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# The Impact of Technological Revolution on the Natural Gas Industry

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## Abstract

China's natural gas industry has entered a new stage of continuous and coordinated development. With the ongoing promotion of green development and the concept of harmony between humans and nature, the three major state-owned natural gas enterprises will play an increasingly critical role in driving progress. At the same time, the construction of natural gas pipelines and storage facilities is accelerating, and the supply of natural gas continues to grow steadily. Previously, China's natural gas industry faced several challenges, including mismatched supply and demand, excessive reliance on imports, delayed pipeline construction, an imperfect pricing mechanism, and inadequate regulatory frameworks. As the country enters a new era, with the deepening of energy structure reforms and continuous improvement in industrial infrastructure, natural gas consumption demand is expected to experience explosive growth. In the future, technological advancements will drive increased natural gas supply through multiple channels and optimize pipeline networks through digital technologies, improving energy distribution efficiency. At the same time, the application of artificial intelligence and big data analytics will help refine the natural gas market pricing mechanism, fostering a more flexible and transparent pricing system. To better adapt to industrial changes, it is also necessary to accelerate the development of regulations and improve the regulatory framework for the natural gas industry, ensuring its healthy and sustainable development. This development trend, supported by advanced technologies and innovative practices, will address current industry bottlenecks and propel the natural gas industry into a more efficient and intelligent new era.

## Keywords

Technological Progress; Current Status; Issues; Opportunities

## 1. Introduction

As a fossil fuel, natural gas produces significantly lower carbon dioxide emissions compared to other fossil fuels like coal and oil. Therefore, as a substitute for coal and oil fuels in power generation and transportation, the global demand for natural gas has been increasing. Using natural gas in transportation helps reduce emissions of other gaseous pollutants such as SOx and NOx. In addition to being a low-carbon

energy source, natural gas is also a major source for hydrogen production through steam methane reforming. criteria that follow.

## 2. Concept of Technological Revolution

Over the past three centuries, the world has experienced several technological revolutions that have affected all areas of human activity, leading to revolutions in various industries such as industrial production, energy, transportation, agriculture, and others. The widespread application of revolutionary innovations has accelerated the development of relevant industries. In most cases, technological revolutions result in the emergence of new technological structures within industries, usually defined as technologies and related control systems that are closely interconnected in terms of physical and functional aspects. Technological revolutions and industrial revolutions are often seen as the same event, although in fact, there are completely different interpretations based on time sequence, technological content, and actual results (Toffler) [1].

The foundation of the First Industrial Revolution was the widespread use of steam and steam engines in industry; the replacement of charcoal with coal in metallurgy; and the shift of rail and maritime transportation to steam engines. This mechanized basic processes, greatly improving labor productivity and reducing production and transportation costs. The mining and sale of coal eliminated limitations on the location of major production facilities, and coal became the primary fuel.

The Second Industrial Revolution involved the advent of conveyor belt production, which led to the mass production of inexpensive products. This created strong demand for "high-density" energy carriers (electricity and oil-based fuels in internal combustion engines) and new, powerful engines (electric motors and internal combustion engines), as well as the development of high-tonnage organic chemistry, initially based on coal. Electric motors enabled high labor productivity even in small-scale facilities. Internal combustion engines facilitated the further development of rail and water transport and the emergence of new transportation modes, including road and air travel.

The Third Industrial Revolution is associated with the rapid growth of mass production, the widespread use of electronic products, the automation of technical processes, and the development of computer equipment, information, and communication technology (ICT). The advent of the internet and the beginning of the digital revolution have led to the penetration of information and communication technology into various fields of production activities and daily life. This has led to the globalization of production and the emergence of global markets for products and services, including energy resources, power engineering equipment, and oil services (Bell) [2].

In this context, technological progress includes improvements in productivity and efficiency, as well as adjustments to infrastructure. In most short-term natural gas

studies, the evolution of technological progress has been overlooked, with specific predictions and evaluations being based solely on the latest technology. However, technology does not evolve overnight. Inventions and innovations are the driving forces behind technological progress and economic development (Roberto F. Aguilera) [3]. In any study looking ahead for 10 years or longer, technology may influence market realities at the same rate as energy policies. Although we cannot predict future policies, it is certain that tomorrow's technology will differ from today's. Over the past 150 years, the global energy system has undergone a series of evolutionary changes, with the fuel structure transitioning from wood to coal and then to oil. These shifts in primary energy forms are linked to fundamental technological transformations (Li Xuka) [4].

All technological revolutions have, directly or indirectly, fundamentally impacted the energy industry, influencing energy demand, including its quantity, structure, and the quality requirements for energy carriers. The new technological revolution is no exception: it, along with the post-industrial economy and society emerging on its foundation, will introduce new demands for the energy sector.

## 3. Current Status and Development History of the Natural Gas Industry

### 3.1. Current Status of the Natural Gas Industry

Natural gas is a multi-component mixture primarily composed of alkanes, with small amounts of ethane, propane, butane, carbon dioxide, hydrogen sulfide, and trace inert gases. It can be classified based on its underground form into associated gas, coalbed methane, shale gas, and natural gas hydrates. Typically, natural gas is stored and transported in the forms of pipeline gas (gaseous natural gas), LNG (liquefied natural gas), and CNG (compressed natural gas). The natural gas industry chain mainly consists of upstream exploration, midstream transportation, and downstream distribution and retail.

The supply of natural gas has been growing rapidly. In terms of domestic proven reserves, the annual increments from 2014 to 2023 were 1,110.72 billion $m^3$, 677.22 billion $m^3$, 726.56 billion $m^3$, 8000 billion $m^3$, 6999 billion $m^3$, 1.2 trillion $m^3$, 1.03 trillion $m^3$, 1.62 trillion $m^3$, 1.13 trillion $m^3$, and 1 trillion $m^3$. Regarding domestic production, China's natural gas production was 134.5 billion $m^3$ in 2014 and reached 235.3 billion $m^3$ in 2023, with an average annual growth rate of 6.41%, achieving over 10 billion $m^3$ of incremental production for seven consecutive years. As for natural gas imports, the growth rate of imports has slowed down. In 2014, China's natural gas import volume was 58.4 billion $m^3$, which rose to 165.6 billion $m^3$ in 2023, with an average annual growth rate of 12.27%. Concerning the length of natural gas pipelines, China's pipeline length reached 69,000 km in 2014 and 118,000 km in 2023, with an annual growth rate of 6.14%. With an increasing diversification of natural gas import channels, continuous advancements in

domestic exploration technology, and the development of corresponding infrastructure, China's natural gas supply is expected to continue increasing.

The demand for natural gas is growing rapidly. The main end uses of natural gas include industrial gas, city gas, natural gas power generation, and chemical gas. In 2014, China's apparent consumption of natural gas was 193 billion $m^3$, which grew to 394.53 billion $m^3$ in 2023, with an average annual growth rate of 8.26%. In 2022, city gas and industrial gas consumption accounted for 33% and 42% of total consumption, respectively. By 2023, the total natural gas consumption reached 394.53 billion $m^3$, with 194.1 billion $m^3$ consumed in the first half of 2023, reflecting a year-on-year growth of 5.4%. The primary consumption of natural gas is city gas and industrial fuel, accounting for approximately 75% of the total.

The three major state-owned enterprises (PetroChina, Sinopec, and CNOOC) are the dominant players in China's natural gas market. In terms of upstream exploration and production, from 2020 to 2023, these three enterprises together accounted for over 93% of the nation's total natural gas production, indicating the highly concentrated development of China's natural gas industry. These companies virtually control all upstream exploration and production. In 2023, CNOOC proposed to continue expanding its natural gas production. In terms of midstream transportation, the construction of natural gas pipelines is closely linked to upstream exploration and production, with a model dominated by the three major enterprises and supplemented by local construction. Regarding the downstream distribution industry, it consists mainly of wholesalers (the three state-owned enterprises), intermediaries (provincial pipeline companies), and distribution retailers (urban gas companies). Unlike wholesalers and intermediaries, who exhibit a higher degree of concentration, retailers show relatively low concentration. However, in specific cities, due to exclusive operating rights, there is typically only one retail distributor, which increases the market concentration of retailers, leading to regional monopolies.

### 3.2. Development History of the Natural Gas Industry

China's natural gas industry has undergone several major reform stages. These reforms began under a highly centralized planned economy system (1949-1981) and eventually led to the separation of government and enterprises (1998-present). In 2008, the National Energy Administration was established to oversee energy management. Several other government agencies, including the National Development and Reform Commission, Ministry of Land and Resources, and Ministry of Environmental Protection, are also involved in the management and regulation of oil and natural gas resources. The downstream natural gas market underwent two major reforms. From 1978 to 2002, the market was dominated by state-owned monopolistic enterprises responsible for pricing, subsidies, network construction, distribution, and marketing. In 2002, the government began to loosen

restrictions, allowing private and foreign capital to participate in facility construction and operation through franchising and joint ventures (Wang et al.) [5].

In September 2023, the National Energy Administration of China released a draft "Natural Gas Utilization Policy" to provide guidelines for the development of the natural gas market in the coming years. This policy draft redefines priority sectors for natural gas use and reduces the deployment of gas in sectors with previous supply tightness. The policy clarifies rules for the coal-to-gas switch in residential and commercial heating and focuses natural gas use in transportation for heavy goods and intercity passenger transport. It also calls for the development of demand-side management and the acceleration of infrastructure development for imports, storage, and transportation. This aligns with China's goal of doubling its natural gas and LNG storage capacity to 55-60 billion $m^3$ by 2025. In December 2023, the National Development and Reform Commission announced the simplification of natural gas transportation tariffs. Starting from January 2024, the reform will establish four regional transportation fee rates, replacing the previous 20 rates, expected to enhance the transparency and flexibility of domestic natural gas trade.

## 4. Impact of Technological Revolution on the Development of the Natural Gas Industry

The technological revolution has significant impacts on the energy industry, including: 1) the ongoing electrification of the production sector, transportation, and daily life; 2) the further segmentation of energy demand among different societal sectors with varying growth rates and structures. In turn, the technological structure of the energy sector will be further segmented to meet future demands as efficiently as possible. This trend will be most evident in the power industry.

The new technological revolution is fundamentally changing the form and development conditions of the global energy industry. The increase in energy demand, along with changes in the energy structure, requires the development of breakthrough technologies and the supply of new energy sources, which comes with significant costs.

A new technological revolution is unfolding around the world. Countless impressive scientific and technological advancements, coupled with the large-scale commercialization of innovative new products, confirm this reality. These changes will inevitably affect the energy sector, as only new energy technologies and carriers can meet the growing demand. Developing these energy sources requires substantial resources, making the prediction of changes in the economic and social spheres and the future demand of the energy industry an especially relevant task. Predictions are always based on the analysis of previous experiences, in this case, previous technological revolutions and their impact on the energy sector (Mahmud Suleiman) [6].

According to the Energy Digital Transformation Report by the International Energy Agency, digital technologies will provide new solutions to the major challenges facing the energy industry, enhancing the efficiency of production and operational models. At the same time, the digital transformation will make energy systems more interconnected, intelligent, efficient, reliable, and sustainable, while continuously driving the emergence of new business models. This will promote and achieve the transformation and upgrading of traditional energy strategies, revitalizing them as a significant driving force. The international community widely recognizes the transformative impact of digital transformation (DT) on energy systems. The digital transformation of energy systems has become an irreversible trend, and digital technologies are key to the smooth transition of future energy systems. Improving energy efficiency is one of the major challenges that need to be addressed to reduce energy consumption, achieve green development, and transition from high-speed growth to high-quality development (Wu et al.) [7]. The technological innovation capability produced by digital technologies has become an important force driving transformation in the energy sector, resulting in significant changes in energy production, transmission, and consumption, leading to benefits such as improved efficiency, reduced costs, and enhanced customer experience (Nazari and Musilek) [8].

## 5. The Impact of Technological Revolution on the Natural Gas Industry

Technological advancements have impacted every stage of the energy chain, ranging from resource extraction to final usage conversion. In addition to improving existing or traditional technologies, new exploration and production technologies have been introduced. For example, advanced equipment used in natural gas pipeline construction, as well as technologies for pipeline maintenance and monitoring systems.

### 5.1. Impact on the United States

The technological revolution has boosted the development of unconventional oil and gas resources in North America, particularly in the U.S., leading to increased production and reduced imports of crude oil and natural gas. From 2006 to 2018, U.S. natural gas production rose by 57%, which reduced imports by 30%, from 4.2 trillion cubic feet in 2006 to 2.9 trillion cubic feet in 2018. During the same period, U.S. consumption increased by 38%, reaching 29.9 trillion cubic feet in 2018, marking the first time U.S. natural gas exports surpassed imports.

### 5.2. Equations

Technological advancements have significantly impacted the natural gas market in Western Europe. These innovations have not only reshaped the region's primary

energy structure but also predicted a 10% reduction in total primary energy consumption by 2030. Technological progress has improved energy system efficiency and shifted the primary energy composition from coal to natural gas, enhancing system performance (Roberto F. Aguilera) [9]. By 2030, natural gas is expected to become the largest primary fuel in Western Europe, with a 26% market share. From 1980 to 2000, gas consumption grew from 220 to 330 billion cubic meters, driven by improved productivity and reduced reliance on imported gas, with a 30 billion cubic meter drop in non-European gas imports by 2000.

## 6. Conclusion

The technological evolution scenario highlights that incorporating technological advancements into long-term energy forecasts significantly impacts the future of the Western European energy system. Expanding natural gas use depends on successfully developing new natural gas utilization and supply technologies. While technology forecasts carry risks, integrating technological change into energy analyses brings significant benefits(David Borge-Diez) [10].. Traditional approaches often extrapolate current conditions into the future, but technological evolution requires looking beyond this. This study predicts the effects of technological dynamics on future natural gas market growth.

Additionally, energy policies and traditional beliefs interact. For instance, in the 1970s, it was believed that natural gas was a scarce resource, but this changed with the discovery of major fields in the North Sea and the entry of Soviet and Algerian gas into the European market. Recognition of natural gas's environmental benefits led to price parity with oil. Technology can help overcome myths, turning sub-marginal resources into economically viable reserves, making natural gas a dominant global fuel (Belgacem Tahchi) [11].

From a neorealist perspective, self-reliance drives state behavior. The U.S. has reduced dependence on Middle Eastern oil and gas through technological advances in unconventional resources, enhancing energy self-sufficiency, geopolitical stability, and global dominance. The technological revolution in energy has decreased U.S. reliance on imports, boosted economic competitiveness, and minimized vulnerabilities to global market fluctuations. These developments also empower the U.S. to influence global energy markets, marking significant outcomes of the revolution.

## References

[1] Toffler, A. Revolutionary Wealth. New Perspect. Q. 2006, 23, 7–15.

[2] Bell, D. The Coming of Post-Industrial Society: A Venture in Social Forecasting. 1984.

[3] Aguilera R F. Effects of technological progress and external costs on upstream petroleum supply[J]. Journal of Petroleum Science and Engineering, 2021,202:108522.

[4] Li, X. The Current Situation and Development Thoughts of China's Natural Gas Industry. Southern Forum, 2021, 41(02): 108-113.

[5] Wang X, Feng G, Hu Y, et al. Recent Advancements in Petroleum and Gas Engineering[J]. Energies, 2024,17(18):4664.

[6] Suleiman M. Modelling and forecasting world oil demand: a regional analysis accounting for asymmetric price responses and technical progress[J]. OPEC Energy Review, 2019,43(2):193-216.

[7] Wu Z, Adebayo T S, Alola A A. Renewable energy intensity and efficiency of fossil energy fuels in the nordics: How environmentally efficient is the energy mix?[J]. Journal of Cleaner Production, 2024,438:140711.

[8] Nazari Z, Musílek P. The Gender Digital Divide and Education in Afghanistan: A Review[J]. 2023 IEEE International Humanitarian Technology Conference (IHTC), 2023:1-7.

[9] Aguilera R F, Ripple R D. Technological progress and the availability of European oil and gas resources[J]. Applied Energy, 2012,96:387-392.

[10] Borge-Diez D. Energy Policy, Energy Research, and Energy Politics: An Analytical Review of the Current Situation: Energies[Z]. 2022: 15, 8792.

[11] Tahchi B. Algerian gas to strengthen energy security of the European Union: Policy, capacity and strategy[J]. Energy Reports, 2024,11:3600-3613.