Indus Consortium
for Humanitarian, Environmental & Development Initiatives

IBA CBER
Center for Business & Economic Research

FOSSIL GAS EXPANSION

Socio-Economic and Environmental Impacts on Pakistan

Fossil Gas Expansion and its Socio-Economic and Environmental Impacts on Pakistan

Acknowledgment

We would like to express our heartfelt gratitude to the organizations for their invaluable contributions especially Pakistan Fisher Folk Forum, Alternative Law Collective, and Village Development Organization. Your insights have been instrumental in shaping the outcomes of this research.

FOREWORD

Liaqat Ali
Chairman, Board of Director
Indus Consortium

It is with immense pleasure that I convey my heartfelt gratitude to the remarkable team of Centre for Business and Economic Research (CBER) at Institute of Business Administration (IBA), who diligently conducted the study "Fossil Gas Expansion and Its Socio-Economic and Environmental Impacts on Pakistan" in collaboration with the Indus Consortium. Indus Consortium's dedication and insights from the study have paved the way for a deeper engagement with the stakeholders in our mission to fulfil our commitments to reducing fossil gas reliance and addressing the pressing issue of climate change.

This study addresses one of the most pressing issues of our time: how to reconcile energy security with environmental sustainability and socio-economic equity. As global energy markets evolve and domestic natural gas production declines, Pakistan's reliance on imported liquefied natural gas (LNG) has surged, reshaping the energy landscape. However, this reliance comes with a price—one that manifests not only in economic and financial terms but also in social and environmental costs.

Through meticulous research, this report highlights the socio-economic disparities and environmental degradation exacerbated by fossil gas projects, using case studies of Karachi's coastal fishing communities and residents from Ghotki to illustrate how local livelihoods, public health, and ecosystems bear the brunt of industrial expansion. The study also serves as a roadmap for action, presenting evidence-based policy recommendations that call for a paradigm shift toward renewable energy, community-centric development, and stringent environmental safeguards. Emphasizing a just energy transition, it underscores the need to prioritize the most vulnerable populations, particularly women, whose livelihoods are disproportionately affected by climate change and industrial activities.

In an era defined by climate urgency and economic volatility, this report is both timely and necessary. It provides policymakers, stakeholders, and citizens with a vital tool to engage in informed, inclusive decision-making. I hope this study sparks constructive dialogue and inspires collective action to secure a sustainable and equitable energy future for Pakistan.

MESSAGE FROM IBA

Dr. Lubna Naz
Director, CBER-IBA

It is a pleasure to share my message on the successful completion of the study "Fossil Gas Expansion and its Socio-Economic and Environmental Impacts on Pakistan" on behalf the Center for Business and Economic Research (CBER). This insightful research sheds light on the challenges faced by Pakistan's energy sector and provides actionable recommendations for building a sustainable and energy-secure future. As domestic natural gas reserves dwindle, with production projected to decline by 4.1% annually, Pakistan's increasing reliance on liquefied natural gas (LNG) imports has brought financial, social, and environmental challenges. Circular debt continues to rise, inefficiencies in gas distribution persist, and methane leakage exacerbates greenhouse gas emissions, making it difficult for the country to meet its climate commitments. Communities in Karachi and Ghotki are particularly affected, facing disrupted livelihoods, environmental degradation, and health risks due to expanding gas infrastructure.

The study outlines key steps to address these issues, including diversifying the energy mix by prioritizing renewable energy sources such as solar, wind, and hydropower. It also calls for upgrading gas distribution systems to minimize inefficiencies, implementing corporate social responsibility (CSR) initiatives to support affected communities, and ensuring alignment with Pakistan's Nationally Determined Contributions (NDC's). Transparent pricing mechanisms and the expedited implementation of regional pipeline projects, such as TAPI and the Iran-Pakistan pipeline, are essential for long-term sustainability.

I extend my sincere congratulations to the research team led by Dr. Amir Jahan and commend the Indus Consortium for facilitating this important research. I am confident that together, our efforts will play a pivotal role in shaping Pakistan's energy policies and fostering a sustainable future.

MESSAGE FROM INDUS CONSORTIUM

Hussain Jarwar
CEO, Indus Consortium

The LNG terminals supported by international financial institutions (IFIs) in Pakistan have contributed to the country's reliance on expensive energy sources over the long term. The changing global political landscape, particularly the Russia-Ukraine conflict, has further exacerbated the challenges faced by low-income countries in purchasing costly LNG from spot markets. In Pakistan, we have repeatedly witnessed disruptions in long-term LNG supply contracts, resulting in cargo shortages and electricity load shedding.

According to World Bank data, Pakistan's power and gas sector faces a staggering circular debt of Rs 5.5 trillion (approximately 5.1% of GDP), driven by overdue generation costs, system losses, and pending payments.

The current government has requested Qatar, a key long-term LNG supplier, to suspend cargo deliveries for the entire year of 2025 due to an LNG surplus in Pakistan, highlighting the country's overcapacity in this sector. Despite this surplus, the government has issued licenses to corporations such as BISON Energy UAE for the construction of the Tabeer LNG terminal and Energas for LNG terminals. This decision risks creating additional stranded assets, especially as Pakistan grapples with economic challenges, a heavy debt burden, and dependence on costly energy imports.

Environmental and social concerns also pose significant risks. LNG infrastructure threatens marine life, adversely affects fishing communities, and has health implications for people living near these facilities.

The report titled "Fossil Gas Expansion and Its Socio-Economic and Environmental Impacts on Pakistan", developed by the CBER-IBA team, provides critical recommendations. It is suggesting halting the expansion of LNG infrastructure and prioritizing the transition to renewable energy. Renewable energy investments offer more sustainable environmental and social benefits while creating economic opportunities for local communities, reducing dependence on imported fossil fuels, and addressing the urgent need for climate action".

On behalf of the Indus Consortium, I extend my heartfelt thanks to Dr. Lubna Naz, Director of Business and Economic Research, and her team, especially Dr. Aamir Jahan Khan and others, for their commendable efforts in producing this insightful research. Their work considers environmental, social, and economic perspectives and will undoubtedly serve as a valuable resource for energy planners, journalists, researchers, and communities focusing on sustainable energy solutions.

IBA TEAM PROFILE

Dr. Amir Jahan Khan

Dr. Amir is a trained economist and Associate Professor of Economics at IBA Karachi. He brings extensive experience as a research economist in the UK and Pakistan, with expertise in decision analytic modeling, cost-effectiveness analysis, and quantitative tools. He has completed consultancy projects for businesses, public and private sectors, and nonprofit organizations while advising on environmental issues, healthcare reforms and energy policy. With over 20 publications in journals such as JMIR and BMJ Open, he specializes in integrating economic insights into business strategy and public policymaking.

Aysha Khatoon

Aysha Khatoon is a dedicated educator and researcher specializing in economics. With extensive teaching experience at renowned institutions, including Government of Sindh, college education Department and the Institute of Business Administration (IBA) Karachi, she excels in curriculum development and innovative teaching methodologies. Her research spans environmental economics, child health, and socioeconomic dynamics, with notable contributions to projects by UNICEF, the World Bank, and the UN-IOM. Aysha's scholarly work includes publications in esteemed journals and presentations at international conferences. She is pursuing a PhD in Economics at IBA, Karachi, focusing on waterborne contamination and child health, and has received accolades for academic excellence and research impact.

INDUS CONSORTIUM TEAM PROFILE

Majid Bilal Khan

Mr. Majid Bilal Khan, a Fulbright Alumni, is a dedicated researcher and professional specializing in renewable energy. He is currently pursuing a PhD in Wind Energy Systems at the University of Massachusetts, Amherst, USA. Mr. Khan earned his master's degree from the University of Applied Sciences-Flensburg, Germany, and conducted research at the prestigious Fraunhofer Institute in Hannover. His academic background is further enriched by significant research and teaching experience, including a faculty role at Comsats University. As the Program Manager for Just Energy Transition at Indus Consortium, Mr. Khan applies his expertise to drive strategic initiatives aimed advancing renewable energy technologies and driving innovative approaches for a sustainable future.

Izzah Batool

Izzah Batool is currently serving as a Research Associate-Just Energy Transition at Indus Consortium. She has a bachelor's degree in physics and has earned a master's degree in Energy Systems Engineering from NUST. She possesses a strong interest in renewable energy technologies particularly solar energy applications and battery storage. Her research work on developing Self-cleaning coatings for solar panels has been published in Solar Energy, an open access journal of International Solar Energy Society. At Indus Consortium, she is engaged in research and advocacy on phase out of fossil fuels and promotion of renewable energy in the country.

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ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
AIIB	Asian Infrastructure Investment Bank
Bcf	Billion cubic feet
CBER	Centre for Business and Economics Research
CO_2	Carbon Dioxide
CH_4	Methane
EETL	Engro Elengy Terminal Limited
EIA	Environmental Impact Assessment
ETPL	Energas Terminal Private Limited
FSRU	Floating Storage Regasification Unit
FZCO	Free Zone Company
GHG	Greenhouse Gases
IC	Indus Consortium
IFC	International Finance Corporation
LNG	Liquefied natural gas
MPCL	Mari Petroleum Company Limited
MMBTU	Metric Million British Thermal Unit
$MtCO_2e$	Million Metric Tons of CO_2 Equivalent
Mtoe	Million Tons of Oil Equivalent
Nox	Nitrogen Oxides
NDCs	Nationally Determined Contributions
OGRA	Oil and gas regulatory authority
PGPCL	Pakistan Gas Port Consortium Limited
PQA	Port Qasim Authority
RLNG	Re-gasified Liquefied Natural Gas
SNGPL	Sui Northern Gas Pipelines Ltd
SO2	Sulfur Dioxide
SSGCL	Sui Southern Gas Company Ltd

ABBREVIATIONS AND ACRONYMS

TEPL	Tabeer Energy Private Limited
UFG	Unaccounted For Gas
WB	World Bank

EXECUTIVE SUMMARY

This report examines the socio-economic and environmental impacts of fossil gas expansion in Pakistan, with a specific focus on the development of Liquefied Natural Gas (LNG) infrastructure. Commissioned by the Indus Consortium and conducted by the Centre for Business and Economics Research (CBER), the study evaluates Pakistan's increasing reliance on LNG to bridge the widening gap between declining domestic gas production and growing energy demand. The findings underscore both the opportunities and challenges associated with this transition.

Domestic gas production has stagnated since 2008, driven by low commercial viability and security challenges in gas-rich regions. Pakistan's gas reserves are depleting, with production forecasted to decline by 4.1% annually through 2033, exacerbating supply shortages. LNG imports, initiated in 2015, now constitute over 28% of local gas consumption. However, reliance on LNG has introduced financial and energy security challenges, including price volatility and rising import costs.

LNG imports have reduced electricity generation costs but have exposed the government to significant fiscal pressures due to subsidies and circular debt, which is projected to rise to PKR 2.429 trillion by 2025. The high cost of LNG has disproportionately burdened households and industries, affecting competitiveness and affordability. Case studies of Karachi's fishing communities and Ghotki's agricultural transition reveal adverse impacts on local livelihoods, health, and social structures, particularly for vulnerable populations such as women.

The construction and operation of LNG terminals have resulted in habitat destruction, biodiversity loss, and increased methane emissions, which have a global warming potential significantly higher than carbon dioxide. Methane leakage during production and transportation exacerbates Pakistan's climate vulnerabilities, with national emissions steadily rising. Coastal communities have suffered from water pollution and reduced fish stocks due to industrial activities, compromising their economic and ecological resilience.

Operational transparency must be enforced through public disclosure of LNG terminal operations to build trust and minimize community disruptions. Formal mechanisms should be developed to involve local communities in monitoring terminal activities and addressing grievances. Additionally, banning the disposal of industrial waste into coastal waters and mandating responsible waste practices are immediate priorities.

Strategic actions include halting the approval of additional LNG infrastructure to prevent financial and environmental risks. Investments should be redirected from fossil gas projects toward solar, wind, and small hydroelectric projects to ensure sustainable energy development. Methane emissions must be minimized through stringent leak detection and repair programs, while comprehensive Environmental Impact Assessments (EIAs) are required for all new LNG projects to address cumulative socio-environmental impacts. Furthermore, systems to track the health impacts of industrial activities on local communities must be established to ensure timely interventions.

While LNG has played a critical role in mitigating Pakistan's energy crisis, its socio-economic and environmental costs underscore the need for a strategic shift. A just energy transition prioritizing renewable energy, community welfare, and environmental sustainability is essential to secure Pakistan's long-term energy future. Policymakers, industry stakeholders, and communities must collaborate to balance immediate energy needs with sustainable development goals.

INTRODUCTION

The Indus Consortium (IC) signed a contract on 04 July 2024 with the Centre for Business and Economics Research (CBER) at IBA to undertake a study on Fossil Gas Expansion and its Socio-economic and Environmental Impacts on Pakistan. The main objective of the project is to document selected development of Liquefied Natural Gas (LNG) terminals in context of fossil gas rising demand in Pakistan and analyze socio-economic and environmental impacts of expansion of fossil gas on Pakistan.

Natural gas is a crucial part of Pakistan's energy mix due the cost advantage over oil and availability of local natural reserves. The natural gas accounts for a significant portion of energy supply and energy consumption in the country. However, since 2008, domestic production of natural gas is stagnated due to security issues in gas-rich areas and low well-head prices, that have affected the commercial viability of new exploration and production projects. The growing demand and declining domestic supply have led to a significant natural gas deficit in the market. Excessive consumption and wastage by the household consumers sector due to relatively low price have exacerbated the situation over the years.

The country's gas reserves are also depleting because of excessive usage. To bridge the gap between supply and demand, Pakistan has turned to LNG imports since 2015. This strategy has been effective in meeting the increasing consumption needs and has positioned Pakistan as a major player in the international LNG market. The import of LNG has not only addressed the supply deficit but also helped reduce the overall cost of electricity generation in Pakistan. Between 2017 and 2020, the use of LNG for power generation saved approximately Rs. 234 billion compared to using residual furnace oil (RFO).

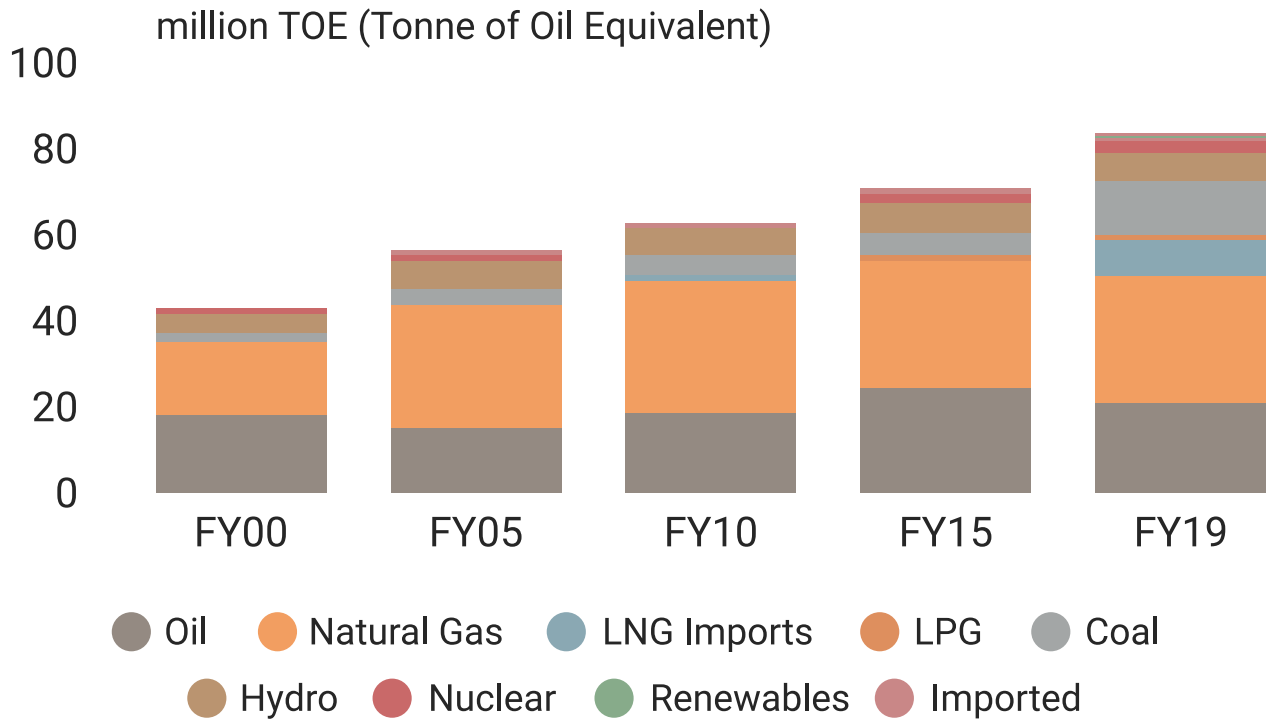


Figure: 1- Primary Energy Supplies by Sources in Pakistan

Source: (Hydrocarbon Developmnet Institute of Pakistan, 2022-23)

Oil has been a significant component of Pakistan's energy mix (Figure 1), although the share of oil in supply has fluctuated. Natural gas consistently contributes a large portion, making up nearly 35% of the total energy supply by FY19. Coal usage has gradually increased, especially in recent

years. Renewable energy sources have also seen a gradual increase, indicating a growing focus on sustainable energy. Hydroelectric power remains a stable part of the energy mix, while nuclear energy contributes a small share. The use of liquefied petroleum gas (LPG) is minimal compared to other sources. LNG imports, which started around 2015, have grown significantly, highlighting Pakistan's efforts to supplement local natural gas supplies. The reliance on imported energy sources has increased to meet growing energy demands.

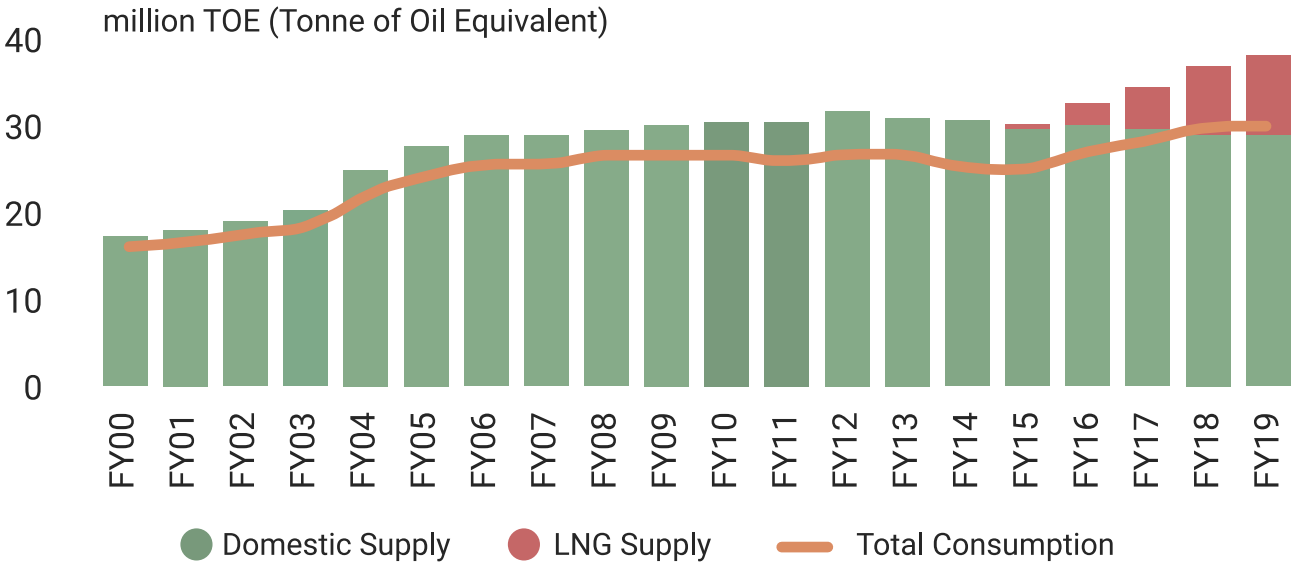


Figure: 2- Natural Gas Supply and Consumption in Pakistan

Source: (Hydrocarbon Developmnet Institute of Pakistan, 2022-23)

Figure 2 shows the supply and consumption of natural gas in Pakistan from 2000 to 2019, also measured in million ton of oil equivalent (TOE). The green bars represent the domestic supply of natural gas. After a steady increase in the early 2000s, domestic production has stagnated since 2008. The blue line indicates the total consumption of natural gas, which has continued to rise despite stagnation in domestic supply, driven by increased demand from various sectors, including power generation, households, and industries. In Figure 3, the red bars starting from 2015 show the introduction and rapid increase of LNG imports. This reflects Pakistan's strategy to address the gap between domestic supply and growing demand by importing LNG.

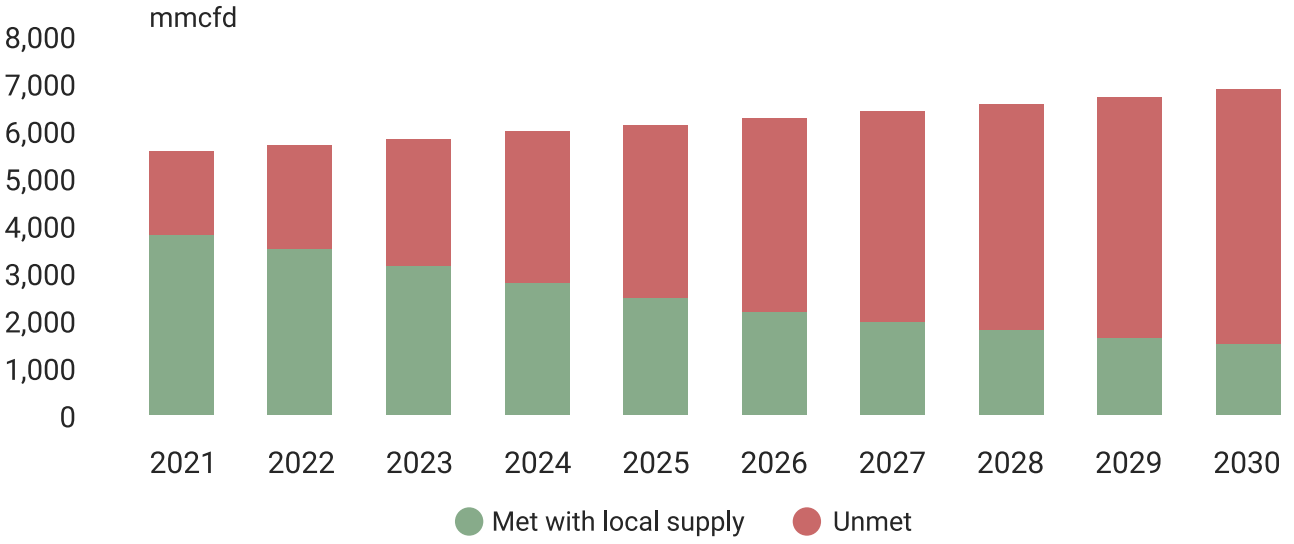


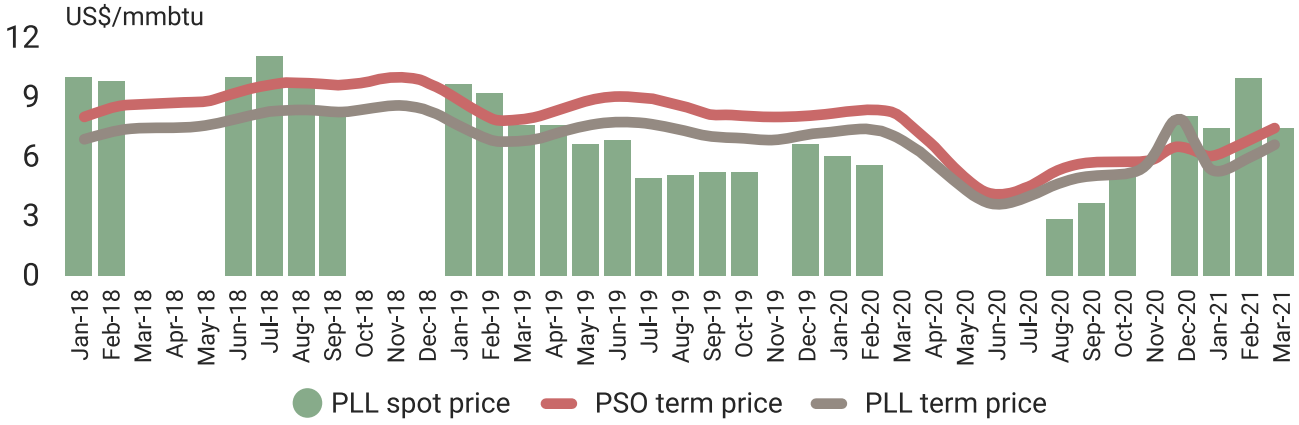
Figure: 3- Estimated Gas Demand in Pakistan

Source: (State Bank of Pakistan, 2019)

Figure 3 shows the projected gas demand in million cubic feet per day (mmcfd) from 2021 to 2030. It highlights the portion of the demand that is expected to be met by local supply versus the unmet

demand. From 2021 onwards, the green bars represent the volume of gas demand that can be met by Pakistan's indigenous gas supplies. However, local supply is insufficient to meet the total demand, as indicated by the substantial red bars that represent the unmet demand. Over the years, the gap between supply and demand widens, with local supply remaining relatively constant while the unmet demand continues to increase.

By 2030, projections suggest that only 22.3 percent of Pakistan's estimated gas requirements may be met through domestic production, underscoring the need for a focused strategy to enhance local natural gas exploration and utilization. Despite frequent announcements of new natural gas discoveries, limited efforts are made to develop and recover these resources effectively. Rather than relying on external solutions, the Pakistani government should prioritize the exploration of untapped reserves and expedite the operationalization of discovered fields to meet the nation's energy demands sustainably. Estimates by the energy ministry and OGRA suggest that the average annual net gas shortfall during the period from 2021 to 2030 will be 2,593 mmcfd. This will require expansion in gas exploration activities in the country, reconsider its pricing policies, and expedite the development of the I-P and TAPI pipeline projects to mitigate the looming energy crisis.



PLL spot price: Price of LNG imports purchased by PLL on spot basis.
PLL term prices: Price of LNG imports purchased by PLL on term basis.
PSO ter price: Price of LNG imports purchased by PSO on term basis.
Months where bars are absent are the onws in which no PLL spot imports were observed.

Figure 4- Import Price on LNG in Pakistan

Source: (State Bank of Pakistan, 2019)

Figure 4 shows the import price trends of LNG in Pakistan from January 2018 to March 2021, measured in US dollars per million British thermal units ($/MMBtu). The comparison of the prices of LNG imported on a spot basis by Pakistan LNG Limited (PLL), shown in green bars, against the term prices of LNG imported by PLL (blue line) and Pakistan State Oil (PSO) (red line).

Overall, the PLL spot prices were generally lower than the term prices. However, there were periods, especially during winter months, where spot prices exceeded term prices. This spike in spot prices during winters is likely due to increased demand driving up global prices. The graph also shows that there were months without green bars, indicating no spot imports by PLL during those times.

Local natural gas demand is projected to grow at an average annual rate of 3% from 2024/25 to 2033/34, driven by the fertilizer and textile manufacturing sectors, and gas-fired power plants.

1.1. Natural Gas Demand Forecasting in Pakistan

Local natural gas demand is projected to grow at an average annual rate of 3% from 2024/25 to 2033/34. This increase will mainly be driven by the fertilizer and textile manufacturing sectors and gas-fired power plants, although the consumption of textile industry will be moderated by efforts to shift towards local coal power.

Years	2022	2023	2024	2025	2026	2027	2028	2033
Consumption	32,640	32,392	32,998	34,013	35,251	36,474	37,746	43,651
% Change	-7.7	-0.8	1.9	3.1	3.6	3.5	3.5	2.1

Notes: The data for 2022 and 2023 are estimates from the Economist Intelligence Unit (EIU). The projections from 2024 onwards are EIU forecasts.

Table: 1- Natural Gas Consumption Forecast (Ktoe)

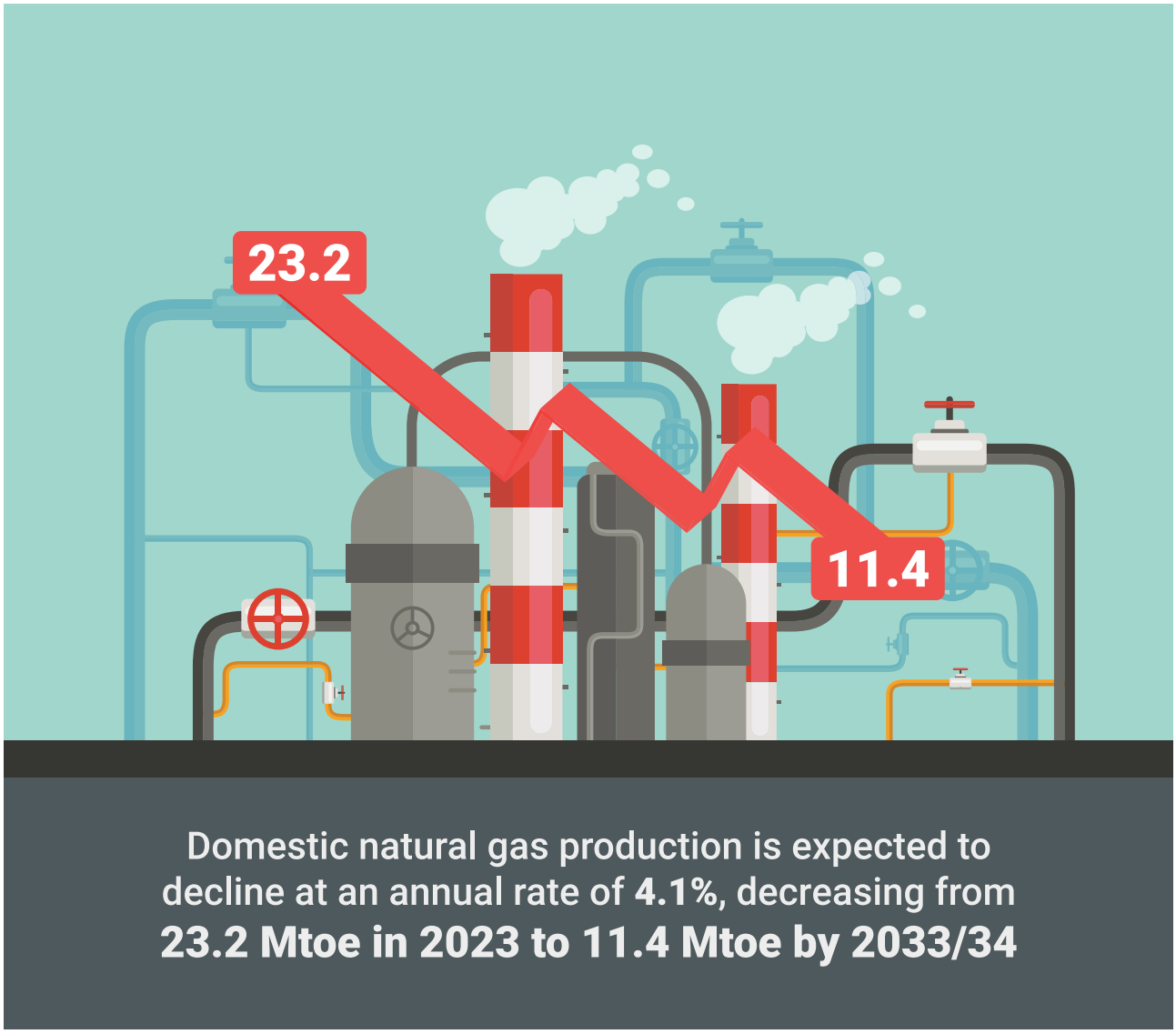
Sources: (EIA, 2017) and (Economist Intelligence Unit, 2024)

Table 1 describes the projected natural gas consumption in Pakistan from 2022 to 2033, measured in thousand tons of oil equivalent (ktoe). In 2022, the estimated consumption was 32,640 ktoe, reflecting a significant decrease of 7.7% compared to the previous year. By 2023, consumption slightly decreased to 32,392 ktoe, a marginal drop of 0.8%. However, from 2024 onwards, the forecast shows a positive trend. Consumption is expected to increase to 32,998 ktoe in 2024, showing a growth of 1.9%. This upward trend continues in 2025 with an estimated consumption of 34,013 ktoe, marking a 3.1% increase. In 2026, consumption is projected to rise to 35,251 ktoe, reflecting a growth of 3.6%. The forecast for 2027 shows consumption reaching 36,474 ktoe, a 3.5% increase, and in 2028, consumption is expected to further rise to 37,746 ktoe, another 3.5% increase. Looking ahead to 2033, the long-term forecast predicts consumption at 43,651 ktoe, with a more modest

annual growth rate of 2.1%. These projections indicate a steady increase in natural gas consumption over the years, following an initial decline.

1.2. Natural Gas Supply Forecasting in Pakistan

In 2023, Pakistan's natural gas reserves were estimated to be around 18.3 trillion cubic feet. Recent exploration activities have yielded only minor gas deposits. Domestic natural gas production is expected to decrease at 4.1% rate, the decline will continue with production reaching 11.4 million toe by 2033/34.



Starting in 2015 LNG import steadily increased in the country, accounting for over 28% of local consumption by 2021. However, from July 2022 to March 2023, imports dropped by 17% year-on-year due to high spot LNG prices and some long-term suppliers also charging high prices. As global natural gas prices are expected to decline in 2024-25, Pakistan's imports are likely to rise.

In 2023, LNG imports grew by 5% year-on-year, with key suppliers being Qatar, the US, Nigeria, the UAE, Oman, Egypt, Algeria, Angola, and Malaysia. These shipments arrive at Pakistan's two LNG terminals at Port Qasim, with a combined regasification capacity of 40.7 million cubic meters per day. Plans to expand these facilities and build additional terminals are expected to face delays due to underutilization and limited government financing. Pakistan also plans to import gas via the Turkmenistan-Afghanistan-Pakistan-India (TAPI) pipeline and a proposed pipeline from Iran, but both projects face significant delays due to funding and security issues. Additionally, the Pakistan Stream gas pipeline project with Russia is not expected to begin construction before 2025.

Years	2022	2023	2024	2025	2026	2027	2028	2033
Consumption	24,206	23,206	22,206	21,006	20,106	19,206	18,006	11,406
% Change	-2.2%	-4.1%	-4.3%	-5.4%	-4.3%	-4.5%	-6.2%	-10.9%

Notes: a: EIU estimates, b: EIU forecasts and c: Fiscal years ending June 30th of year indicated.

Table 2: Natural Gas Production Forecast (Ktoe)

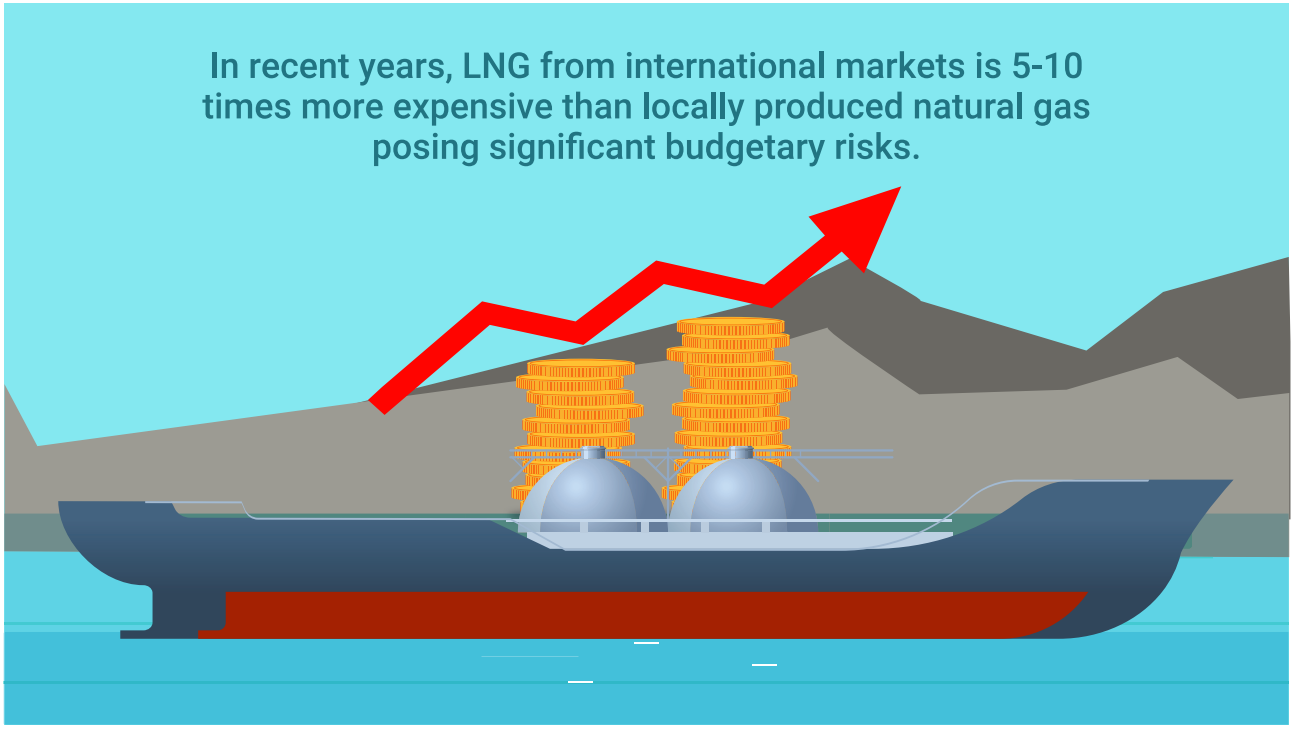
Sources: (EIA, 2017) and (Economist Intelligence Unit, 2024)

In 2022, production was 24,206 ktoe, marking a 2.2% decrease from the previous year. By 2023, production dropped further to 23,206 ktoe, a 4.1% decline (Table 2). The downward trend continues with a forecasted production of 22,206 ktoe in 2024, a 4.3% decrease. In 2025, the decline sharpens to 5.4%, with production expected to be 21,006 ktoe. The pace of decline slightly moderates in 2026 with a 4.3% reduction to 20,106 ktoe. However, in 2027, production is projected to drop to 19,206 ktoe, a 4.5% decrease. The forecast for 2028 shows a more significant decline of 6.2%, bringing production down to 18,006 ktoe. By 2033, production is expected to fall drastically to 11,406 ktoe, a substantial 10.9% decrease from the previous year.

1.3. Increasing Reliance on LNG in Pakistan

Pakistan's growing reliance on imported liquefied natural gas (LNG) is worsening energy insecurity and financial challenges within the energy sector. Natural gas has traditionally been a cornerstone of Pakistan's economy, but with domestic production on the decline, policymakers are increasingly turning to LNG imports to fill the gap. This shift is driven by several factors that align with optimistic projections for LNG demand, such as rising consumption, a varied end-user base spanning multiple economic sectors, and an extensive and expanding transmission and distribution network. However, the anticipated benefits of integrating more LNG into the country's energy mix have instead led to economic and energy security challenges.

LNG suppliers have frequently failed to fulfil their contractual obligations, sometimes leaving Pakistan without sufficient fuel or power. These unexpected shortages have had a direct negative impact on the productivity of domestic businesses. LNG procured from international markets has often been 5-10 times more expensive than locally produced natural gas. The extreme price volatility of LNG over the past two years has complicated energy sector planning and exposed the government to significant budgetary risks (IEEFA, 2022).



Although LNG is often promoted as a "bridge fuel" to cleaner, more affordable energy sources, it has at times forced Pakistan to fall back on more polluting alternatives, such as coal sourced from Afghanistan, when gas prices surge. Experts anticipate that LNG prices will remain high and subject to significant fluctuations for the next several years. The high cost of imported gas has also highlighted persistent issues within the national gas system, including final tariffs that do not reflect true costs, inefficient cross-subsidization, and substantial losses of unaccounted-for gas (UFG) during distribution. As LNG imports increase, these systemic issues are expected to worsen. The circular debt problem a chronic cash flow deficit arising from unpaid dues between buyers and suppliers that has long affected Pakistan's power sector—has now extended into the gas sector. The financial strain posed by LNG, compounded by payments required in U.S. dollars, is likely to ripple through the economy, impacting the national budget, household energy expenses, investor confidence in the energy sector, and the productivity of key industries such as textiles and fertilizers (IEEFA, 2022).

1.4. The Escalating Circular Debt Crisis

Circular debt remains one of the most pressing challenges facing Pakistan's power sector. Despite government efforts, the debt is projected to rise, reflecting systemic inefficiencies and poor financial management within the sector. As of the current fiscal year, circular debt stands at Rs2.393 trillion and is expected to increase to Rs2.429 trillion by June 2025. Key contributors include electricity theft, low bill recoveries, and persistent line losses, which have already exceeded permissible regulatory limits. For instance, line losses are allowed up to 11.4% by NEPRA, but the government has permitted 17.3% under the new plan, effectively admitting its inability to enforce stricter efficiency measures. Additionally, under-recoveries of Rs315 billion in the last fiscal year are now expected to grow to Rs419 billion a 33% increase (Shahbaz Rana, 2024) and (Government of Pakistan, 2023-24).

To manage the circular debt, the government has resorted to significant electricity tariff hikes. In June 2023, the base electricity rate (excluding taxes) was Rs23.39 per unit, which has since risen to Rs28.44 per unit, with projections of Rs33 per unit by June 2025. These adjustments are intended to generate additional revenue, but they come at a steep cost to consumers. Increased tariffs exacerbate the financial burden on households and businesses, making electricity less affordable and further eroding public trust in the power sector (Shahbaz Rana, 2024) and (Government of Pakistan, 2023-24).

The reliance on tariff hikes highlights deeper structural issues, as these increases fail to address the root causes of inefficiencies. Instead of improving recoveries and reducing operational losses, the government's strategy disproportionately shifts the financial burden onto consumers. The rising circular debt and its associated challenges directly impact on the financial sustainability of power distribution companies (Discos). These entities struggle to invest in infrastructure upgrades, leading to frequent outages and poor delivery service. The financial strain also discourages private investment in the energy sector, leaving the government to shoulder the load of subsidies and operational costs.

1.5. Gas Based Electricity Plants in Pakistan

Pakistan's energy sector includes both operational and proposed gas-based electricity plants that contribute to its energy needs. The operational plants provide a substantial portion of the energy supply and have been established over the past several decades. Notable among these is the Engro Elengy Terminal at Port Qasim, Karachi, which has a capacity of 690 MMCFD and has been operational since 2015. This facility, built at a cost of $150 million, is owned by Engro Corporation and represents a private-sector initiative supported by the government. Similarly, the Pakistan GasPort Consortium Limited (PGPC) Terminal, also located at Port Qasim, Karachi, has been operational since 2017, boasting a capacity of 750 MMCFD. This project cost $450 million and was partly financed by the World Bank (IEEFA, 2022) (details in appendices table 07).

Older facilities, such as the Sui Gas Field in Balochistan, have been operational since 1955 and continue to provide 400-500 MMCFD, owned by Pakistan Petroleum Limited (PPL). The Qadirpur Gas

Field in Sindh, managed by the Oil and Gas Development Company Limited (OGDCL), adds another 500 MMCFD. Other operational fields include the Kandhkot Gas Field in Sindh, contributing 200 MMCFD under PPL's management, and the Mari Gas Field in Sindh, which supplies 700 MMCFD and is owned by Mari Petroleum Company Limited (MPCL) (IEEFA, 2022) (details in appendices table 07).

In addition to these operational plants, Pakistan is planning to expand its energy capacity through proposed LNG-based plants. The Energas LNG Terminal at Chara Creek, Port Qasim, Karachi, is one such project, anticipated to have a capacity of 750-1000 MMCFD with an estimated cost of $180 million. Similarly, the Tabeer LNG Terminal at Jhari Creek, Port Qasim, Karachi, is proposed to reach a capacity of 750-1000 MMCFD, also with an estimated cost of $180 million, backed by UAE-based Bison Energy. The Daewoo Gas Terminal in Karachi, planned with a capacity of 365 MMCFD and a projected cost of $300 million, is spearheaded by Daewoo Gas and CNCEC. Additionally, the Easy LNG Terminal in Karachi, with a proposed capacity of 50-60 MMCFD and an estimated cost of $200 million, is managed by LNG Easy Pvt. Ltd (IEEFA, 2022) (details in appendices table 07).

The Fossil Gas is a relatively clean, and safe fuel, the gas supplies contribute to about 28.9 percent of Pakistan's total primary energy supply (Government of Pakistan, 2023-24). The government of Pakistan is trying to expand indigenous gas production and importing gas to meet the increasing energy demand in the country. The commercial supplies have increased over the last decade from 1,472 billion cubic feet (bcf) to 1,534 bcf, about one quarter of that consists of imported gas (Figure 1) . On the other hand, the total consumption in the country have reduced negligibly over the decade from 1,241 bcf to 1,225 bcf, that shows potential inefficiencies in the national grid and distribution system. About 40% fossil gas is consumed by various industries including cement and fertilizer, while power generation and household share stands at 32% and 26% respectively (Government of Pakistan, 2023-24).

Estimates show that over the next decade till 2033-34, local fossil gas demand will grow at an annual average of 3% (Economist Intelligence Unit, 2024). On the other hand, based on current projections the local supply of gas will decline between 3% to 4% over the next decade. With the current scenario of dwindled reserves and limited commissioning of new gas in the grid the gap between consumption and supply will widen. Therefore, reliance on imported LNG will increase in the coming days.

The LNG imports in Pakistan is growing at 3% annually in recent years (Government of Pakistan, 2023-24). The operational LNG infrastructure includes two LNG terminals near Karachi. Oil and gas regulatory authority (OGRA), granted licenses in 2016 and 2018 to Engro Elengy Terminal Limited (EETL) and Pakistan Gas Port Consortium Limited (PGPCL), respectively. The capacity of two FRSUs to Re-gasified Liquefied Natural Gas (RLNG) is 1,200 million cubic feet (per day) accordingly.

Further, OGRA granted construction licenses in April 2021 to Tabeer Energy Private Limited (TEPL) and Energas Terminal Private Limited (ETPL) to develop LNG terminals in Port Qasim Karachi. Moreover, an extension in the validity of these licenses has been granted by OGRA for a further two years (Government of Pakistan, 2023-24).

The rest of the document is structured in seven sections. Sections two and three present the profile of new companies in gas markets including Energas and Bison Energy. Section four and five present analyses on unaccounted for gas (UFG) and methane leakage in the gas supply. Section six list the contributions of bilateral and multilateral initiatives in Pakistan's gas market. Section seven report case studies of gas expansion's socio-economic impact on local communities in Ghotki and Karachi. The last section concludes with some discussion on policy recommendations.

ENERGAS TERMINAL PRIVATE LIMITED

The Energas LNG Terminal is constructed for affordable, competitive, and sustainable gas supplies for local RLNG buyers. A new firm's entry will potentially increase competition in the market that will help to provide affordable and sustainable gas supplies. The terminal also helps to reduce the national gas deficit, supporting the nation's growth. Further, the terminal will promote the usage of clean and environmentally friendly fuel sources. The terminal will also create jobs market and stimulate the development of an associated services industry (Energas, 2022).

The terminal is strategically located at Chara Creek, Port Qasim, Karachi (Energas, 2022) . The location offers numerous advantages for LNG import operations. The proximity to major industrial and urban centers in Sindh and Balochistan, ensuring efficient distribution to high-demand areas. Terminal's position along international LNG routes facilitate the receipt of LNG shipments from global suppliers, enhancing supply chain efficiency. Port Qasim provides essential infrastructure, including jetties, storage, and transportation facilities, which are crucial for the smooth operation of the LNG terminal. The terminal's strategic location and modern infrastructure makes the entity a critical asset in Pakistan's energy landscape. (Details of operational and proposed gas based electricity plants provided in table 4 appendices).

Owners and Stakeholders of Energas

Energas LNG Terminal Private Limited is a consortium of prominent Pakistani business groups. Key stakeholders include the Yunus Brothers Group, one of Pakistan's largest conglomerates involved in textiles, cement, and energy; the Lucky Group, known for its diverse business interests in cement, chemicals, automotive, and energy sectors; Halmore Power Generation Company, a significant player in Pakistan's power generation sector; and the Sapphire Group, engaged in textiles, power generation, and other sectors (Energas, 2022) This consortium aims to aggregate demand for a diverse customer base that might struggle to secure large LNG quantities independently, thus enhancing energy security and supporting industrial growth in Pakistan.

Licenses for LNG Terminal

ETPL has secured several key licenses and approvals to operate its LNG terminal efficiently. OGRA have issued the license for 10 years, starting January 8, 2021, and will expire on January 7, 2031. The regulator's license allows Energas to import LNG. Energas did not conduct an official Environmental Impact Assessment (EIA); however, it has received environmental clearance from the federal Environmental Protection Agency (EPA). This clearance was granted based on alternative environmental studies or assessments, such as a feasibility study or a Preliminary Environmental Report (PER). Energas fulfilled the necessary environmental documentation requirements stipulated by the EPA to obtain this approval, even though a full EIA was not undertaken. For the construction of the terminal, the company has been granted the required construction permits by the Port Qasim Authority (PQA) and other relevant bodies. Furthermore, Energas has secured operational approval from the Ministry of Energy (Petroleum Division), permitting the commencement of LNG regasification and distribution operations. These licenses come with two conditions: Energas needs to finalize an implementation agreement with the PQA to begin constructing the FSRU and must enter into gas transportation agreements (GTAs) with Sui Southern Gas Company Ltd (SSGCL) and Sui Northern Gas Pipelines Ltd (SNGPL) to facilitate the delivery of LNG to customers through the national gas pipeline network (OGRA, 2024).

Capacity and Cost

The terminal has a regasification capacity ranging from approximately 750 to 1,000 million cubic feet (per day) (IEEFA, 2022). This substantial capacity enables a robust supply of natural gas to the

national grid, ensuring energy security and supporting industrial growth. The terminal also includes large storage facilities, which are crucial for maintaining a continuous and reliable supply of LNG. Furthermore, the terminal is designed to accommodate a floating storage and regasification unit with a capacity of approximately 170,000 cubic meters. The FSRU enhances the terminal's operational flexibility and ability to handle varying demand levels, positioning it as a critical infrastructure asset in Pakistan's energy landscape. The estimated cost for the development and operationalization of the Energas LNG terminal is approximately $180 million (IEEFA, 2022) .This investment encompasses a wide range of expenditures necessary for the project's completion, including infrastructure development, the construction of storage facilities, the installation of regasification units, and the provision of ancillary services. This significant financial commitment underscores the project's scale and its pivotal role in strengthening Pakistan's energy infrastructure.

2.1. Environmental Impact Assessment (EIA) for LNG Projects Based on Port Qasim and International Terminals

The analysis presented for the Energas LNG Terminal project is not an official Environmental Impact Assessment (EIA), as no formal EIA has been conducted for this project to date. Instead, this evaluation is based on findings from previous studies and EIAs conducted for LNG terminal projects located at Port Qasim, Karachi. Since the proposed Energas LNG Terminal is also planned to be situated at Port Qasim, the environmental impacts are expected to be largely similar due to the shared location characteristics.

Additionally, this assessment incorporates insights from international LNG terminal EIAs to provide a broader context and reference for potential environmental effects. It examines possible impacts on biodiversity, ecosystem health, water and air quality, soil and surface water ecology, social and coastal communities, and climate, using analogous developments as a basis to anticipate likely outcomes.

Impact on Biodiversity

The construction activities associated with the LNG terminal could lead to significant habitat disturbances, including the removal of vegetation and disruption of soil. This could potentially displace local wildlife such as small mammals, reptiles, and bird species. Certain species, particularly those that are endangered or threatened, might be especially vulnerable to these habitat changes. Assessing the presence of these species is crucial to ensure they are not adversely affected (Consortium, 2023) (Catherine., 2019) (EMC, 2014). The construction and operation of the LNG terminal could impact marine life, including fish, crustaceans, and other aquatic organisms. Increased human activity and construction noise could disrupt local ecosystems. The fish and fishery-related sector employs 1% of the country's population. This sector also contributes 1% to Pakistan's GDP through the export of fishery products (Salma Nusrat, 2021)

Impact on Ecosystem Health

Construction activities can have profound and far-reaching impacts on ecosystem health. One of the most significant consequences is habitat fragmentation, which occurs when large, continuous habitats are divided into smaller, isolated patches. This fragmentation disrupts the natural movement and interaction of species, making it challenging for them to access resources, find mates, and maintain healthy populations (EMC, 2014) (Catherine., 2019) (Consortium, 2023).

Impacts on Water Quality

The construction and operation of the LNG terminal at Port Qasim pose several environmental challenges. Dredging activities in the Near Shore Project Area have severe pre-mitigation impacts on seagrass, coral, and associated biological communities (ADB, 2013) (Catherine., 2019). These impacts result from increased turbidity, cutting through reefs, and sediment deposition. Although

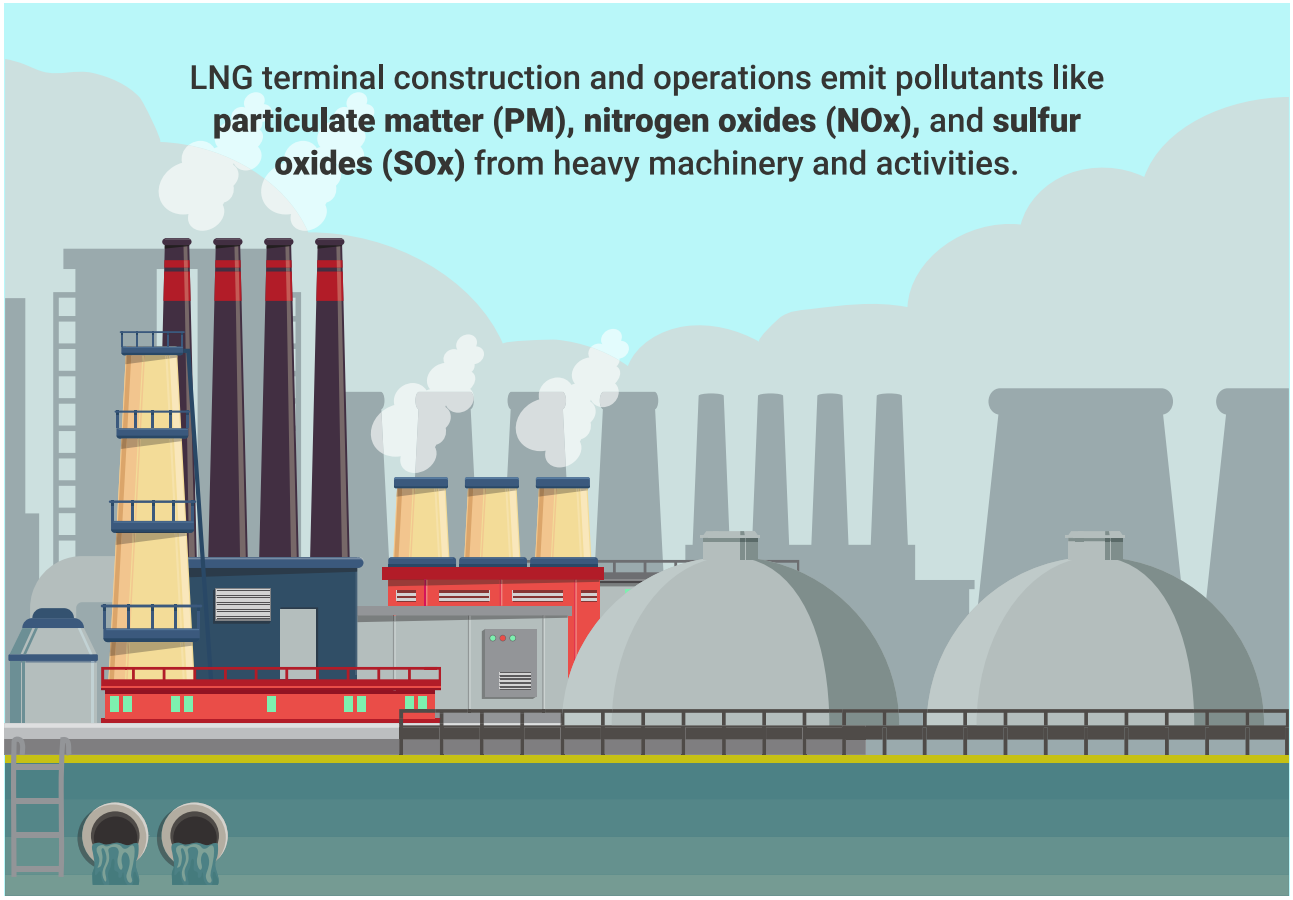
mitigation measures, such as changing dredging techniques and avoiding sensitive areas, can reduce the severity, some major impacts remain (Catherine., 2019) (EMC, 2014)

Discharges from desalination and sewage treatment plants, along with treated produced water, are expected to have negligible to minor significant impacts on near-shore water quality and marine flora and fauna. With proper mitigation, these impacts should remain negligible. Construction activities can lead to increased runoff and sedimentation, potentially introducing pollutants into nearby water bodies. This runoff can adversely affect aquatic ecosystems and the organisms that rely on them (Catherine., 2019) (EMC, 2014)

Although LNG spills are unlikely, they pose significant risks to both terrestrial and marine ecosystems. To mitigate such risks, robust emergency response plans are necessary. Thermal pollution is another concern, as the regasification process involves significant amounts of water, which can lead to thermal pollution if not properly managed. Additionally, there is a risk of chemical spills and leaks that could contaminate local water sources. This includes potential contamination from antifouling agents used on ships and other chemicals involved in the LNG process (Catherine., 2019) (EMC, 2014)

Impacts on Air Quality

In analyzing the environmental impacts of the Pakistan Energas LNG terminal, it is important to compare relevant statistics with those of established LNG projects, such as those in Australia. Air dispersion modeling for LNG projects, such as the study conducted by (Catherine., 2019) (EMC, 2014), indicates that emissions have minimal impacts on human and ecological receptors beyond the project site. Specifically, the modeling shows that sulfur dioxide (SO2) emissions before mitigation are of minor significance and become negligible post-mitigation. However, the expansion of LNG facilities, such as adding more processing trains, can elevate SO2 emissions to levels of moderate significance pre-mitigation.



During the construction and operational phases, LNG terminals release various pollutants, including particulate matter (PM), nitrogen oxides (NOx), and sulfur oxides (SOx), due to heavy machinery and construction activities. These pollutants contribute to atmospheric emissions that affect local air quality. Regasification and related processes also add to this environmental burden. For example, a report by (Phillips Petroleum Company, 2007) highlights significant annual emissions from LNG projects, including 537 tons of particulates, 130 tons of SO2, 6,152 tons of NOx, 1,942 tons of carbon monoxide (CO), 4,559,940 tons of carbon dioxide (CO2), and 464 tons of total organic carbon/ methane (TOC/CH4). These figures underscore the potential for considerable air pollution from LNG terminals, emphasizing the importance of robust mitigation strategies to minimize environmental impacts.

The Energas project is expected to significantly increase Pakistan's national GHG emissions, particularly CO2 and methane (CH4), potentially reaching major significance both during construction and operation. Methane leaks, though infrequent, pose additional risks due to methane's higher global warming potential compared to CO2 (Catherine., 2019) and (EMC, 2014). Pakistan has set an ambitious target under its Nationally Determined Contributions (NDCs) to achieve a cumulative 50% reduction in projected emissions by 2030. Under its Nationally Determined Contributions (NDC) report in 2021 for the UN Climate Change Conference COP26 in Glasgow in November 2021, Pakistan set an ambitious cumulative GHG reduction target of 50% below its projected 2030 emissions under a business-as-usual (BAU) scenario (equivalent to more than 4,000 MtCO2): with an unconditional reduction of 15% financed from the country's own resources and a conditional reduction of 35% subject to the provision of international grant finance that would require an estimated US$101 billion just for energy transition (Government of Pakistan, 2021). This is a substantial upgrade of Pakistan's ambition relative to its 2016 NDC report for the COP21 in Paris in December 2015. At the time, the country set a conditional reduction target of 20% below its projected 2030 BAU emissions, subject to the availability of international support amounting to US$40 billion (Government of Pakistan, 2016). To reach these updated goals, Pakistan plans to transition to 60% renewable energy and ensure 30% of vehicles are electric by 2030, along with banning coal imports and enhancing nature-based solutions. The updated NDC also expands its scope to include new sectors and additional greenhouse gases to bolster contributions. Moreover, the revised NDC emphasizes a more comprehensive approach to adaptation, addressing the needs of various sectors and highlighting the importance of addressing loss and damage due to climate impacts (UNDP, 2021).

Impacts on Soil and Land Capability

Site clearance will result in soil compaction, topsoil loss, erosion, and alteration of natural drainage, with moderate significance reduced to minor with mitigation. Fuel spills are likely to have negligible impacts due to preventive measures. Groundwater abstraction may result in negligible impacts on community wells and environmental receptors during the early construction phase (Catherine., 2019) (EMC, 2014).

Impacts on Surface Water Ecology

The loss of wetland and estuarine habitat during construction is of major significance due to the loss of ecological functions. Mitigation measures will reduce this to moderate significance. Increased turbidity and changes to sediment patterns may affect connectivity and primary production, with impacts potentially remaining major but reduced to minor to moderate with mitigation (Catherine., 2019) (EMC, 2014).

The Darwin LNG Terminal in Northern Territory, Australia, began operations in 2006 with a capacity of 3.7 million tonnes per annum (mtpa), or 0.46 billion cubic feet per day (bcfd). The project had an initial cost of USD 1.6 billion. The terminal is primarily operated by Santos (43.4%) and supported by various partners such as SK E&S, INPEX, Eni SpA, JERA, and Tokyo Gas. It initially processed gas from the Bayu-Undan field and is set to restart operations in 2025, sourcing gas from the Barossa field.

Table 3 represents that, in solid waste such as waste lubricating oils, spent oils, cellulose, biological sludge, inorganic sludge, oily sludge, spent solvents, ceramic balls, molecular sieve waste, and trash is removed from the site by waste management contractors. Waste lubricating oils, spent oils, oily sludge, and spent solvents are typically transported to a lime kiln for disposal. Cellulose, ceramic balls, molecular sieve waste, and trash are disposed of in landfills following appropriate testing and regulatory approval. Biological sludge is disposed of at local sewage treatment plants according to regulatory requirements, while inorganic sludge is de-watered, tested, and then disposed of in landfills. Darwin-based waste management companies have facilities to dewater oily sludge. Treated water effluent is mostly used for irrigation and landscaping of premises. Atmospheric emissions, including particulates, SO2, NOx, CO, and CO2, are monitored, reported, and released into the atmosphere as per permits, while TOC/CH4 is burnt in an incinerator and transformed into CO2 (Phillips Petroleum Company, 2007)

Solid waste type	Tonnes per year	Liquid waste type	Tonnes per year	Emission Type	Tonnes per year
Waste lubricating oils	16	Treated water effluent	96725	Particulates	537
Spent oils	1.5			SO2	130
Cellulose	2			NOx	6152
Biological sludge	5			CO	1942
Inorganic sludge	0.4			CO2	4,559,940
Oily sludge	60			TOC/CH4	464
Spent solvents	0.2				
Ceramic balls	5.5				
Molecular sieve waste	72				
Trash	80				

Table: 3 Waste expected from Darwin LNG construction and operation

Source: (Phillips Petroleum Company, 2007)

Social Impact

The coastal communities around Port Qasim rely heavily on the economic and ecological benefits provided by the mangrove forests and mud plains for their livelihoods. Over the past two decades, these communities have been significantly affected by increased construction and economic activities in the area. The addition of a new LNG terminal and its operations is expected to further strain their livelihoods due to reduced fish catches, increased water pollution, and the displacement of mud and waste (Consortium, 2023) (details provided on section 7).

Impact on Coastal Communities

Several coastal communities, including permanent fishing villages such as Ibrahim Hyderi, Rehri, and Lat Basti, are situated along the coast. Rehri, a primary fishing village located east of the proposed LNG plant site, has a history spanning about 400 years and has been home to generations of fishermen. The construction of the Kotri Barrage in 1958 led to the loss of freshwater in many parts of the Indus Delta, prompting many affected individuals to settle in and around Rehri Village. These communities rely on coastal resources for food, fodder, fuel wood, sea salt, timber for temporary huts (jhuggis), and income. Most of the population in these areas is engaged in fishing, fishing trade, labor in fishing industries, forest products, fishing boats, boat engine mechanics, and camel raising. These traditional fishing communities practice sustainable fish harvesting, ensuring they do not deplete fish stocks or damage the mangroves (Consortium, 2023) (details provided on section 7).

Climate Impact

The Energas LNG Import Terminal Project will be situated in a coastal zone characterized by a relatively mild climate, with dry, hot, and humid conditions. Around Port Qasim, the meteorological

conditions are characterized by hot and relatively humid weather, especially during the summer months from April to October. Winters in the region are short and mild, lasting from December to mid-February, with prevailing northeast winds and very little rainfall. A significant feature of the area's meteorological conditions is the generally high dust levels due to the arid surroundings; dust storms are common during both summer and winter monsoons.

Given these climatic conditions, the Energas LNG Import Terminal Project faces several challenges. The hot and humid weather can lead to operational inefficiencies and increased energy consumption for cooling and maintaining the LNG at cryogenic temperatures, potentially increasing greenhouse gas emissions. Furthermore, the high dust levels can impact the equipment's longevity and efficiency, leading to frequent maintenance and operational disruptions. Additionally, the region's susceptibility to dust storms can cause significant safety hazards and operational shutdowns. (Ebinger, 2011) found that high temperatures and dust storms significantly impair the efficiency of energy projects in coastal areas, posing risks to both infrastructure and environmental sustainability.

Figure 5 provide a comprehensive record of maximum and minimum air temperatures at 2 meters above the ground for the coastal area of Chara Creek, Port Qasim, Karachi. The data spans from the year 2001 to 2022, showing monthly variations in temperature. The maximum temperatures show a seasonal pattern, with the highest temperatures typically occurring in the months of May, June, and October. The highest recorded maximum temperature was 47.99°C in May 2017. Other notably high maximum temperatures include 46.68°C in May 2009 and 46.18°C in May 2018. January and February have relatively lower maximum temperatures, generally ranging between 27°C and 31°C. The summer months (April to June) often see temperatures exceeding 40°C, with peaks reaching above 45°C in certain years. During the southwest monsoon (July and August), temperatures moderate slightly due to cloud cover, but still remain high, ranging between 35°C and 44°C.
The minimum temperatures also show seasonal patterns, with the lowest temperatures generally recorded in January and December. The lowest recorded minimum temperature was 2.49°C in February 2008. Other notably low minimum temperatures include 4.24°C in February 2005 and 3.26°C in February 2012. Winter months (December to February) show minimum temperatures ranging between 5°C and 15°C. The summer months (April to June) have higher minimum temperatures, generally between 18°C and 27°C. During the southwest monsoon (July and August), minimum temperatures are also high, ranging between 23°C and 27°C.

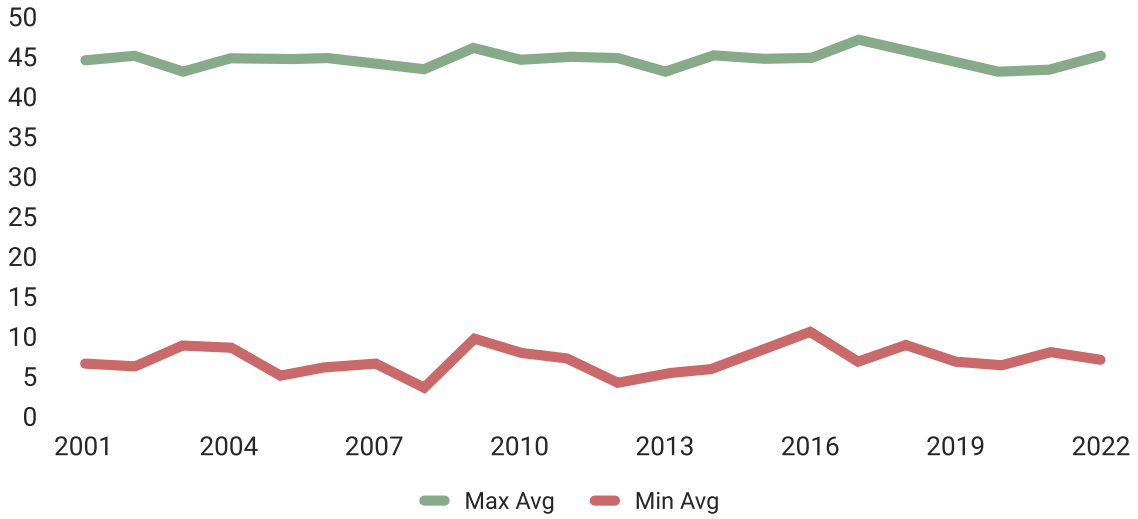


Figure: 5 Comparison of Minimum and Maximum Average Temperature (Celsius) of Chara Creek Port Qasim (2001-2022), from Satellite data (Power access NASA)

2.2. Energas LNG Terminal and Adherence to International Standards

The Energas LNG Terminal at Port Qasim, Karachi, has been designed to meet Pakistan's growing energy needs by reducing reliance on depleting local gas resources. Since no Environmental Impact Assessment (EIA) has been conducted for the Energas LNG Terminal, it cannot be definitively stated that the project adheres to international standards. However, based on general practices in LNG infrastructure development and information from similar projects, it appears that the design incorporates elements commonly aligned with international standards in areas such as safety, environmental considerations, and technology deployment. A formal EIA would be necessary to validate compliance with these standards for this specific project. Energas complies with International Maritime Organization (IMO) guidelines for LNG shipping and storage, and the project incorporates ISO 16903 standards to address cryogenic risks and environmental safety. Additionally, the use of FSRU aligns with global technological standards, ensuring cost-effectiveness and quick deployment, while financing through a consortium of local and international investors meets international norms for transparency and private sector involvement.

However, the project also faces challenges that may deviate from global best practices. Regulatory uncertainties in Pakistan, particularly in pipeline capacity allocation and energy pricing, contrast with the transparency and predictability emphasized in international standards. The potential for cost overruns due to regulatory delays and evolving policies could further complicate the project, straying from the efficient timelines seen in developed markets. The Energas LNG project has conducted a feasibility study; however, this document is not publicly available. Additionally, there is no Environmental Impact Assessment (EIA) currently available for the Energas LNG terminal. This lack of publicly accessible information makes it challenging to evaluate potential gaps in the EIA, such as those related to methane leakage or impacts on the local ecosystem. This underscores the importance of ensuring transparency and accessibility to key environmental and feasibility documents for stakeholders and the public to assess the project comprehensively.

BISON ENERGY FREE ZONE COMPANY (FZCO): PAKISTAN OPERATIONS PROFILE

Bison Energy FZCO, a UAE-based energy company, made a strategic entry into Pakistan's energy market by acquiring the TEPL. This terminal plays a critical role in the nation's energy infrastructure, focusing on the import, storage, and distribution of LNG and RLNG. The company's operations in the country align with the urgent need to address energy shortages in the local market, particularly the gas supply shortfall that affects both industrial and residential sectors (CCP, 2023).

Acquisition and Ownership

In 2023, Bison Energy completed the 100% acquisition of TEPL and Tabeer Energy Marketing (Private) Limited. The acquisition was approved by the Competition Commission of Pakistan (CCP) after a Phase-1 competition assessment, which determined there were no competition concerns. These entities were previously owned by Diamond Gas International, a subsidiary of Mitsubishi Corporation, Japan. The move marks a significant step in fostering foreign direct investment in Pakistan's energy sector (CCP, 2023) (Abbas, 2023).

Strategic Importance in the Supply Chain

Bison Energy's control over the Tabeer LNG Terminal places it at a critical juncture in Pakistan's energy supply chain. In addition to importing LNG, the terminal handles regasification and facilitates the distribution of RLNG to domestic markets, making it a vital link between global LNG producers and end consumers in Pakistan. As a business strategy, the company does not directly own upstream production facilities, engaged in the midstream sector, especially in managing import terminals and the logistics around LNG (CCP, 2023).

Capacity and Supply Chain Contributions

The Tabeer LNG Terminal, under Bison Energy's management, has a capacity to import approximately 3 million tonnes of LNG per year. This constitutes a significant share of Pakistan's total LNG import capacity, which is around 15 million tons annually across multiple terminals. The Tabeer Terminal, along with other terminals like ETCL and PGPCL, collectively handle the majority of LNG imports in the country. Bison's share in the overall LNG capacity represents about 20%, making it one of the key contributors to meeting Pakistan's growing energy demands. However, the overall supply chain faces constraints due to limited pipeline infrastructure and storage capacity, leading to occasional bottlenecks in distribution (IEEFA I. o., 2024) (AsianPower, 2022)

Foreign Direct Investment (FDI)

The acquisition of LNG firms by Bison Energy is seen as a positive step for foreign direct investment (FDI) in Pakistan's energy infrastructure, which is critical for ensuring the country's long-term energy security. While specific FDI figures remain undisclosed, this investment signifies growing international interest in Pakistan's energy sector and provides much-needed foreign capital to alleviate some of the financial challenges in developing and upgrading energy infrastructure. However, it is crucial to also consider the associated risks and counterarguments.

LNG transactions are conducted in dollars, but the fuel is sold in Pakistan in local currency (PKR). These dynamic exposes the sector to vulnerabilities such as currency depreciation and fluctuating exchange rates, which have already contributed to a significant increase in the circular debt within

the gas sector. Consequently, rather than enhancing energy security, this financial strain heightens energy and economic insecurity. Moreover, conditions imposed by international financial institutions (IFIs) to increase energy tariffs exacerbate the burden on consumers, leading to higher costs and reduced affordability for households and industries. Pakistan's power sector circular debt is anticipated to hit an all-time high of Rs2.8 trillion by the conclusion of the 2024-25 fiscal year, even after a substantial 51% hike in electricity tariffs implemented in July 2024 (Government of Pakistan, 2023-24)

While FDI in the LNG sector may appear as a short-term solution to energy challenges, these underlying risks underscore the need for a more sustainable and equitable energy strategy to ensure true energy security without disproportionately impacting consumers.

Energy Infrastructure Development

Bison Energy's role in Pakistan is expected to lead to enhanced LNG infrastructure and supply chain efficiency. This is particularly relevant as Pakistan continues to face challenges in securing a stable and affordable supply of natural gas, which is vital.

CHALLENGES IN PAKISTAN'S GAS DISTRIBUTION SYSTEM AND COST OPTIMIZATION

The proposed injection of more LNG into Pakistan's gas distribution system raises concerns about existing financial challenges, particularly circular debt, driven by pricing inefficiencies and UFG losses. The analysis of the issues related to UFG and their implications for the country's energy landscape are discussed in this section, starting with comparative LNG and LPG price analysis.

4.1. Price Inefficiency

Globally, LPG (Liquefied Petroleum Gas) is generally more expensive than LNG. In Pakistan, the price of LPG has consistently been higher. Table 4 provides the basket price analysis of LNG and LPG. The data from 2022 shows that LNG basket prices were more favorable compared to LPG ($14.64/ Metric Million British Thermal Unit (MMBTU) for LNG with existing UFG vs. $22.06/MMBTU for LPG), indicating that increasing LNG supply may offer a cost-effective solution for the country.

Year	LNG Spot Price	LNG Basket Price*	LPG Producer Price	LPG Basket Price*	Natural Gas Price
2017	6.85	10.56	12.15	20.49	4.21
2018	7.81	11.74	11.09	19.08	4.08
2019	9.08	13.40	11.30	17.75	3.91
2020	7.34	11.97	8.97	14.50	5.00
2021	6.40	9.68	10.40	15.86	5.02
2022	10.69	16.84	17.11	22.06	5.02

Table: 4- Price Analysis for LNG and LPG ($/MMBTU)

Source: (OGRA price notifications, 2022)
** LNG basket price and LPG basket price include other components details given in Appendix Table 10*

The difference between LNG and natural gas prices reflects the subsidies provided by the government when delivering imported LNG at the lower natural gas price. For example, in 2022, the LNG basket price stood at $14.64/MMBTU, while natural gas was priced at $5.02/MMBTU, resulting in a variance of $9.62. The government has begun passing these increased costs onto consumers, but the transition is slow, and the higher prices are already being applied to new residential connections. Although local natural gas prices have also been rising, potentially narrowing the gap, the increasing international LNG prices continue to widen the disparity. This adds more pressure on government subsidies or, alternatively, forces consumers to bear higher costs, which is already causing significant financial strain for households facing higher energy bills.

4.2. Unaccounted for Gas (UFG) Losses

UFG refers to the difference between the volume of gas injected into the system and what is delivered to end-users. These losses are driven by both technical issues (such as leaks) and non-technical factors (theft, measurement errors). High UFG leads to inefficiencies and higher costs for consumers, as demonstrated in the table 04. UFG losses contribute significantly to financial inefficiencies. As UFG increases, the cost of gas distribution rises, forcing the government and gas companies to bear the burden, which often gets passed on to consumers (table 8 and 9 appendices).

	Southern		Northern	
Year	**Consumption**	**UFG**	**Consumption**	**UFG**
2016	404,019	64,280	535,061	46,652
2017	378,497	58,012	614,755	39,547
2018	363,191	74,953	550,317	49,882
2019	377,047	72,644	738,663	52,576
2020	356,088	68,625	650,093	48,256
2021	360,808	54,496	709,948	34,406

Table: 5- Gas Consumption and UFG Losses (million cft)

Source: (Government of Pakistan, 2023)

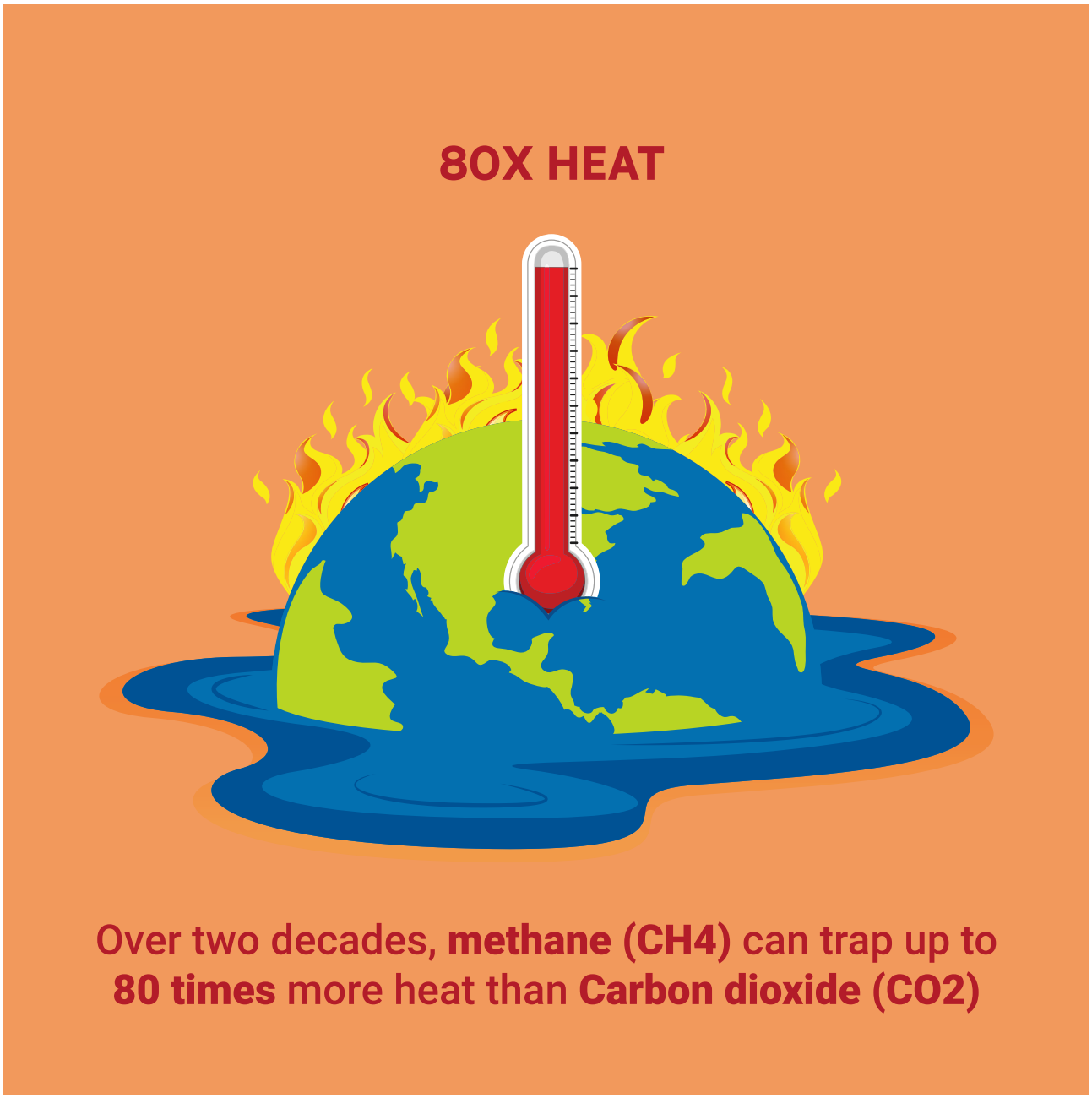
Injecting more LNG into Pakistan's gas distribution system, while addressing immediate supply shortages, exacerbates systemic inefficiencies. These include significant unaccounted-for gas (UFG) losses and pricing disparities, which burden the government, utilities, and consumers alike. The growing circular debt and financial strain from subsidies or cost transfers further highlight the unsustainable nature of expanded LNG reliance without structural reforms. Moreover, increasing LNG imports risks entrenching inefficiencies and diverting resources from investments in sustainable and renewable energy alternatives.

In addition to financial challenges, the environmental impact of expanded LNG usage cannot be overlooked. Methane leakage, a critical issue in LNG production and transportation, poses severe environmental risks due to its high global warming potential. The next section delves into the methane emissions associated with LNG, underscoring its implications for Pakistan's climate and energy policies.

METHANE LEAKAGE AND CARBON FOOTPRINT OF LNG

Despite being termed the 'cleanest' fossil fuel, LNG is not without environmental concerns, particularly regarding methane leakage and carbon footprint. While LNG releases about half the carbon dioxide of coal per unit of power, methane the primary component of natural gas has a significant impact on climate change due to its high heat-trapping capacity.

Over two decades, methane can trap up to 80 times more heat than CO2 (Chronicle, 2024) (UNEP, 2023). The production and transportation of LNG can emit notable volumes of methane and other greenhouse gases, although these emissions are not always accurately quantified in current research. Proponents of LNG argue that it is a cleaner alternative compared to other fossil fuels. They claim LNG produces 30% less CO2 than oil and 45% less than coal, positioning it as a favorable option in the global energy transition (Environment, 2023). During LNG transportation, some gas may boil off, but this is generally consumed by the vessel's engines and does not pose significant environmental hazards.



Further, modern technology and sophisticated systems are employed to manage LNG handling, storage, and transportation, aiming to prevent methane emissions (Saeid Mokhatab, 2014). However, critics argue that methane leakage remains a risk, particularly during transportation upcountry, and that leakages, while sometimes mitigated, can still contribute to GHG emissions. They point to the fact that despite advancements in technology, the potential for methane to escape during the LNG lifecycle cannot be entirely eliminated.

Thus, while LNG offers some environmental benefits over other fossil fuels, its role in the energy landscape must be carefully evaluated in light of these ongoing concerns about methane emissions and overall carbon footprint. Methane and carbon emissions are harmful, and they are primarily produced in the energy sector. This sector predominantly relies on oil, gas, and coal. Consequently, the expansion of LNG infrastructure will likely lead to an increase in emissions.

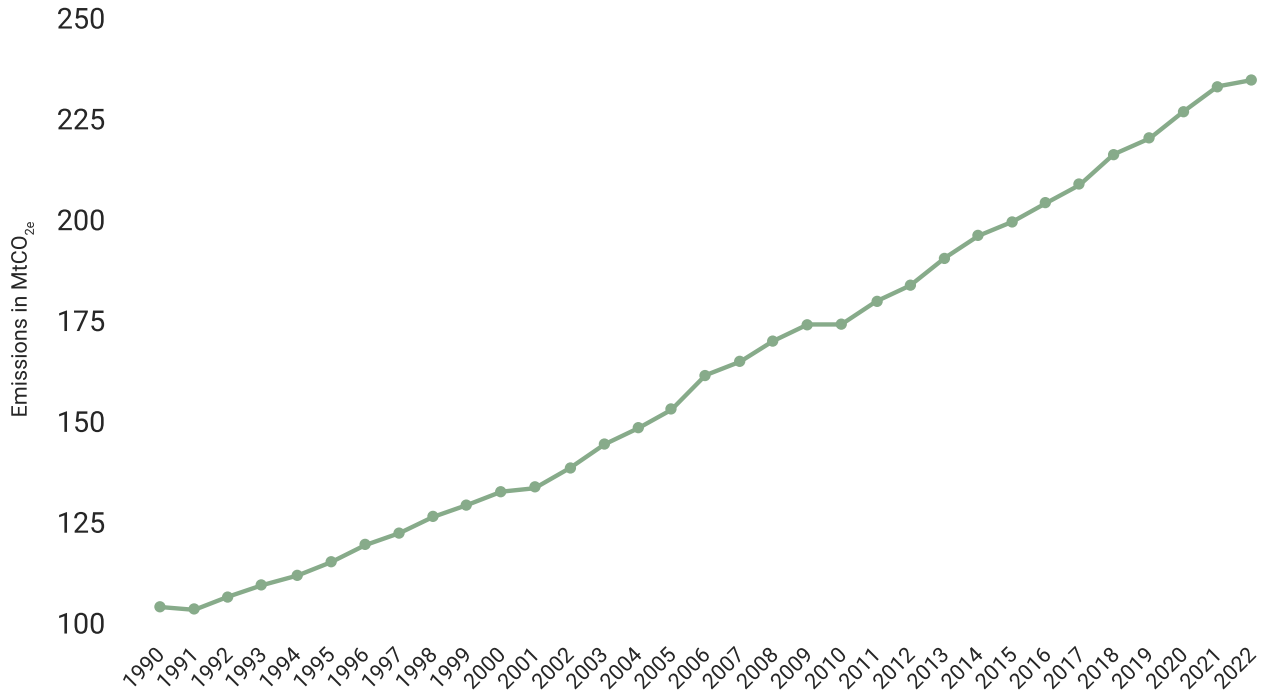
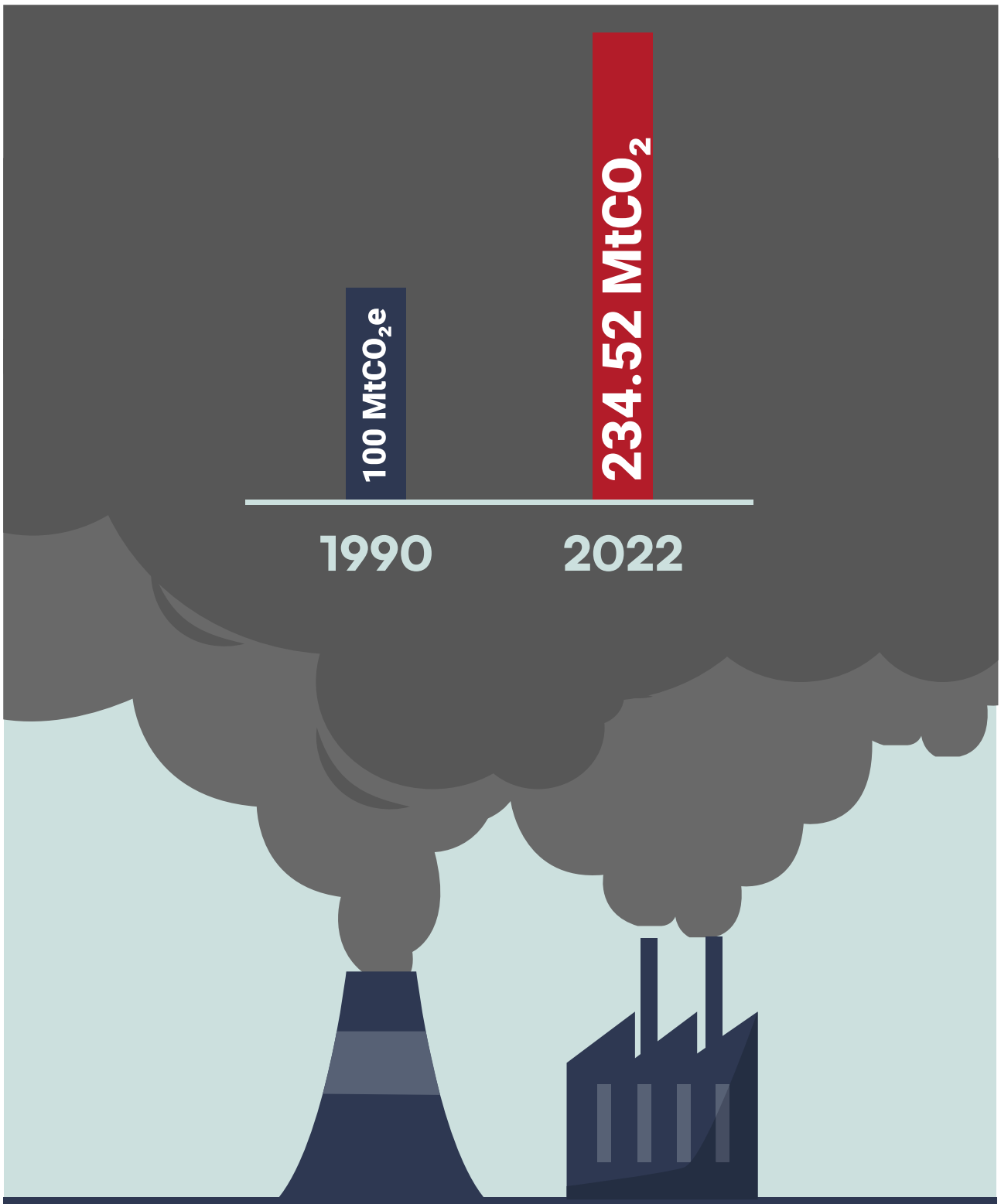


Figure:6 Methane Emission in Pakistan Annually from 1990-2022 (Tiseo I. , 2024)

The figure 6 illustrates the trend in methane emissions in Pakistan from 1990 to 2022, showing a steady increase from approximately 100 million metric tons of CO_2 equivalent ($MtCO_2e$) in 1990 to a peak of 234.52 $MtCO_2e$ in 2022. This marks a more than twofold increase over 32 years, highlighting the challenges Pakistan faces in managing emissions due to industrial growth, urbanization, and reliance on agriculture and fossil fuels, including natural gas and LNG. The data indicates a consistent upward trend, particularly from the early 2000s, with a notable year-on-year increase of around 0.5% in 2022. Consequently, Pakistan has emerged as one of the largest global methane emitters, raising significant environmental concerns regarding its impact on climate change and air quality (Tiseo, 2024).



Methane emissions in Pakistan have more than doubled from **100 $MtCO_2e$ in 1990** to **234.52 $MtCO_2e$ in 2022**, driven by industrial growth, urbanization, agriculture, and fossil fuel reliance.

INTERNATIONAL TECHNICAL ASSISTANCE IN GAS MARKET OF PAKISTAN

The Asian Development Bank (ADB), World Bank (WB), Asian Infrastructure Investment Bank (AIIB), and International Finance Corporation (IFC) have all contributed significantly to Pakistan's gas sector. ADB supported the TAPI Gas Pipeline Project (2016) and its total cost involved 10 billion, improving gas supply from Turkmenistan to South Asia. The construction of an 1127-mile (1814-kilometer) long pipeline with a 56-inch diameter, able to pass 3.2 billion cubic feet per day from Turkmenistan's Galkynysh gas field with deposits amounting to 27.4 trillion cubic meters, started in 2018. The Pakistan Natural Gas Efficiency Project, funded by the World Bank with a total of US$200 million (comprising US$100 million from an IBRD loan and US$100 million from an IDA grant), was implemented between 2012 and 2022. The project aimed to reduce gas losses and improve the natural gas supply in Pakistan's pipeline system. ADB also focused on governance and pricing reforms through its Energy Sector Reform Program and increased gas supply reliability under the Energy Sector Resilience Project. The WB backed the Pakistan Gas Infrastructure Development Project (PGIDP) to upgrade gas transmission networks and improve efficiency through the Natural Gas Efficiency Project, while also easing pressure on gas consumption through the Dasu Hydropower Project. Additionally, the WB's Energy Sector Reform Development Policy Credit focused on enhancing efficiency and governance in the gas sector. AIIB co-financed Pakistan's energy sector projects with ADB and the World Bank, supporting gas infrastructure upgrades, transmission network expansion, and LNG import infrastructure (WB). The IFC's investment in Pakistan's first LNG terminal at Port Qasim, near Karachi, involved a $125 million project for the design, construction, and operation of the Engro Elengy terminal. This project began in 2015, marking a significant contribution to Pakistan's energy infrastructure, enabling increased LNG imports to address the country's energy shortages (International Finance Corporation).

FOSSIL GAS INFRASTRUCTURE DEVELOPMENT'S IMPACT ON LOCAL COMMUNITIES

Fossil gas infrastructure development impacts local communities. The gas infrastructure such as LNG terminals or establishing gas fields impacts biodiversity, health, wildlife, air and water quality. To understand how fossil gas expansion affects the quality of life. Two case studies have been conducted to find evidence.

7.1. Case Study 1: Case Study of Karachi Fisherman Community

The Ibrahim Hyderi and Rehri Goth areas are home to centuries-old fishing communities. However, rapid industrialization, including the establishment of LNG terminals and coal power plants, has drastically altered the local environment. While these projects promise economic development and energy production, the fishing communities have been left to bear the environmental, social, and economic costs.

The expansion of fossil fuel infrastructure has left a lasting impact on Karachi's coastal communities, particularly those dependent on fishing for their livelihoods. This case study sheds light on the devastating effects of LNG terminals and coal power plants on Ibrahim Hyderi and Rehri Goth, two fishing communities located near Karachi's coast. Both communities are increasingly grappling with environmental degradation, economic hardship, and health crises, largely due to the unchecked industrial development in their vicinity. The experiences of two veteran fishermen, Abdul Majid Mutani of Ibrahim Hyderi and Younis Khaskheli of Rehri Goth, reveal the urgent need for regulatory reforms and community support.

Economic Impact on Fishermen

The construction of LNG terminals has imposed severe restrictions on local fishermen. In Ibrahim Hyderi, Mutani explains how fishing grounds are closed off multiple times each month to accommodate incoming LNG ships. "We are forced to stop fishing and leave the area when the ships arrive," he says. These closures disrupt the fishermen's schedules, causing significant income losses.

Similarly, Younis from Rehri Goth describe how industrial pollution has forced fish populations farther offshore.

"We have to travel 4 to 5 kilometers out to sea now, making our trips more expensive and less productive," he laments.

The deteriorating fish stocks and increased operating costs have reduced the income of both communities, leaving fishermen struggling to sustain their livelihoods.

Environmental Degradation

Mangrove destruction is a critical issue for both Ibrahim Hyderi and Rehri Goth. Mangroves, which play an essential role in maintaining coastal ecosystems and fish breeding grounds, have been cleared to make way for LNG terminals.

Mutani notes, "The loss of mangroves has damaged the fish habitat, making it harder for us to catch fish." In addition, industrial waste and oil spills are contaminating the waters around both communities.

Younis explains how the sea has become “black and foul-smelling” due to pollution from nearby plants. This contamination has caused mass fish deaths and reduced the quality of fish, further endangering the local economy.

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Health and Social Consequences

The health of local populations in both Ibrahim Hyderi and Rehri Goth is deteriorating due to air and water pollution. Mutani reports that fumes from the LNG terminals and power plants cause respiratory problems and skin diseases among residents, particularly children. Similarly, Younis describes how Rehri Goth’s residents, including himself, suffer from eye infections and chronic respiratory issues due to air pollution. Waterborne diseases such as diarrhea and hepatitis are becoming increasingly common as a result of contaminated water sources.

Women in these communities are especially vulnerable to the environmental and social changes. In Ibrahim Hyderi, Mutani highlights how women’s traditional roles in fish processing have been affected by the decline in fish quality and quantity. In Rehri Goth, Younis shares how women face additional domestic burdens, such as traveling long distances to fetch water due to pollution, increasing their exposure to health risks and limiting their time for education and community involvement.

Governance and Corporate Responsibility

Despite the severe impacts on local communities, neither the government nor the corporations running the LNG terminals have taken meaningful steps to address these issues.

Mutani criticizes the lack of corporate social responsibility (CSR) programs, noting,

“There’s nothing done for the local community.”

Similarly, Younis points out that industries offer minimal compensation, such as temporary medical camps, but fail to address the root causes of pollution.

Both Mutani and Younis call for government intervention to enforce stricter environmental regulations and promote renewable energy solutions.

“Government should decrease fossil fuel projects and focus on renewable energy,” Mutani asserts,

while Younis advocate for relocating industries away from coastal areas to protect the communities and ecosystems.

The experiences of Abdul Majid Mutani and Younis Khaskheli reveal the profound effects of industrialization on Karachi’s coastal communities, marked by environmental degradation, lost livelihoods, and health crises. Urgent action is needed from both government and corporations to implement sustainable practices and improve community welfare. Addressing the struggles in Ibrahim Hyderi and Rehri Goth requires a collaborative effort among stakeholders, ensuring that these communities are not left behind in Karachi’s industrial progress. Sustainable development and genuine corporate responsibility are key to safeguarding their future.

7.2. Case Study 2: Case study of Local Community in Ghotki

Ghotki, a district in the Sindh province of Pakistan, is known for its rich agricultural history and more recently as an industrial hub. Ghotki is home to prominent power and natural gas plants, including the Engro Powergen Qadirpur Plant, Liberty Power Tech Limited, a biomass power plant, and facilities by Mari Petroleum Company Limited (MPCL). However, this power plants have brought about numerous environmental, social, and health issues, especially for women, who are disproportionately affected by the transition. This case study is based on an interview conducted with Ali Hassan, a 57-year-old NGO worker and former teacher, who provides insight into the challenges faced by Ghotki's residents, especially in terms of the gendered impacts of industrialization and climate change.

Historically, Ghotki was a predominantly agricultural district, known for producing cotton, wheat, and other crops. However, over the past few decades, industrialization, driven by the establishment of gas, fertilizer, and power plants, has shifted the district's identity. Ali Hassan reflects on this change:

"Ghotki cotton was once second in Asia, but now agriculture is suffering due to the pollution from industrial waste. Fertile lands are becoming barren."

The environmental toll is severe, with industrial waste contaminating agricultural lands and water supplies. This shift has disproportionately affected women, who are heavily involved in farming, livestock rearing, and other agricultural activities. With agriculture in decline, many women have been forced into low-paying, labor-intensive jobs, further exacerbating their vulnerability.

Environmental Degradation and Health Issues

The industrial waste produced by power plants has not only harmed agriculture but has also severely impacted drinking water supplies. According to Ali Hassan, hand pumps that once provided clean water now produce water contaminated with industrial waste, leading to a surge in health problems, including skin diseases, kidney issues, and gastrointestinal disorders.

"Women and children are the most affected by the contamination," Hassan explains. "The OPDs in hospitals are filled with women suffering from stomach and skin issues due to the toxic environment they work in daily."

The polluted water and air also contribute to respiratory diseases, eye infections, and a range of other health problems. With limited access to healthcare facilities, especially for women and children, the community faces a health crisis that shows no signs of abating.

Gendered Impact: Women's Vulnerability to Industrialization and Climate Change

The gender-specific challenges facing women in Ghotki are profound. Women, who once played a vital role in agriculture, have been disproportionately affected by the decline in farming. The reduction in agricultural productivity has worsened economic conditions, forcing many women into low-wage, unskilled labor, which further reduces their financial independence.

The burdens on women have only increased, as they are often responsible for securing food and water for their families. Environmental degradation has made these tasks more difficult, particularly in the aftermath of extreme weather events like the 2022 floods, which devastated farms and contaminated drinking water supplies. Ali Hassan elaborates:

"After the floods, women had to deal with destroyed crops, contaminated water, and the loss of livestock. This increased their workload and worsened their already precarious situation."

Women, who were once key contributors to the local economy, now face marginalization as their roles in decision-making processes have diminished, leaving them without a voice in community and household matters.

Climate Change and Its Gendered Consequences

The adverse effects of climate change, compounded by industrial pollution, have had gender-specific impacts on women in Ghotki. The floods of 2010 and 2022, along with extreme temperatures exceeding 50°C, have devastated local livelihoods, particularly for women who depend on farming and livestock rearing. In these extreme conditions, women experience heat stress, dehydration, and a lack of access to clean water, making daily tasks far more challenging.

"The extreme heat and lack of water make it impossible for women to work in the fields or care for their families properly," says Ali Hassan.

The impacts of climate change have further limited women's economic opportunities, pushing them deeper into poverty and exacerbating existing social inequalities.

Social and Economic Impact on Women

The decline of agriculture and the rise of industrial pollution have driven many households in Ghotki to turn to low-wage labor, where women are often paid less than men. With wages as low as 200-300 rupees per day, women struggle to make ends meet. Ali Hassan describes the bleak situation:

"Women in Ghotki face low wages, and child labor is becoming more common as families try to survive. Girls are often pulled out of school to help at home or work in the fields."

The mental health toll on women is also significant, as they face constant anxiety and stress due to economic hardship and the deteriorating health of their families.

The Role of Fossil Fuel LNG: Environmental and Health Threats

The rise of power plant production in Ghotki has further compounded the environmental and social challenges facing the community. The gas produced in the district is primarily used for international consumption, leaving local communities to deal with the pollution. Ali Hassan shares the stark reality:

"We face noise pollution, air pollution, and gas leaks from these plants, and it's making our environment unlivable. The OGDCL plant is just a few kilometers away, and its flames and emissions are visible from my rooftop."

The proximity of these industrial plants to residential areas has created serious health risks, particularly for women and children, who are more vulnerable to the pollutants emitted by the power plants.

The transformation of Ghotki from an agricultural region to an industrial hub has brought significant environmental, social, and economic challenges, particularly for women. The rise of fossil fuel power plant production has devastated the local environment and left women to bear the brunt of the region's economic decline and health crises. Addressing these challenges requires urgent action from both government and private sector stakeholders to develop gender-sensitive policies that promote sustainable development, improve public health infrastructure, and mitigate the harmful effects of industrialization. Ali Hassan's account underscores the need for a just energy transition that considers the unique vulnerabilities of women and ensures their participation in decision-making processes to address their specific needs and concerns.

Conclusion

The case studies of Karachi and Ghotki demonstrate the profound and multifaceted impacts of fossil gas infrastructure development on local communities. In Karachi, the fishing communities of Ibrahim Hyderi and Rehri Goth face severe environmental degradation, loss of livelihoods, and health crises due to the establishment of LNG terminals and coal power plants. Similarly, in Ghotki, the

transition from an agricultural economy to an industrial hub has disproportionately affected women, exacerbating their economic vulnerability and health challenges amidst worsening environmental conditions and climate change.

These cases underscore the urgent need for sustainable development practices, stricter environmental regulations, and inclusive policies that prioritize community welfare. Addressing these challenges requires collaborative efforts from government and industry stakeholders to mitigate the negative impacts of industrialization, ensure corporate accountability, and promote renewable energy solutions. A just energy transition must also incorporate gender-sensitive strategies, empowering women and safeguarding their roles in economic and social structures. Only through such comprehensive measures can the long-term well-being of these communities be secured.

POLICY RECOMMENDATIONS AND CONCLUDING REMARKS

Based on the evidence presented in the study and drawing from international best practices, the following policy recommendations are categorized into major and minor actions to address the environmental and social impacts of LNG terminal activities.

Minor Recommendations

Operational Transparency for LNG Terminals: Increase transparency by requiring terminal operators at Port Qasim to publicly disclose non-sensitive information about LNG cargo arrivals and terminal operations. This will foster trust between the community and terminal operators as the timely announcements will help the fisherman to plan their day activities earlier.

Community Access and Engagement Mechanisms: Develop formal engagement channels where local communities can monitor terminal activities, particularly during critical operations such as cargo offloading. Regular public forums should be organized to address community concerns and enhance accountability.

Ban on Disposal of Industrial Waste into Coastal Waters: Enforce a strict ban on the disposal of machinery cleaning waste, oil, and other hazardous materials into the sea to protect marine ecosystems. LNG companies must adopt responsible waste management practices, preventing the harmful impact on fisheries and coastal biodiversity.

Major recommendations

The Role of Fossil Fuel LNG: Environmental and Health Threats

Prohibit the construction of new LNG terminals, following the example of countries like Ireland, which declared a moratorium on new LNG projects in 2020 to align with climate goals and address local environmental concerns. Bangladesh provides a recent example, having canceled three LNG terminal projects in 2024 due to economic and environmental considerations. This approach helps prevent further debt accumulation and avoids stranded asset risks, while aligning with Pakistan's climate goals. (ECC, 2020).

Promote Renewable Energy as a Viable Alternative

Redirect investments from LNG terminal projects, such as Tabeer and Energas at Port Qasim, toward accelerating renewable energy (RE) development. Pakistan possesses significant potential in solar, wind, and small hydropower resources. For instance:

- **Wind:** Coastal areas of Sindh and Balochistan have substantial wind energy potential.
- **Solar:** With some of the highest solar insolation levels globally, solar energy can be deployed across the country, particularly in arid regions.
- **Small Hydro:** Upper areas, including Khyber Pakhtunkhwa and Gilgit-Baltistan, are ideal for small hydropower projects.

Electrification for heating and cooling purposes should be prioritized to reduce dependency on fossil fuels and enable a sustainable energy transition.

Enforce Methane Leakage Monitoring and Reporting

Mandate robust methane leakage monitoring and reporting for existing LNG terminals. Learning

from countries like Norway, Pakistan should implement stringent leak detection and repair (LDAR) programs to minimize emissions from LNG infrastructure, addressing both environmental and economic concerns. (UNEP, 2021).

Strengthen Environmental Impact Assessments (EIAs)

Strengthen EIA requirements for new LNG projects, ensuring they account for cumulative environmental, social, and health impacts on local communities. The European Union requires a comprehensive EIA under the Environmental Impact Assessment Directive (2011/92/EU) for projects likely to have significant effects on the environment (EIA, 2017).

Establish Public Health Monitoring Systems

Establish a public health monitoring system for communities living near LNG terminals. International examples include Australia's Gladstone LNG project, which has been subject to continuous environmental and health assessments to protect local communities (Australian Government's Department of Health and Ageing, 2012)

No Further Expansion of LNG Terminals

Halt the expansion of LNG infrastructure in Pakistan. Instead, focus on fostering a transition to renewable energy, which offers greater environmental and social benefits. Renewable energy investments are not only more sustainable but also provide economic opportunities for local communities, reducing Pakistan's reliance on imported fossil fuels and addressing the urgent need for climate action.

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APPENDICES

S. No	Terminal/ Gas Field	Location	Capacity (MMCFD)	Status	Cost (Million $)	Ownership
01	Engro Elengy Terminal	Port Qasim, Karachi	690	Operational since 2015	150	Engro Corporation (Private-sector initiative with government facilitation)
01	Pakistan GasPort Consortium Limited (PGPC) Terminal	Port Qasim, Karachi	750	Operational since 2017	450	Pakistan GasPort Consortium, partly financed by the World Bank
01	Energas LNG Terminal (Proposed)	Chara Creek, Port Qasim, Karachi	750-1000	Proposed	180	Energas LNG Terminal Private Limited
01	Tabeer LNG Terminal (Proposed)	Jhari Creek, Port Qasim, Karachi	750-1000	Proposed	180	Bison Energy (UAE-based)
01	Daewoo Gas Terminal	Karachi	365	Proposed	300	Daewoo Gas and CNCEC
01	Easy LNG Terminal	Karachi	50-60	Proposed	200	LNG Easy Pvt. Ltd
01	Sui Gas Field	Balochistan	400-500	Operational since 1955	N/A	Pakistan Petroleum Limited (PPL)
01	Qadirpur Gas Field	Sindh	500	Operational	N/A	Oil and Gas Development Company Limited (OGDCL)
01	Kandhkot Gas Field	Sindh	200	Operational	N/A	Pakistan Petroleum Limited (PPL)
01	Mari Gas Field	Sindh	700	Operational	N/A	Mari Petroleum Company Limited (MPCL)

Table: 6- Gas Based Electricity Plant in Pakistan

Source: (IEEFA, 2022)

Year	Theft	Law and Order Affected Areas	Leakages	Measurement Errors	Increase in Gas Prices	Total
2016	30,290	1,850	17,356	14,784	3,214	64,280
2017	27,108	1,896	15,663	13,342	2,900	58,009
2018	31,855	5,621	20,237	17,239	3,748	74,952
2019	30,874	5,448	19,614	16,708	3,632	72,644
2020	29,165	5,147	18,529	15,784	3,431	68,625
2021	23,161	4,087	14,714	12,534	2,725	54,496

Table: 7- Component-wise Breakdown of UFG Losses of SSGC (Million CFt)

Source: (Government of Pakistan, 2023)

Year	Theft	Law and Order Affected Areas	Others	Total
2016	5,894	11,526	29,232	46,652
2017	4,739	11,982	22,826	39,547
2018	3,355	14,629	31,898	49,882
2019	2,680	15,391	34,505	52,576
2020	1,370	16,176	30,710	48,256
2021	425	10,069	23,912	34,406

Table: 8- Component-wise Breakdown of UFG Losses of SNGPL (Million CFt)

Source: (Government of Pakistan, 2023)

Year	LNG Price	Terminal Charges	Other Import Costs and Margin	T&D and Adjusted Cost	LNG Basket Price with Existing UFG	LNG Basket Price with Additional 15% UFG	LPG Producer Price (Rs. / Metric Ton)	LPG Producer Price	Marketing Margin	Petroleum Levy	LPG Basket Price
2017	6.85	0.42	0.22	1.70	9.18	10.56	57,831	12.15	7.35	0.98	20.49
2018	7.81	0.48	0.29	1.62	10.21	11.74	55,268	11.09	7.05	0.94	19.08
2019	9.08	0.71	0.35	1.52	11.65	13.40	69,187	11.30	5.70	0.76	17.75
2020	7.34	0.91	0.65	1.50	10.41	11.97	64,057	8.97	4.88	0.65	14.50
2021	6.40	0.48	0.58	0.96	8.42	9.68	75,244	10.40	4.82	0.64	15.86
2022	10.69	0.66	1.29	2.00	14.64	16.84	138,292	17.11	4.36	0.58	22.06

Table: 9- Price Analysis for LNG and LPG ($/MMBTU)

Source: (OGRA price notifications, 2022)

رپورٽ جو خلاصو

هن رپورٽ ۾ پاڪستان ۾ فوسل گيس جي واڌ جي سماجي، اقتصادي ۽ ماحولياتي اثرن جو جائزو ورتو ويو آهي، خاص طور تي قدرتي گيس (ايل اين جي) جي درآمد جي ترقي سبب ٿيندڙ اثرن تي ڌيان ڏنو ويو آهي.

انڊس ڪنسورشيئم جي تعاون سان سينٽر فار بزنس اينڊ اڪنامڪس ريسرچ (سي بي اي آر) جي ذريعي ڪرايل هن مطالعي ۾ پاڪستان جي وڌندڙ ايل اين جي ٽي پاڻ جو جائزو ورتو ويو آهي، جيئن گهٽندڙ ملڪي گيس جي پيداوار ۽ وڌندڙ توانائي جي گهرج جي وچ ۾ وڌندڙ خلا کي پري سگهجي. رپورٽ جي نتيجن مان هن تبديلي سان لاڳاپيل موقعن ۽ مسئلن کي اجاگر ڪيو ويو آهي.

ملڪي گيس جي پيداوار 2008 کان روڪيل آهي، جيڪا گهٽ واپاري منافعي ۽ گيس سان مالا مال علائقن ۾ انتظامي مسئلن جي ڪري آهي. پاڪستان جا گيس جا ذخيرا تيزيءَ سان گهٽجي رهيا آهن، ۽ اندازو آهي ته پيداوار 2033 تائين سالانه 4·1 سيڪڙو گهٽ ٿيندي، جنهن سبب گيس جي فراهميءَ جي ڪوٽ ۾ اضافو ٿيندو. 2015 ۾ شروع ٿيندڙ ايل اين جي گيس جي درآمد هاڻي ملڪي گيس جي استعمال جو 28 سيڪڙو کان وڌيڪ حصو بڻجي ٿو. تنهن هوندي به ايل اين جي ٽي پاڻ، مالي ۽ توانائي جي پاڻ پرائي جي مسئلن کي جنم ڏنو آهي، جن ۾ قيمتن جي وهڪري ۽ وڌندڙ درآمدي خرچ شامل آهن.

ايل اين جي درآمدن بجلي پيداوار جي قيمتن کي گهٽ ڪيو آهي، پر سبسڊي ۽ گردشي قرض جي ڪري حڪومت کي سخت مالي دٻاءُ کي منهن ڏيڻو پيو، جيڪو 2025 تائين 2·429 کرب روپين تائين پهچڻ جي اميد آهي. ايل اين جي جي وڌندڙ قيمت گهرن ۽ صنعتن تي اضافي بار وڌو آهي، جنهن سبب مقابلي بازي ۽ وسيلن جي دستيابي تي اثر پيو آهي. ڪراچي جي ماهيگير برادري ۽ گهوٽڪي جي زرعي تبديليءَ جي ڪيس اسٽڊيز مان معلوم ٿئي ٿو ته مقامي روزگار، صحت، ۽ سماجي جوڙجڪ تي منفي اثر پيا آهن، خاص طور تي عورتن جهڙن ڪمزور طبقن تي ان جا وڌيڪ اثر آهن.

ايل اين جي ٽرمينلن جي تعمير ۽ آپريشن سبب قدرتي ماحول جي تباهي، حياتياتي تنوع جي گهٽتائي، ۽ ميٿين گيس جي اخراج ۾ اضافو ٿيو آهي، جيڪو ڪاربان دٻاءِ آڪسائيڊ جي پيٽ ۾ گهڻو اثرائتو آهي. پيداوار ۽ ٽرانسپورٽ دوران ميٿين گيس جي رِسڻ سبب پاڪستان ۾ موسمياتي خطرا وڌي رهيا آهن، ۽ قومي سطح تي اهن گيسن جي خارج ٿيڻ ۾ اضافو جاري آهي. سامونڊي برادرين صنعتي سرگرمين جي ڪري پاڻي جي آلودگي ۽ مڇين جي گهٽتائي سبب معاشي ۽ ماحولياتي طور تي ڪمزور ٿي رهيون آهن.

ايل اين جي جي ڪاروبار تي عوامي اعتماد کي يقيني بڻائڻ لاءِ، ايل اين جي شعبي ۾ ٿيندڙ ترقياتي ڪمن کي شفاف ڪيو وڃي ته جيئن اعتماد پيدا ٿئي ۽ مقامي ماڻهن جي مسئلن کي گهٽ ڪيو وڃي ۽ شڪايتن جي ازالي ۾ شامل ڪرڻ لاءِ باضابطه طريقيڪار جوڙيو وڃي. ان کان علاوه، صنعتي فُضلي کي سامونڊي پاڻي ۾ ڦٽو ڪرڻ تي پابندي لڳائي وڃي.

ايل اين جي جي حڪمت عملي جي قدمن ۾ وڌيڪ ايل اين جي بنيادي ڍانچي جي منظوري روڪڻ شامل آهي ته جيئن مالي ۽ ماحولياتي خطرا گهٽجي سگهن. فوسل گيس منصوبن مان سيڙپڪاري کي شمسي، هوائي، ۽ ننڍن هائيڊرو منصوبن ڏانهن منتقل ڪيو وڃي ته جيئن پائيدار توانائي جي ترقي کي يقيني بڻائي سگهجي. ميٿين گيس جي اخراج کي گهٽائڻ لاءِ سخت نگراني جا پروگرام لاڳو ڪيا وڃن، جڏهن ته سپني نون ايل اين جي منصوبن لاءِ جامع ماحولي اثرن جي تشخيص ضروري هجي ته جيئن سماجي-ماحولي اثرن کي منهن ڏئي سگهجي. ان کان علاوه، مقامي برادرين تي صنعتي سرگرمين جي صحت تي اثرن کي جانچڻ لاءِ نظام قائم ڪيا وڃن ته جيئن تڪڙا قدم کڻي سگهجن کي يقيني بڻائي سگهجي.

جيتوڻيڪ ايل اين جي پاڪستان جي توانائي بحران کي گهٽ ڪرڻ ۾ اهم ڪردار ادا ڪيو آهي، ان جا سماجي، اقتصادي ۽ ماحولياتي اثر هن اسٽرٽيجڪ تبديليءَ جي ضرورت کي اجاگر ڪن ٿا. هڪ منصفاڻي توانائي جي منتقلي جو منصوبو جيڪو قابل تجديد توانائي کي وڌائڻ تي مشتمل هجي مقامي ماڻهن جي بهبودي، ۽ ماحولياتي استحڪام کي ترجيح ڏئي، پاڪستان جي ڊگهي مدي واري توانائي مستقبل کي محفوظ ڪرڻ لاءِ ضروري آهي.ان سلسلي ۾ سمورا پاليسي ناهيندڙ ادارا، صنعت جي شعبي سان لاڳاپيل ماڻهون ، مقامي ماڻهون گڏجي ڪم ڪن ته جيئن توانائي جي ضرورتن ۽ پائيدار ترقي جي مقصدن جي وچ ۾ فوري توازن قائم ڪري سگهجي.

رپورٹ کا خلاصہ

یہ رپورٹ پاکستان میں فوسل گیس کے پھیلاؤ کے سماجی، اقتصادی اور ماحولیاتی اثرات کا جائزہ لیتی ہے، خاص طور پر مائع قدرتی گیس (ایل این جی) کے بنیادی ڈھانچے کی ترقی پر توجہ مرکوز کرتی ہے۔ انڈس کنسورشیم اور سینٹر فار بزنس اینڈ اکنامکس ریسرچ کے ذریعے کی گئی اس تحقیق میں پاکستان کے بڑھتے ہوئے ایل این جی کے انحصار کا جائزہ لیا گیا ہے تاکہ گھٹتی ہوئی مقامی گیس کی پیداوار اور بڑھتی ہوئی توانائی کی طلب کے درمیان وسیع ہوتے خلا کو پورا کیا جا سکے۔ نتائج اس تبدیلی کے ساتھ جڑے مواقع اور چیلنجز کو اجاگر کرتے ہیں۔

مقامی گیس کی پیداوار ۲۰۰۸ سے رکی ہوئی ہے، جو کہ گیس سے مالا مال علاقوں میں کم تجارتی منافع بخش دیگر چیلنجز کی وجہ سے ہے۔ پاکستان کے گیس کے ذخائر تیزی سے کم ہو رہے ہیں، اور اندازہ ہے کہ پیداوار ۲۰۳۳ تک سالانہ ۴.۱ فیصد کم ہو جائے گی، جس سے فراہمی کی قلت میں مزید اضافہ ہو گا۔ ۲۰۱۵ میں شروع ہونے والی ایل این جی درآمدات اب مقامی گیس کے استعمال کا ۲۸ فیصد سے زیادہ حصہ بنتی ہیں۔ تاہم، ایل این جی پر انحصار نے مالی اور توانائی کی سلامتی کے چیلنجز کو جنم دیا ہے، جن میں قیمتوں میں اتار چڑھاؤ اور بڑھتے ہوئے درآمدی اخراجات شامل ہیں۔

ایل این جی درآمدات نے بجلی پیدا کرنے کی لاگت کو کم کیا ہے لیکن سبسڈی اور گردشی قرضوں کی وجہ سے حکومت کو شدید مالی دباؤ کا سامنا کرنا پڑا ہے، جو کہ ۲۰۲۵ تک ۲.۴۲۹ ٹریلین روپے تک پہنچنے کی توقع ہے۔ ایل این جی کی زیادہ قیمت نے گھریلو صارفین اور صنعتوں پر غیر متناسب بوجھ ڈالا ہے۔ کراچی کی ماہی گیر برادریوں اور گھوٹکی کی زرعی تبدیلی کے کیس اسٹڈیز سے پتہ چلتا ہے کہ مقامی روزگار، صحت، اور سماجی ڈھانچے پر منفی اثرات مرتب ہو رہے ہیں، خاص طور پر خواتین جیسے کمزور طبقات پر۔

ایل این جی ٹرمینلز کی تعمیر اور آپریشن کے نتیجے میں قدرتی ماحول کی تباہی، حیاتیاتی تنوع میں کمی، اور میتھین کے اخراج میں اضافہ ہوا ہے، اور میتھین کے اثرات کاربن ڈائی آکسائیڈ کے مقابلے میں کہیں زیادہ ہیں۔ پیداوار اور ترسیل کے دوران میتھین کا اخراج پاکستان کے ماحولیاتی خطرات کو بڑھا دیتا ہے، جہاں قومی سطح پر اخراج میں مسلسل اضافہ ہو رہا ہے۔ ساحلی پٹی پر صنعتی سرگرمیوں کے باعث پانی کی آلودگی اور مچھلی کے ذخائر میں کمی کی وجہ سے معاشی اور ماحولیاتی طور پر کمزور ہو چکی ہیں۔

شفافیت کے عمل کو یقینی بنانے کے لیے ایل این جی ٹرمینلز کے کام کے ساتھ مقامی ماہیگیر ون اور کمیونٹیز کو اعتماد میں لینا ضروری ہے تاکہ مقامی برادریوں کے مسائل کو کم کیا جا سکے اس کے علاوہ، صنعتی فضلے کو ساحلی پانیوں میں پھینکنے پر پابندی عائد کی جانی چاہیے۔

اس کی علاوہ حکمت عملی میں مزید ایل این جی کے بنیادی ڈھانچے کی مزید فسلائو منظوری کو روکنا شامل ہے تاکہ مالی اور ماحولیاتی خطرات سے بچا جا سکے۔ فوسل گیس منصوبوں میں سرمایہ کاری کو شمسی، ہوا، اور چھوٹے ہائیڈرو منصوبوں کی طرف منتقل کیا جانا چاہیے تاکہ پائیدار توانائی کی ترقی کو یقینی بنایا جا سکے۔ میتھین کے اخراج کو کم سے کم کرنے کے لیے سخت نگرانی کے پروگرام لاگو کیے جائیں، جبکہ تمام نئے ایل این جی منصوبوں کے لیے جامع ماحولیاتی اثرات کی تشخیص کو لازمی قرار دیا جائے تاکہ مجموعی سماجی-ماحولیاتی اثرات کو حل کیا جا سکے۔ مقامی لوگوں پر صنعتی سرگرمیوں کے صحت پر اثرات کو ٹریک کرنے کے نظام قائم کیے جائیں تاکہ اس کے لے مناسب انتظام کو یقینی بنایا جا سکے۔

اگرچہ ایل این جی نے پاکستان کے توانائی کے بحران کو کم کرنے میں کردار ادا کیا ہے، لیکن اس کے سماجی، اقتصادی اور ماحولیاتی نقصانات اس میں بنیادی ڈانچے میں بنیادی تبدیلی کی ضرورت کو اجاگر کرتے ہیں۔ ایک منصفانہ توانائی کی منتقلی، جو قابل تجدید توانائی کے فروغ، کمیونٹی کی فلاح و بہبود، اور ماحولیاتی استحکام کو ترجیح دیتی ہے، پاکستان کے طویل مدتی توانائی مستقبل کے تحفظ کے لیے ناگزیر ہے۔ پالیسی سازوں، صنعتی اسٹیک ہولڈرز، اور برادریوں کو مل کر کام کرنا ہو گا تاکہ فوری توانائی کی ضروریات اور پائیدار ترقی کے اہداف کے درمیان توازن قائم کیا جا سکے۔

Indus Consortium

for Humanitarian, Environmental & Development Initiatives

The Indus Consortium, founded by Help Foundation, Doaba Foundation and LHDP in 2008, comprises 64 affiliates working with grassroot communities, academic institutions and government bodies.

It addresses climate change, disaster risk and development issues of communities living along the river Indus basin through enhancing their resilience and facilitating them to raise their voices at policymaking platforms.

By bridging the knowledge gap, promoting green & fair financing, RE acceleration, Fossil fuel phaseout & Industrial decarbonization, the Consortium aims to achieve a Just Energy Transition which is both Paris and SDGs aligned.