Deep Ground•Collaboration•Integration and Intelligence: Development Trends and Strategic Reflections on China's Unconventional Natural Gas

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Abstract

Under the "dual carbon" goal, unconventional natural gas (shale gas, coal-rock gas, tight gas) has transformed from a "substitute" for conventional natural gas to a "main force" for China's energy security and green transformation. By using methods such as literature research, data statistics, and case analysis, a systematic summary of China's unconventional natural gas resource foundation and its deep breakthroughs, theoretical and technological revolutions, and new patterns of coordinated development was conducted. The results show that unconventional natural gas resources in China account for 66.5% of the total natural gas resources in the country, with a proven rate of less than 10%, indicating huge potential for increasing reserves and production. In recent years, historic breakthroughs have been made in the deep field, with breakthroughs in multi-layered marine shale gas formations in the southern Sichuan Basin and the implementation of the first trillion cubic meter large-scale gas production area in China for deep coal-rock gas in the Ordos Basin. The position of tight gas as a stable production "ballast stone" continues to consolidate. Theoretical and technological innovation profoundly drives industrial transformation, forming geological theories such as "binary enrichment", "ternary accumulation", and "three-field controlling accumulation" as well as intelligent development technology based on geological engineering integration. In response to challenges such as resource degradation and high cost, a four-dimensional integrated strategy of "deep breakthrough, stereoscopic collaboration, integrated development, and intelligent production" is proposed: implementing four major paths of strategy development which are resource collaboration, nonconventional gas-conventional gas collaboration, nonconventional gas-new energy integration, and intelligent upgrading, constructing an intelligent dynamic evaluation model of "economy-technology-policy", promoting intelligent development and institutional mechanism reform. It is expected that the proportion of unconventional gas production will exceed 50% by 2030, and the peak in 2045 will reach over $1500\times10^{8}m^{3}$. This article provides strategic reference for the high-quality development of unconventional natural gas and national energy security guarantee.

Keywords

Deep Breakthrough, Stereoscopic Collaboration, Integrated Development, Unconventional Natural Gas, Shale Gas, Coal-rock Gas, Tight Gas, Intelligentization, Development Strategy