feet deep. As a result, the extraction of shale oil and gas deposits necessitates the use of heavy technology (Qureshi, 2013).

Domestic crude oil and refining capacity is significantly less than demand, resulting in a considerable quantity of foreign exchange wasted on crude and refined oil imports. Similarly, domestic pipeline network for oil and gas have been worn out and needs to be upgraded on priority basis. Regulations regarding the various aspects of this sector need serious attention. Natural resources industry requires effective, unbiased, and stable regulation to ensure equitable and efficient development. Unfortunately, the Oil & Gas sector has been plagued by a regulatory deficiency for several years, which has manifested itself in a variety of challenges that have hampered the sector's progress.

Natural gas is important in the power sector. Currently some local and international companies are involved in the oil upstream and downstream sector, and the government of Pakistan is establishing policies to attract more international investors

in this sector, but the country's rapid pace of change, high level of uncertainty, and unstable political situation present significant challenges and risk to national and international investors to perform E&P activities in Pakistan and KP.

In the same vein, the sector is also faced with some serious environmental issues. At the sites of shale gas exploration activities, a variety of environmental problems may arise. In a drought-prone, high-water-demand location, fracking faces significant hurdles. As global climate change accelerates, the threats will increase. Increased soil erosion and a hazard to the integrity of containment pits are possible outcomes. There is also a greater chance of surface and groundwater contamination. Furthermore, wastewater disposal poses a seismic danger, while fracking water storage in open containments poses a significant risk to wildlife and domestic animals. Air pollution and health effects are caused by volatile substances. Similarly, water may be impacted. Neglected surface pumps, unlined storage pits, insufficient or faulty casing, and new cracks are all risks of pollution of ground water aquifers during shale oil and gas production. Methane is an asphyxia and explosive hazard . As a water-scarce country, Pakistan would encounter hurdles in developing shale gas due to water requirements and pollution. Heavy metals are found in the polluted tracing fluid. Shale begins to extract gas or oil and bring it to the surface. During such extractions, a poisonous fluid called "Flowback" is collected and held in lined pits, with pits leaking due to inadequate lining procedures. As a result, gas starts permeating the soil and ultimately the aquifer from the surface, polluting the ground water aquifer. A variety of substances contaminate the water. Methane rises higher and contaminates the groundwater aquifer. Methane leakage is caused by incorrect or insufficient cement casing. Pores in the earth cause leaks in poorly made casings and tubes. The chemicals employed in hydraulic fracturing have the potential to leak into underground water, eventually contaminating drinking water sources. Again, the long-term exposure to such chemicals has been linked to a variety of health problems . Depending on the water management measures employed, fracking necessitates a large amount of water. This could represent a problem in water-stressed areas as well as lower groundwater levels.

Similarly, gasification can be a great challenge. When gas migrates from the shale layer to the groundwater, it builds up pressure, which can cause earthquakes or explosions (Peduzzi and Reis, 2013). It has a significant negative influence on the ecology, soil, and land. Because of methane emissions from flow-back fluids and drill out of wells during well completion, shale gas has a much greater Green House Gases (GHG) footprint than conventional gas. Routine production and downstream methane emissions are similarly high, although both conventional and shale gas emit the same amount of methane. Total methane emissions from conventional gas range from 1.7 to 6%, whereas those from shale gas development range from 3.6 to 7.9%, resulting in significant global warming (Jiang et al., 2011). There are also connection leakages resulting in fugitive methane emissions. The concentration of GHG emissions is caused by fugitive methane releases. Then there is global climate change, which lasts a lifetime. Heaters, dehydrators, meters, vapor recovery apparatus and compressors are among the equipments connected to a well's 55 to 150 connections. Adequate well care is essential because many of the connections leak and constitute a source of pollution (Jiang et al., 2011).

The amount of solid waste generated during drilling and fracking is enormous, posing a risk to soil in terms of contamination, management, and so on. As a result, waste management is another aspect that should be dealt with and managed using technological instruments during shale oil and gas production. Hydraulic fracturing is

increasingly seen as a source of water and land contamination, as well as a source of natural gas infiltration into freshwater aquifers and earthquakes.

The sector may also be faced with some regulatory risks. Shale gas projects are underway in a variety of countries, each with its own legal and regulatory framework and traditions. As a result, projects are carried out in a variety of legal and regulatory contexts. The political attitude regarding shale gas has a significant impact on the environment. It also results in issues like permitting, access challenges, licensing, approval delays, municipal actions, regulatory gas, record keeping, community compensation agreements and road reconstructions (Zahid, Junaid & Inam, 2016). There may also be reputational risks which are related to business behavior, corporate compliance, and the impact on other economic sectors such as farming, and tourism are all examples of reputational hazards.

One of the most important challenges the sector is facing is the scarcity of trained and skilled human capital in the field. With a smaller number of competent and trained employees, human resource productivity is low. There is no specific oil and gas training institute that provides high-quality instruction. A stronger legal framework, infrastructure development, resource mapping, access to finance, technological up-gradation, marketing and human resource development are required to fully exploit the natural resources fully.

Conclusion

This study has tried to give a picture of the oil and gas potential of KP. It showed that if the province's potential resources are wisely utilized, multi-faceted benefits can be realized. KP and merged districts contain around five TCF gas and related oil resources. Furthermore, KP possesses unconventional resources of 1.13 billion barrels of shale oil and a substantial amount of shale gas in the Kohat and Bannu Basins. The province has grown to become the country's largest oil producing province because of the enabling environment given by the KP government. Only four of the twenty-five Exploration Blocks in KP are now providing more than 52% of Pakistan's oil (39,000 bpd), 12% of natural gas (440 MMSFD), and 8% (790 TPD) of LPG output. As compared to the rest of the globe, more than 40 exploration wells have been drilled in KP, with a favorable success ratio (1:2) compared to the rest of the world (1:5). Similarly, KP presently has 27 Exploration Blocks out of a total of 28. The basin of Kohat is almost discovered. Blocks in the merged districts contain significant oil and gas potential, which should be vigorously explored. The Nashpa (OGDCL) and Makori East fields in KP are among Pakistan's major oil and gas fields in terms of daily production rate and hydrocarbon reserves. E&P firms operating in KP are now digging wells that are projected to inject an extra 50 MMCFD of natural gas in the near future which by December, 2021 will increase KP gas production to over 480 MMCFD. In the oil and gas industry, KP has expanded by leaps and bounds, becoming the greatest contributor to indigenous oil and gas production. Under the present government, the KP government has gained traction in the oil and gas industry. KP would become a symbol of wealth, a province of opportunity, and a light of prosperity. Considering the present active E&P operations in KP, as well as the existing oil and gas resources potential as stated in the Pakistan Energy Yearbook 2018 (PEYB), the KP oil production projection for the years 2025 and 2030 is 65,000 to 80,000 bpd.

There are a variety of factors driving Pakistan's decision to pursue oil and gas exploitation for example the enormous unmet gas demand and cheap transport fuel where shale gas has the potential to help with public transportation difficulties. Pakistan is the world's 27th largest gas producer. CNG is used in over 80% of automobiles in Pakistan because it is 30% cheaper than gasoline. As a result, Pakistan is the world leader in CNG vehicles. In the same vein poor economic conditions of the country which is now

experiencing the worst economic conditions and a severe energy deficit can be rectified by exploiting the natural resources of the country. Due to energy problem, many companies have left Pakistan . The good news is that Pakistani experts and technicians working in the Middle East are leveraging technological expertise to provide economically feasible solutions. The same may be done throughout the country, resulting in a more cost-effective and efficient oil and gas extraction program. To produce shale oil and gas, Pakistan might approach donors such as the Asian Development Bank and the World Bank as a single pilot horizontal well cost between $10 and $20 million .

Recommendations

a. Petroleum Policy needs to be amended by providing some fiscal incentives that will promote and encourage sound management of resources of the country and especially KP i.e., quick reforms initiative, more gas/oil production. The government should introduce reforms to make it easier to do business in the upstream and downstream petroleum sectors, in line with the current regulatory regime and business environment, in order to attract Foreign Direct Investment through international E&P companies and encourage much-needed investment in the country where energy security will be the most pressing issue in the near future;

b. Pakistan must address the regulatory shortfall as well as other industry-related issues that are impeding the local petroleum industry's development. A closer examination shows a plethora of linked issues that must be addressed in depth to enhance the country's oil and gas industry performance. To address these issues, we should begin by focusing on opportunities and how we can seize them as quickly as possible and provide feedback to the government on how to introduce and implement key changes in petroleum policies with the goal of increasing transparency and reducing administrative discretion. By reducing the government's discretion, the government should create a new strategy that would reduce conflicts and delays in the country's oil and gas exploration. It would also result in job creation and process simplification, as well as marketing freedom;

c. E&P firms should be encouraged by providing them with an easy-to-do-business environment as well as a congenial and safe working environment, allowing them to engage in high-risk exploration activities across the country. Encouragement of oil and gas production through providing incentives, resources, and information exchange should be ensured. The government should give attractive terms and conditions to investors. These increased exploration efforts will raise indigenous oil and gas output, lower reliance on fossil fuel imports and enhance energy security, which is the greatest issue confronting the country in the near future. The private sector should be encouraged to conduct state-of-the-art geophysical surveys for offshore oil and gas development, while the government should explore a multi-client survey campaign with private sector involvement. To improve exploration in shallow and deep-water offshore regions with recognized geological conditions, the private sector may create joint ventures with Pakistani state-owned firms;

d. We should implement production-increasing measures, such as Potential Tapping (PT) and Enhanced Oil Recovery (EOR) in mature oil and gas fields that have entered a production-decreasing phase. Similarly, we should introduce preferential policies to encourage mid- and small-size international oil companies with capital and technical capability to invest in oil and gas development in Pakistan and particularly in KP;

e. We should develop preferential policies and execute pilot projects as soon as feasible in the field of shale oil and gas exploration and development to attract local and international oil and gas firms to enter this industry;

f. Estimation and mapping of gas and oil reserves and deposits using modern scientific approaches such as geo and 3D modeling, in collaboration with others should be made possible;

g. Human Resource Development may be accomplished by establishing upgraded and dedicated training facilities with state-of-the-art training facilities in key oil and gas bearing areas;

h. The job of the Director General Petroleum Concessions should be redefined, and the office restructured along the lines of NEPRA, OGRA and others. As the rule is Minimum Government and Maximum Governance, a new regulatory authority, Pakistan Upstream Regulatory Authority (PURA), should be established, where procedures and policies are well defined, and the E&P industry is not to seek clearance at every stage PURA's scope should be limited to hydrocarbons. The regulatory procedure should follow a set of guidelines. All exploration activities should be provided with complete free security;

i. Petroleum policy should be adopted with input from all industry shareholders, with the goal of easy adoption and execution. It should also guarantee that all previous policies are abolished and covered by a single policy, and that this new policy is retroactive to all past and present E&P leases and licenses. Petroleum policy should stimulate public and private sector investments in E&P, as well as the supply chain (infrastructure development, storage, and transmission/transportation);

j. To attract global and local investment, bidding rounds should create standardized data packages in accordance with international standards. Under the current Pakistan Petroleum E&P Data Repository (PPEPDR) initiative, the regulatory body should be granted new powers and support to guarantee high standards of data ownership, administration, and marketing;

k. The government should deregulate the selling and purchase of local hydrocarbons over time by putting them on a commodities exchange. This will lead to more efficient price discovery and encourage direct trading between buyers and sellers. The transactions may be subject to royalty taxes;

l. Local companies should be granted "Preferential Points" in any competitive bidding rounds based on their ability to perform relevant contracts;

m. Companies establishing business in Pakistan must ensure that at least 70% of their employees should be native Pakistanis and in order to obtain contracts or bid on projects, they need to engage with a local service firms;

n. KP should create an enabling environment that would ultimately encourage E&P operations in the province, where the newly merged districts will pique investors' interest, resulting in a bright future for the KP Oil and Gas industry. The sitting KP government is working hard to increase oil and gas E&P activities in the KP, including the merged districts, by introducing new incentives for interested investors, with the goal of increasing indigenous production for sustainable energy supply and security, thereby driving businesses, creating jobs, and contributing to lowering the import bill and energizing the country;

o. And last but not the least, the KP government should develop an oil and gas vision that includes creative efforts to address the energy crisis through the province's indigenous resources. As a result, inexpensive energy will be available, economic activity will be boosted, and employment opportunities will be created, which will considerably raise the living standards of the masses. KP's vision should speed up oil and gas production, as well as regulatory and policy reforms that focus on economic growth, indigenization and industrialization.

References

Associated Press of Pakistan. (2014, December 14). Gas shortage exposes Pakistan's energy crisis. *The Daily Dawn*. http://beta.dawn.com/news/771259/gas-shortage-exposes-pakistans-energycrisis

Azad, A. R. (2012, September 13). Energy woes: Over 40% of textile industry has shifted to BD? *Business Recorder*. http://www.brecorder.com/top-news/1-frontt op-news/79119-energy-woes-over-40pc-of-textile-industry-has-shifted-to-bd-.html

Binnion, M. (2012). How the technical differences between shale gas and conventional gas projects lead to a new business model being required to be successful. *Marine and Petroleum Geology, 31*(1), 3-7.

Bishop, R. E. (2010). Chemical and biological risk assessment for natural gas extraction in New York. *Sustainable Otsego*. http://www.sustainableotsego.org/Risk%20Assessment%20Natural%20Gas%20Extraction-1.htm

British Petroleum. (2013). Statistical review of world energy. www.bp.com/en/global/corporate/about-bp/energyeconomics/statistical-review-of-world-energy-2013.html

Douglas, C. C., Qin, G., Collier, N., & Gong, B. (2011). Intelligent fracture creation for shale gas development. *Procedia Computer Science, 4*, 1745-1748.

Hussain, F., & Hussain, S. (2014). Natural gas allocation and management in Pakistan: Issues and actors. *ISSRA Papers*. https://www.ndu.edu.pk/issra/issra_pub/articles/issra_paper/ISSRA_Papers_Vol6_IssueI_2014/02-Natural-Gas-Allocation-Faiz-hussain-Kazmi.pdf

Hussain, N. (2013). Pakistan's energy crisis and Iran-Pakistan gas pipeline. *IPRI Journal Conference, Islamabad*.

International Energy Outlook. (2020). *Energy information administration*. http://www.eia.gov/forecasts/ieo/

Jiang, M., Griffin, M., Hendrickson, C., Jaramillo, P., VanBriesen, J., & Venkatesh, A. (2011). Life cycle greenhouse gas emissions of Marcellus shale gas. *Environmental Research Letters, 6*(3). https://iopscience.iop.org/article/10.1088/1748-9326/6/3/034014

Khan, A. N., Begum, T., & Sher, M. (2012). Energy crisis in Pakistan: Causes and consequences. *Abasyn Journal of Social Sciences, 4*(2), 341-363.

Khan, H. A., & Pervaiz, S. (2013). Technological review on solar PV in Pakistan: Scope, practices and recommendations for optimized system design. *Renewable and Sustainable Energy Reviews, 23*, 147-154.

Khyber Pakhtunkhwa Oil and Gas Company Limited (KPOGCL). (n.d.). Marketing plan. http://kp.gov.pk/uploads/2017/07/MARKETING_PLAN_FOR_INVESTMENT_IN_SEVEN_EXPLORATION_BLOCKS.pdf

Masood, A. (2013). Pakistan's gas crisis due to gas theft & unaccounted for gas (UFG). *International Journal of Renewable Energy Technology Research, 2*(2), 53-58.

Ministry of Petroleum and Natural Resources, Government of Pakistan. (n.d.). Opportunities in Pakistan's upstream oil and gas sector. www.mpnr.gov.pk

Mustafa, K. (2019, November 25). Oil and gas reserves of Pakistan going to India due to lack of exploration. *The News International*. https://www.thenews.com.pk/print/573899-oil-and-gas-reserves-of-pakistan-going-to-india-due-to-lack-of-exploration

Pakistan Energy Yearbook. (2015). *Hydrocarbon Development Institute of Pakistan*.

Peduzzi, P., & Reis, H. R. (2013). Gas fracking: Can we safely squeeze the rocks? *Environmental Development, 6*, 86-99.

Qureshi, N. M. (2013, June 25). Good news: Pakistan has shale oil reserves. *Arab News*. http://www.arabnews.com/news/456080

Rehman, A., & Zhang, D. (2018). Pakistan's energy scenario: A forecast of commercial energy consumption and supply from different sources through 2030. *Energy Sustainability and Society, 8*(26). https://doi.org/10.1186/s13705-018-0167-y

Suan, K., Tan, J., & Wu, D. (2012). The research on dynamic rules of crack extension during hydraulic fracturing for oil shale in-situ exploitation. *Procedia Environmental Sciences, 12*, 736–743.

Tirmizi, F. (2011, March 14). The myth of Pakistan's infinite gas reserves. *The Express Tribune*. http://tribune.com.pk/story/124157/energy-crisis-pakistan-to-seekfree-oil-from-kuwait/

U.S. Energy Information Administration. (2013). Technically recoverable shale oil and shale gas resources: An assessment of 137 shale formations in 41 countries outside the United States. *Independent Statistics and Analysis, USEIA*. https://www.eia.gov/analysis/studies/worldshalegas/pdf/overview.pdf

Valasai, G. D., Uqaili, M. A., Memon, H. R., Samoo, S. R., Mirjat, N. H., & Harijan, K. (2016). Assessment of renewable energy for electricity generation: Using Pakistan TIMES Energy Model. *Sindh University Research Journal, 48*, 775–778.

Valasai, G. D., Uqaili, M. A., Memon, H. R., Samoo, S. R., Mirjat, N. H., & Harijan, K. (2017). Overcoming electricity crisis in Pakistan: A review of sustainable electricity options. *Renewable and Sustainable Energy Reviews, 72*, 734-745.

Zahid, J., Junaid, A., & Inam, M. A. (2016). Prospects of shale oil and gas production in Pakistan: A review. *SSRN*.