Upstream Innovations – Exploring Next Big Thing

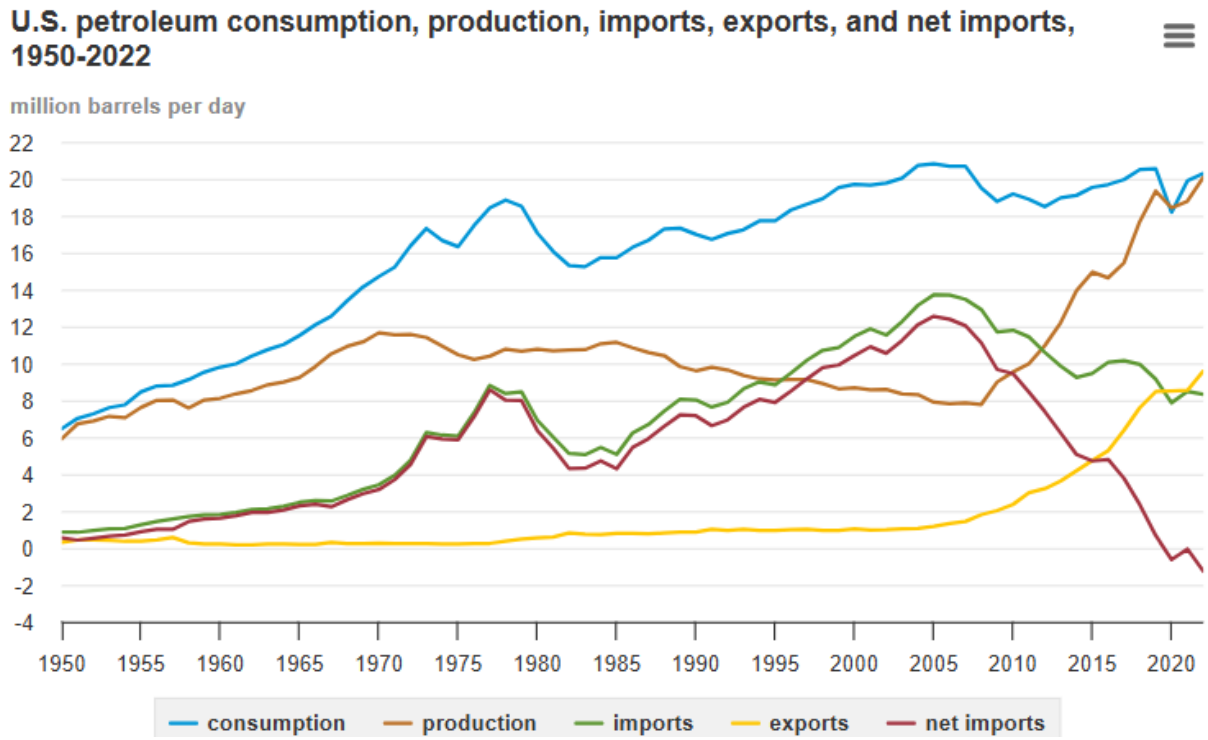
Introduction

The United States offers an inspiring example of how an innovative approach and a strong focus on research and development [R&D] enabled the country to move from dependence on oil imports to full energy independence, all while maintaining its dominant position in the global economy. As highlighted in previous analytical articles by ENERGY Insights & Analytics, the world is undergoing rapid change: capital is increasingly flowing into fast-growing IT sectors, while traditional oil megaprojects are becoming more compact and efficient.

For Kazakhstan, which over three decades of independence had to simultaneously build a state, modernize infrastructure, and ensure economic stability, it was virtually impossible to immediately emerge as a leader in science and technology. Today, the country faces significant challenges in the scientific sphere but possesses massive potential to catch up.

Transformative Power of R&D and Shale Revolution

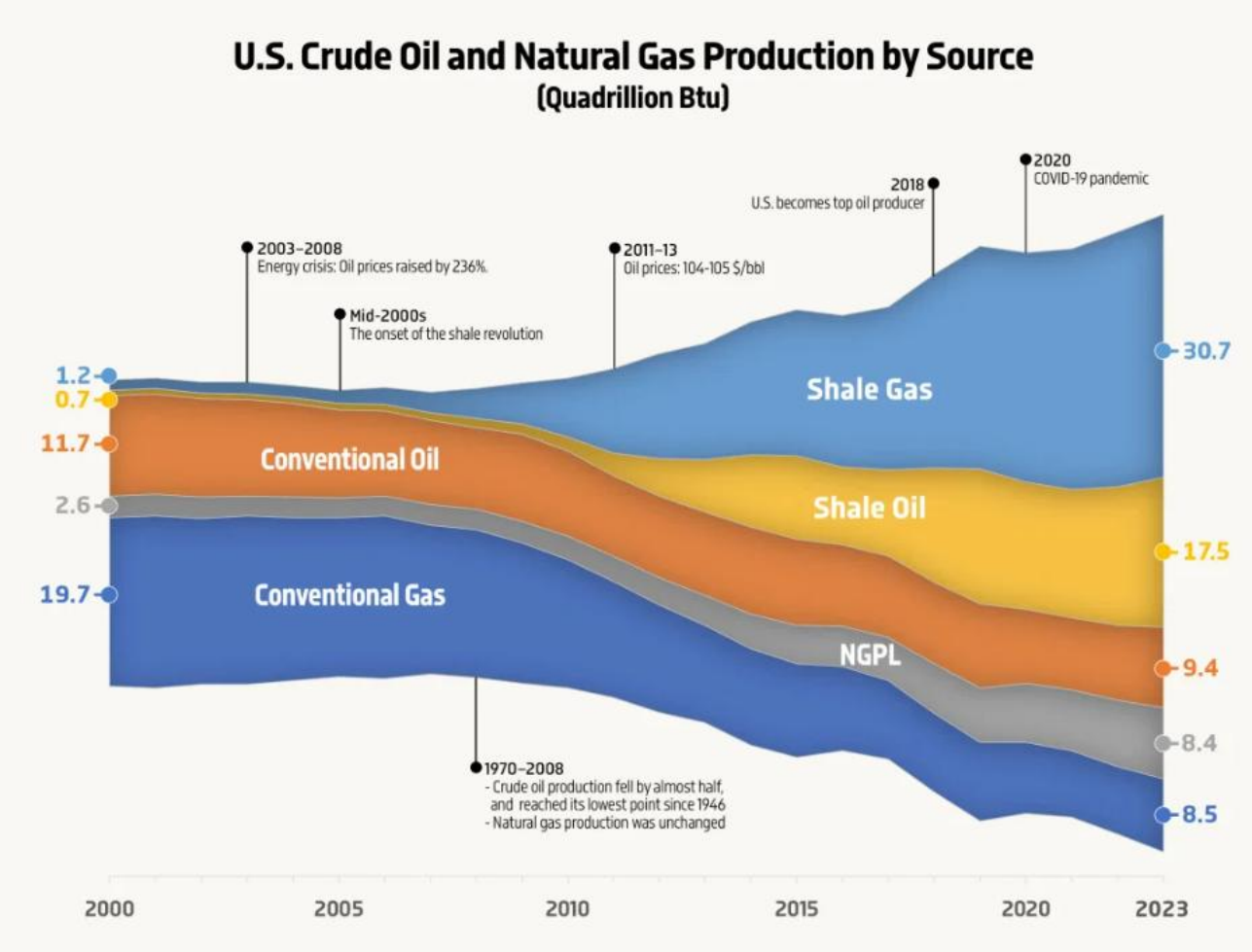
For a significant portion of the 20th and early 21st centuries, the economic and foreign policy of the United States was inextricably linked to, and heavily influenced by, its significant dependence on foreign oil. This reliance was particularly pronounced with respect to the Gulf states, creating a complex web of geopolitical and economic interdependencies. In the early 2000s, U.S. reliance on imported oil was substantial, a situation that amplified concerns regarding the nation's energy security. This pronounced vulnerability, however, served as a powerful catalyst, spurring a quiet yet momentous revolution within the domestic energy sector. As the below chart by the U.S. Energy Information Administration [EIA] suggests, petroleum imports peaked in 2005, covering almost 66% of the country's total consumption.



Source: EIA, Monthly Energy Review [September 2023]

The undeniable game-changer in this evolving narrative was the advent of the "shale revolution". This term encapsulates the successful and widespread application of two key, synergistic technologies: hydraulic fracturing, more commonly known as "fracking," and horizontal drilling. While the foundational principles of these techniques had been understood for some time, it was the persistent, and often bold, R&D efforts, frequently driven by smaller, more agile, and entrepreneurial companies, that meticulously refined and ingeniously combined them. This concerted innovative push unlocked the economic viability of extracting vast, previously inaccessible reserves of oil and natural gas trapped within shale rock formations. This technological breakthrough did not merely incrementally alter but dramatically and fundamentally reshaped the U.S. energy trajectory[1].

[1] The (exceptional and fascinating) story about the shale revolution has made the US into an energy superpower in book "The New Map: Energy, Climate, and the Clash of Nations" by Daniel Yergin



Source: visualized by econovis.net based on data from EIA

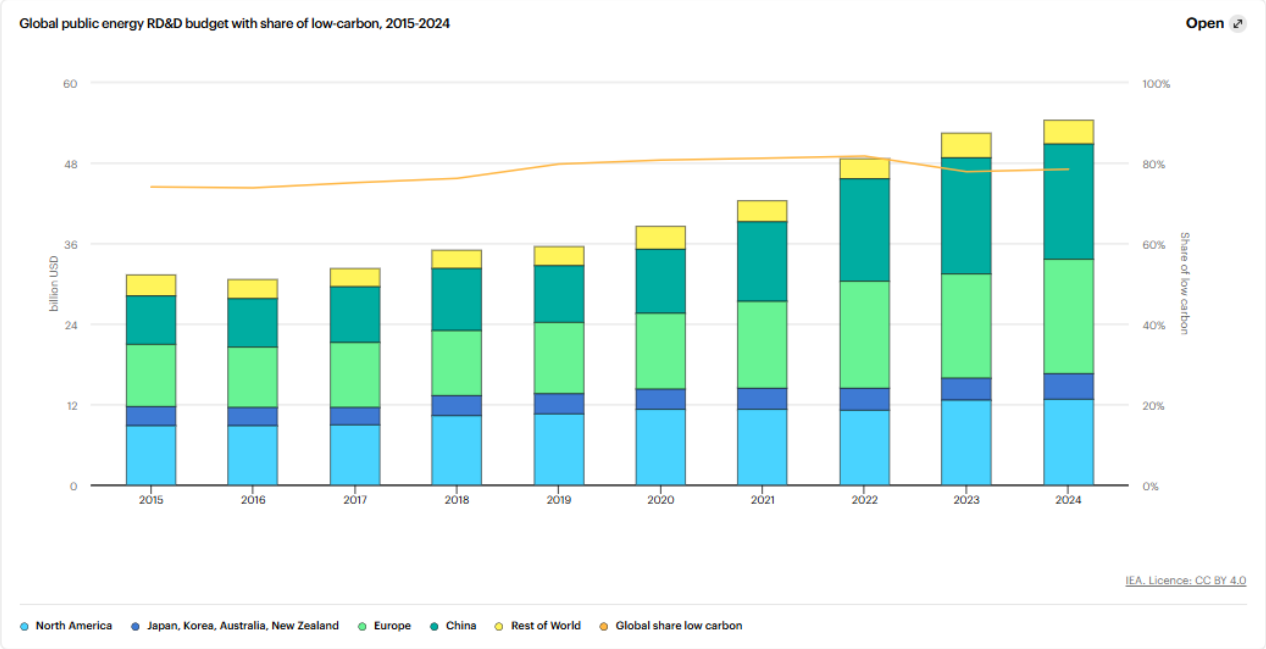
The ensuing impact of the shale revolution was nothing short of staggering and reverberated across the global energy markets. U.S. crude oil production, which had been on a consistent downward trend since its peak in 1970, experienced a remarkable resurgence, more than doubling between 2008 and 2023. By 2018 the U.S. surpassed both Russia and Saudi Arabia to claim the title of the world's largest oil producer. This extraordinary surge in domestic production precipitated a dramatic and sustained decrease in the country's reliance on foreign oil imports. In a landmark moment, the United States transitioned to a net exporter of oil and refined fuels in late 2018, a status it had not held for nearly 75 years. This new reality was further solidified by 2020 when the nation firmly established itself as a net petroleum exporter on an annual basis.

Global R&D Trends

The U.S. shale revolution stands as a powerful illustration of the transformative potential of sustained R&D. Yet today, the global oil and gas sector faces a more challenging funding

environment. While R&D in digitalization, decarbonization, and enhanced recovery remains indispensable, overall new upstream oil field investment is structurally declining. According to World Energy Investment 2025 by the International Energy Agency [IEA], global upstream spending is expected to plateau at around $570 billion in 2025, well below the early 2010s peaks above $700 billion.

This set-off is not only climate-policy driven but also a function of relative returns: capital is flowing disproportionately into technology sectors, where investors see stronger growth and margins. Meanwhile, global corporate R&D spending tells a similar story: tech giants such as Amazon, Alphabet (Google), and Microsoft each spend $30–70 billion annually on R&D, while the combined annual global public energy budget amounts to around $50 billion, a figure that seems less impressive compared to the tens of billions each tech giant invests individually. Moreover, almost 80% of the public R&D spending is allocated to low-carbon studies.



Source: IEA, Energy Technology RD&D Budgets Data Explorer [May 2025]

When it comes to individual major oil and gas companies, their R&D budgets are not even comparable to those of "Big Tech". For instance, according to its 10-K report, the largest U.S. oil and gas conglomerate, ExxonMobil, allocated less than 1 (one) billion USD to R&D efforts. The world's largest oil and gas company, Saudi Aramco, also spent slightly under a billion dollars on R&D in FY2024, while Chevron's R&D spending was about three times lower than that of Exxon Mobil and Saudi Aramco.

This divergence is reshaping energy investment psychology. Where once oil field megaprojects symbolized long-term value creation, today AI infrastructure, semiconductors, and cloud services are viewed as "advantaged investments" delivering faster, more scalable

returns. Oil and gas companies must therefore compete not only against each other but also against the superior capital efficiency of the tech sector.

While the sector has undoubtedly faced periods of significant volatility and persistent pressure to curtail costs, overall R&D spending has remained a critical and indispensable component of long-term strategy for many forward-thinking companies.

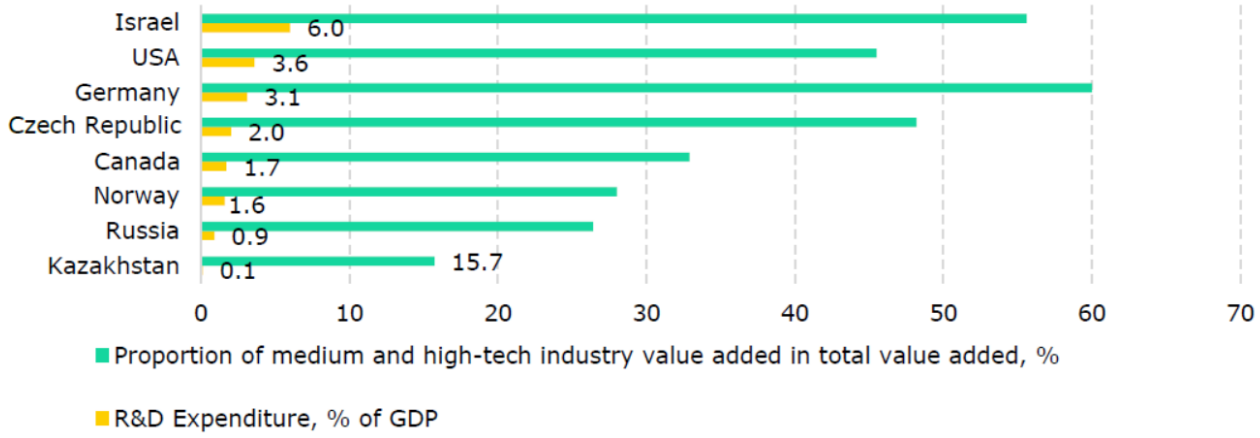
Several key and interconnected trends are currently shaping the direction and focus of R&D in the global oil and gas industry:

- **Digitalization and Automation:** The industry is increasingly and enthusiastically embracing a suite of digital technologies to enhance operational efficiency, improve safety outcomes, and drive down costs. This encompasses the sophisticated use of big data analytics, the growing field of artificial intelligence [AI], and the expansive network of the Internet of Things [IoT]. These technologies are being deployed to optimize complex drilling operations, predict maintenance needs with greater accuracy, and improve the management of vast reservoirs.
- There has been a significant shift **in the approach to megaprojects**, which are now fundamentally different from the 'mega-builds' of the early 2000s. Today's projects are smaller, modular, and efficiency-driven rather than monumental in scale, as we explored in our article on new kind of megaprojects. This same strategic shift applies to R&D investments, which follow similar principles of modularity and efficiency over sheer size.
- **Decarbonization and Sustainability:** In response to the (time to time) escalating global pressure to address the complex challenges of climate change, a significant and growing portion of R&D investment is now being strategically directed towards a range of decarbonization technologies.
- **Subsea and Deepwater Exploration:** A substantial portion of the world's remaining untapped hydrocarbon resources is located in challenging and often hostile deep offshore environments. Consequently, R&D is crucial for developing the sophisticated and reliable technologies needed to safely and economically explore and produce in these demanding settings. This encompasses significant advancements in subsea processing capabilities, the deployment of advanced robotics for intricate inspection and maintenance tasks, and the use of powerful simulation technologies for planning and operational guidance.
- **Advanced Materials:** The ongoing research into new and innovative materials is leading to the development of more durable, resilient, and corrosion-resistant equipment. This is essential for extending the operational life of critical assets and for ensuring safe and reliable operations in increasingly harsh and extreme environments.

The Innovation State of Kazakhstan's O&G Gas Sector

Kazakhstan is a (relatively) young nation whose economic foundations were laid under exceptionally challenging circumstances. Following the dissolution of the Soviet Union in 1991, Kazakhstan confronted an abrupt and deep transition from a centrally planned system to a market-driven economy, a process widely regarded as "shock therapy". In the early days of independence, the country was compelled to build much of its sovereign economic infrastructure from the ground up, making immediate stability and survival the core priorities for policymakers. During this formative period, safeguarding the economy and ensuring the viability of the state necessarily took precedence over ambitious, long-term development. As part of the global economy, Kazakhstan has also confronted major worldwide challenges, including the Great Recession and the economic disruptions caused by the COVID-19 pandemic.

As a result, the comparative chart from Halyk Finance below clearly shows that Kazakhstan's R&D spending as a share of GDP [yellow bars] is not only far behind the world's most developed and technologically advanced countries, such as Israel and the United States, but is also significantly lower than that of Russia, its closest neighbor. Additionally, the green bars indicate that Kazakhstan also lags well behind these countries in the share of value added by medium- and high-tech industries within its manufacturing sector.



Source: Halyk Finance / UN Global SDG Database, adapted from "Innovation in Kazakhstan" [August 2025]

Three decades later, the results of these efforts are clear: Kazakhstan stands on solid economic ground, having weathered post-Soviet instability and established itself as a resilient and globally integrated market economy. This hard-earned stability now provides a reliable platform on which to launch the country's next transformation - becoming a dynamic scientific and technological hub. Kazakhstan's strategic location neighboring powerful economies such as China and Russia, the exceptionally high literacy rate of its population,

and thousands of students studying in the world's best universities via the Bolashak scholarship program backed by the state, all point to substantial innovation potential.

Recent reforms bring renewed optimism: the new Tax Code elevates importance of R&D investment, global universities are opening branches within the country, and the government's multi-vector policy is attracting capital from the U.S., Europe, China, and Russia alike. These developments set the stage for Kazakhstan to leverage its unique advantages and transition from economic stability to regional leadership in science and innovation.

A notable milestone in Kazakhstan's evolving energy innovation framework is the recent establishment of the Scientific-Technical Council [STC] under the Kazakhstan Ministry of Energy. This advisory and consultative body is tasked with identifying priority R&D directions, evaluating scientific and technical projects, and developing recommendations for the effective allocation of state and private funding for research and technology development in the oil and gas sector. The STC brings together representatives of government agencies, leading scholars, national companies, and the private sector. It coordinates interdisciplinary collaboration on strategic projects, commercializes research outcomes, and ensures transparency in the management of mandatory R&D contributions from subsoil users, which amount to 1% of mineral extraction costs annually. These efforts are designed to elevate the quality, impact, and relevance of scientific advancements in regulated energy fields. The council's expert composition, mandated procedures, and its prioritization of key technological initiatives showcase the government's intent to foster a well-governed, transparent, and internationally competitive environment for research and innovation. The STC intended to serve as a critical link between long-term national goals and practical projects, helping Kazakhstan strengthen the connection between fundamental research and industrial application in energy and resource management.

There is also an STC of the KAZENERGY Association, which is a permanent advisory body that coordinates and supports R&D, innovation, and technology adoption among its members in Kazakhstan's oil, gas, and electricity sectors. Its main tasks include identifying priority areas for research and innovation, adapting global best practices, forming expert opinions, and evaluating the effectiveness of R&D and new technologies. The STC also reviews policy issues and provides recommendations to improve scientific and technical progress in the industry.

Another integral part of Kazakhstan's R&D infrastructure is the Samgau Center for Scientific and Technological Initiatives, that acts as a unified gateway for consolidating, reviewing, and funding innovation projects for Samruk-Kazyna's companies. Its selection process focuses on technological solutions that address critical production and environmental challenges while supporting long-term competitiveness. Through regular technological sessions and diagnostic surveys, Samgau has assessed and financed projects, many of which involve major national companies.

There are notable innovation initiatives within the private sector of Kazakhstan's oil and gas industry. For example, Caspiy Neft JSC, in collaboration with the Kazakhstani company Intelligent Digital Solutions LLP [IDS], has implemented comprehensive digitalization solutions to enhance the efficiency of its mature Airankol oilfield, efforts that are already delivering significant positive results. This case was explored in detail in our article, "Mature Oilfields – Nurture and Revitalize".

Another private oil company from Kazakhstan, SOUTH-OIL LLP, recently achieved a milestone by drilling Kazakhstan's first horizontal shale oil well at the Akshabulak field, reaching a total depth of over 4,100 meters and confirming shale reserves in the Karagansai Formation. The project was completed efficiently and safely, using modern drilling fluids and updated equipment. While commercial-scale production has yet to begin, preparations for a second horizontal well are already underway, indicating real technical progress. Although SOUTH-OIL's results are still in the early stages compared to the transformative shale boom in the United States, this achievement could become an important milestone and a potential opportunity for investors. EIA estimates Kazakhstan's technically recoverable shale oil and concentrate reserves at 10.6 billion barrels [approximately 1.4 billion tons].

Within Kazakhstan's oil and gas innovation ecosystem, a notable digital initiative is Dereknet, a platform designed for comprehensive verification of production data. Selected for the state scaling program under the supervision of the Kazakhstan Ministry of Energy, Dereknet represents a domestically developed solution to one of the industry's critical challenges: ensuring accuracy and integrity of operational data across highly complex production processes. The platform is already being piloted by major international operators active in Kazakhstan, including Tengizchevroil [TCO], Karachaganak Petroleum Operating [KPO], and the North Caspian Operating Company [NCOC].

Kazakhstan moves beyond the foundational challenges of its early independence and builds on its hard-won economic stability, and now it is essential that research and development become a central focus of national strategy. For Kazakhstan to realize its ambition of becoming a regional leader in science and technology, R&D must not only attract greater interest from both the public and private sectors but also grow as a share of GDP.

The Bottom Line

Kazakhstan is well positioned to make a significant leap in innovation. We are already seeing a positive trend: both the government and the private sector increasingly recognize the importance of innovation, as demonstrated by a range of new initiatives and reforms. Kazakhstan has enormous potential to build a strong R&D ecosystem but realizing this potential will require a gradual shift toward a more strategic and long-term approach to investment in science and research. By fostering this mindset, Kazakhstan can lay the groundwork for sustainable technological progress and strengthen its position in the global innovation landscape.

ENERGY Insights & Analytics

Analytical center "ENERGY" LLP (ENERGY Insight & Analytics) is a joint venture between the KAZENERGY Association and IT company AppStream. The company aims to become a priority source of data, analytical information, and recommendations for Kazakhstan's oil, gas, and electric power industries, allowing decision-makers to analyze and predict the most significant industry indicators with details on leading market players. Activities of ENERGY Insight & Analytics incorporate the whole analytics cycle with consequent stages: Descriptive, Diagnostic, Predictive, and Prescriptive analytics.

The key tool and product of ENERGY Insight & Analytics is internally developed software - the Analytical Platform EXia, aimed to identify, localize, format, and present data most efficiently for the specified use cases.

Disclaimer

This document is for informational purposes only. The information in this document is not a recommendation to buy, hold until maturity, sell any securities, or make any investment decisions and is not a call for action.

Any statement, estimate, or forecast included in this document regarding the expected future results may not be accurate and, therefore, should not be relied upon as an obligation or assurance regarding future results. Analytical Center "ENERGY" LLP (hereafter – ENERGY Insight & Analytics) does not assume any obligation or liability with respect to the recipient or any other person for damage or loss of any kind resulting from the use or erroneous use of this document or its part by the recipient or other person; does not accept and does not assume any future obligations to update the document or its part or to clarify or notify any person about inaccuracies contained in the document or its part that may be revealed.

ENERGY Insight & Analytics materials cannot replace the knowledge, judgment, and experience of the users, their management, employees, consultants, and (or) clients during the adoption of investment and other business decisions. ENERGY Insight & Analytics receives information from sources that are, in the company's opinion, reliable, but ENERGY Insight & Analytics is not responsible for the accuracy of the information, i.e., does not audit or otherwise verify the data presented and is not responsible for their accuracy and completeness.

Contact and Follow Us

www.exia.kz

info@exia.kz

https://www.linkedin.com/company/energy-insight/

10 D. Kunayev street, Astana, Kazakhstan