Front. Eng. Manag. 2019, 6(3): 453–456
https://doi.org/10.1007/s42524-019-0046-z

COMMENTS

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Accelerating the construction of natural gas system engineering in green smart cities

Natural gas is a high-quality, high-efficiency, clean and low-carbon energy. The CO_2 produced by its combustion accounts for only 55% of the combustion of coal and 80% of the combustion of petroleum. Natural gas combustion is almost free of sulfur, dust and other harmful substances, thus natural gas can form a benign complement with low-emission and renewable energy, such as electricity, which is an appropriate choice for urban clean energy supply (Ma, 2017). A green smart city is composed of subsystems of organization (people), business/government affairs, transportation, communication, water and clean energy, among which a clean energy supply subsystem should be green, low carbon, safe, efficient, smart and friendly (Liu and Wang, 2017). Natural gas can be used in residences, commerce, public utilities, distributed energy, and other fields in smart cities.

1 Natural gas system engineering: The fundamental engineering of green smart cities

Green smart city infrastructures include energy power, water supply and drainage, road traffic, post and telecommunication, ecological environment, and disaster prevention systems, in which the natural gas infrastructure system is an important part of the supply of urban energy power systems. Natural gas system engineering is an indispensable part of the comprehensive energy utilization system of green smart cities. Green smart city natural gas system engineering is a public infrastructure engineering of green smart cities that aims to meet the dynamic consumption demand of highly diversified urban users for natural gas. With the use of green, safe, and efficient natural gas supply and utilization facilities, the intelligent deployment of target-oriented natural gas application and adaptive optimization and substitution with other energy sources can be realized using advanced information and intelligent control technologies, such as Internet + , big data, cloud computing, and the Internet of Things (Li et al., 2017). The natural gas system engineering of green smart cities must meet the diversified and dynamic needs of users, which is a typical characteristic different from the functional goals of traditional gas. User demand is dominant in the natural gas system engineering of green smart cities, i.e., for the same user or the same type of users, the alternate utilization and consumption of multiple energy sources can be dynamically adjusted to meet the needs of multiple dynamic consumption patterns according to the characteristics of different energy peaks and valleys, price fluctuations, and even personal preferences in a short period of time.

Its basic framework is built on the concept and main characteristics of the natural gas system engineering of green smart cities. The framework covers the basic components of natural gas system engineering and reflects the logical structure of deep integration of advanced intelligent information technologies, such as the Internet, the Internet of Things, big data, cloud computing, and the green production, transmission, storage, and consumption of natural gas. Energy and information are highly integrated in this new energy system (Fig. 1) (Wang et al., 2018). The physical layer consists of natural gas utilization, pipe network, reserve and gas source systems. The support layer consists of smart and green technical support systems.

Received March 25, 2019

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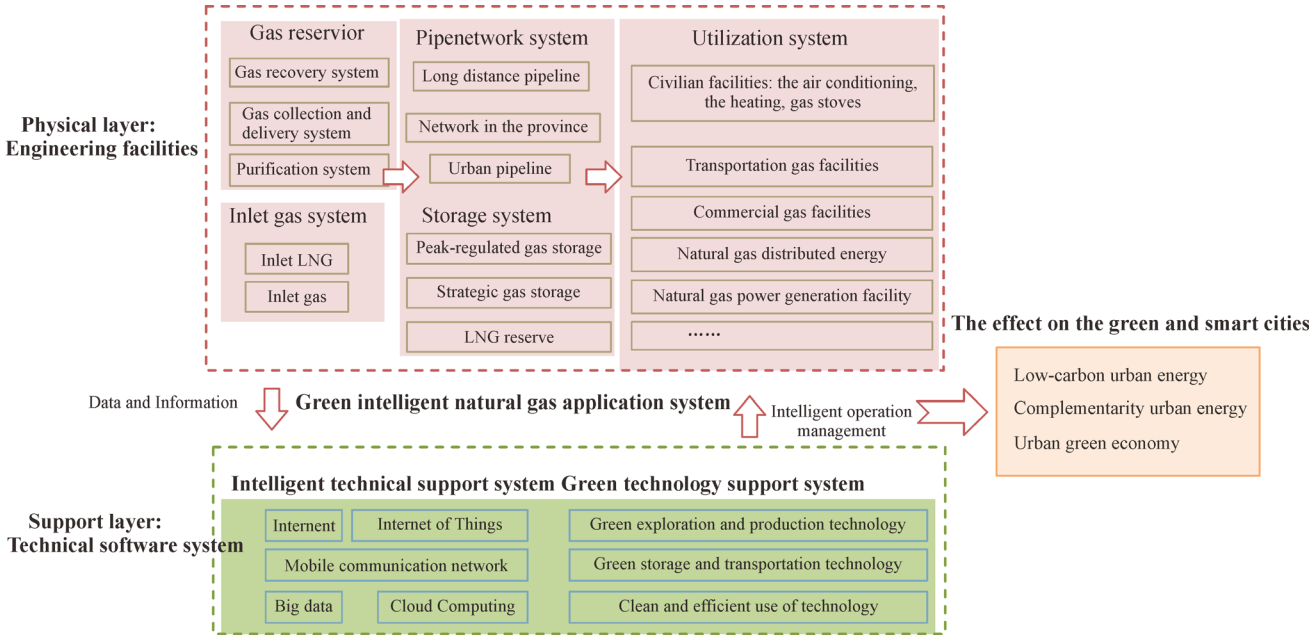

Fig. 1 Basic structure of natural gas system engineering in green smart cities.

2 Main approaches and suggestions for promoting the construction of natural gas system engineering in green smart cities

Accelerating the construction of urban natural gas system engineering helps improve the comprehensive utilization structure of urban energy, air environment quality, and people's living standards and city grades. Moreover, it helps create green, ecological and livable cities. The construction of smart cities at home and abroad places green and low carbon in an important position for urban development.

2.1 Main approaches

2.1.1 Scientific and reasonable planning layout and focusing on top-level designs

Urban development planning, energy utilization system, natural gas supply and utilization, intelligent support platform and other basic factors should be comprehensively considered for a scientific and reasonable planning layout (Calvillo et al., 2016). 1) Combined with urban development planning. The planning and deployment of urban development are comprehensively and profoundly integrated in accordance with the "Five in One" overall layout of the Party Central Committee to promote socialist modernization power with Chinese characteristics. 2) Combined with the layout of energy system utilization. The scale and structure of the utilization of various energy sources, such as urban wind energy and solar energy, should be fully considered to realize the joint supply and utilization of natural gas and complementary energy as much as possible, and urban energy system solutions should be formulated to from a macroscopic approach to overall planning. 3) Combined with the layout of natural gas supply and utilization. Natural gas system engineering can be fully adapted to the requirements of industrial development and meet the needs of users by considering the development trends of gas source, market structure and scale by combining with the characteristics of urban natural gas utilization. 4) Combined with intelligent support platforms. The construction of green smart cities remains at an early stage, and the construction of natural gas system engineering should be forward looking. Both constructions should not only be based on the existing intelligent support platform and level but also fully consider the future development ability and strive to improve the intelligence level.

2.1.2 Promoting the coordinated development of the entire industry chain, and realizing the transformation and upgrading of the natural gas industry

Green smart city natural gas system engineering is inseparable from the overall wisdom of the modern natural gas industry system. China's natural gas industry is presently developing rapidly, but natural gas is in short supply. The producers and suppliers of natural gas dominate the industry. The natural gas industry in the future will be modern, intelligent, based on a strong guarantee system for supplies, and oriented by consumer demands. The entire industry chain must be coordinated as a whole to transform the natural gas industry. The

government and enterprises should establish a coordinated development mechanism to solve the problems arising from the deployment and implementation of the upper, middle, and lower reaches of the natural gas industry. They should promote intelligent production and operation in accordance with the overall requirements for the development of the smart natural gas industry and in combination with their own characteristics to promote the construction of green and smart natural gas industry chain as a whole.

2.1.3 Strengthening technological innovation and integration and promoting the upgrading of technical support systems

State and natural gas-related enterprises should strengthen the construction of technical support systems, which mainly include smart energy technology systems based on big data, cloud computing, Internet + , the Internet of Things, and other technologies; intensive construction technology of urban gas infrastructure represented by distributed pipe network technology; clean and efficient utilization technology of natural gas; and intelligent natural gas engineering technology standard systems. These enterprises should continuously promote the construction of technical support systems by improving R&D organization systems, increasing capital investment, and implementing major special projects and scientific and technological incentives (Wang and Yang, 2014).

2.1.4 Strengthening infrastructure construction and urban natural gas commodity supply security system

The first approach is to build a diversified urban gas supply pattern, including multiple pipeline gas sources and LNG. The second approach is to build multiple peak-shaving facilities in cities, including peak-shaving gas storage tanks around the cities, LNG peak-shaving storage, and customer peak-shaving storage tanks. The third approach is to build a complete urban distributed pipe network system, i.e., to improve the ability to adapt to changes in gas consumption and pressure through pipe network annulation and pressure distribution. The fourth approach is to build an intelligent natural gas supply network based on the above three items with advanced information technologies to form a secure and reliable urban natural gas commodity supply system capable of strong emergency response.

2.1.5 Improving the utilization level and promoting a reasonably distributed, clean and efficient urban natural gas utilization system

The first method is to expand the scale of natural gas utilization, optimize the structure of natural gas consumption, and increase the share of natural gas consumption in a clean utilization field. The second method is to actively expand the field of clean and efficient natural gas utilization and vigorously promote the use of natural gas in the fields of urban gas, coal replacement, transportation, distributed energy and peak-shaving power generation. The third method is to improve the level of natural gas utilization technology and achieve clean, efficient and intelligent utilization of natural gas through technological innovation.

2.2 Suggestions

The natural gas industry remains at the stage of rapid development. The following key points should be highlighted at this stage to accelerate the construction of natural gas system engineering of green smart cities in China:

1) Improving the peak-shaving capacity of urban natural gas to ensure safe and stable gas supply in cities. The general shortage of peak-shaving capacity of natural gas has become a key factor that restricts the improvement of natural gas utilization in cities or even the country. Three methods can be applied to improve the peak-shaving capacity of urban natural gas: accelerating the construction and implementation of an urban natural gas peak-shaving responsibility system; introducing a peak-shaving gas pricing policy for promoting gas storage construction; and formulating a clear, reasonable and feasible deployment plan for enhancing the peak-shaving capacity of urban natural gas.

2) Exploring a new type of utilization represented by smart natural gas distributed energy and exerting the role of intelligence in demonstration. Distributed energy is a typical representative of clean and efficient utilization of natural gas, and its intelligent utilization has a positive demonstration effect on improving the green intelligence level of urban natural gas utilization. To this end, we should actively explore the utilization of cutting-edge technologies, such as Internet + , intelligent microgrid, energy system integration and automatic control technology, coupling technology of distributed and energy storage, and the multi-energy complementary technology of distributed and renewable energy. We should also promote natural gas distributed energy projects in urban energy load centers, industrial logistic parks, tourism service areas, commercial centers, transportation hubs, hospitals, and schools to achieve multi-energy collaborative supply and comprehensive cascade utilization of energy for intelligent management of natural gas distributed energy projects.

3) Actively promoting the transformation and upgrading of traditional natural gas systems and making preparations for smart utilization. The natural gas system projects that have already been built can be upgraded step by step through modern informative and intelligent technological means, such as Internet + and the Internet of Things, to take the lead in realizing intelligent operation management. The intelligence level of newly planned natural gas system

projects can be controlled from the design stage by using the most advanced technologies as much as possible to provide a good interface for future intelligent upgrades. The macroplanning and deployment of research and development, manufacturing, integration, and management adjustment should be conducted through key technical preparations, equipment and facilities, measurement and pricing methods, standard systems, and other aspects to transform and upgrade traditional natural gas system engineering.

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