



Research article

Energy revolution: From a fossil energy era to a new energy era[☆]Zou Caineng^{a,b}, Zhao Qun^{b,*}, Zhang Guosheng^b, Xiong Bo^b^a PetroChina Research Institute of Petroleum Exploration & Development, Beijing 100083, China^b Langfang Branch of PetroChina Research Institute of Petroleum Exploration & Development, Langfang, Hebei 065007, China

Received 4 December 2015; accepted 1 February 2016

Available online 15 July 2016

Abstract

This paper aims to predict the future situation of global energy development. In view of this, we reviewed the history of energy use and understood that new energy sources will usher in a new era following oil & gas, coal and wood one after another in the past time. Although the fossil energy sources are still plenty in the world, great breakthroughs made in some key technologies and the increasing demand for ecological environmental protection both impel the third time of transformation from oil & gas to new energy sources. Sooner or later, oil, gas, coal and new energy sources will each account for a quarter of global energy consumption in the new era, specifically speaking, accounting for 32.6%, 23.7%, 30.0% and 13.7% respectively. As one of the largest coal consumer, China will inevitably face up to the situation of tripartite confrontation of the coal, oil & gas and new energy. The following forecasting results were achieved. First, the oil will be in a stable period and its annual production peak will be around 2040, reaching up to 45×10^8 t. Second, the natural gas will enter the heyday period and its annual production peak will be around 2060, reaching up to 4.5×10^{12} m³, which will play a pivotal role in the future energy sustainable development. Third, the coal has entered a high-to-low-carbon transition period, and its direct use and the discharged pollutants will be significantly reduced. In 2050, the coal will be dropped to 25% of the primary energy mix. Last, the development and utilization of new energy sources has been getting into the golden age and its proportion in the primary energy mix will be substantially enhanced. On this basis, we presented some proposals for the future energy development in China. At first, we should understand well that China's energy production and consumption has its own characteristics. Under the present situation, we should strengthen the clean and efficient use of coal resources, which is the key to solving our energy and environmental issues. Then, under the low oil price circumstance, we should keep 200 million tons of annual oil production as “the bottom line” so as to ensure national energy security and to accelerate tight gas, shale gas and other unconventional resources development. In 2030, the annual natural gas production will reach up to more than 300 Bcm. Finally, the development and utilization of new energy resources should be further strengthened and non-fossil energy sources will be expected to reach as high as 20% of the primary energy consumption by 2030.

© 2016 Sichuan Petroleum Administration. Production and hosting by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Keywords: Energy revolution; Fossil energy; New energy; Oil & gas; Coal; Renewable energy; Unconventional oil & gas; Shale gas; Tight oil; Nanotechnology; Graphene; Internet plus

Energy, water and food are three major elements to ensure human survival. The world energy development is entering a new historical period, when clean and low-carbon energy is inevitably required. Unconventional oil and gas revolution

made the 40-year strategic dream of “energy independence” in the United States come true. The US government proposed the great energy strategy of “remaking America with green energy” in 2008, and especially, provided the revolutionary “four innovations” in unconventional oil and gas represented by shale oil and gas and tight oil, i.e. innovation in geological theory centering round continuous oil/gas accumulation, innovation in technologies with volume fracturing of horizontal wells as core, innovation in production methods for

[☆] Foundation project: The National Key Basic Research and Development Program (973 Program) (No.: 2014CB239000).

* Corresponding author.

E-mail address: zhaoqun69@petrochina.com.cn (Zhao Q.).

Peer review under responsibility of Sichuan Petroleum Administration.

platform-type “factory” exploitation, and innovation in management centering around market competition mechanism. The unconventional oil and gas revolution in the United States is now changing the pattern of global oil and gas and even energy, exerting a profound impact on global political and economic development. The Chinese government has recently proposed an energy revolution strategy of “promoting energy consumption revolution to curb irrational energy consumption, promoting energy supply revolution to establish a diverse supply system, promoting energy technology revolution to drive industry upgrade, and promoting energy system revolution to open up a fast lane for energy development. The authors first summarized the general trend of world energy development by reviewing its history. Then, they analyzed the challenges to the energy development of China, and proposed relevant countermeasures.

1. The general trend of world energy development

1.1. Three transformations in energy development

Following the transformation from wood to coal then to oil & gas, the future will see the third major transformation from oil & gas to new energy. Since primitive humans first began to use fire, energy has become an essential resource for human survival. Easily accessible timber satisfied heating, cooking and other basic needs for the survival of primitive humans. With technological advances in coal mining, coal, which had higher energy density, was widely used. In 1769, Watt invented the steam engine. In 1875, the French built the first coal-fired power plant in the world. The progress of human civilization accelerated the development of the coal industry, and coal accounted for the largest share in primary energy mix in the 1780s, surpassing wood for the first time. This was the first transformation – from wood to coal. In 1886, Daimler invented the internal combustion engine, stimulating a great increase in the demand for oil and gas as efficient energy resources. Progress in geological theory, and drilling, completion and refining technologies drove oil and gas production to increase substantially. Accordingly, the share of oil and gas in primary energy mix grew rapidly to more than 50% in 1965. These energy resources replaced coal as the largest energy in the world, recording the second transformation – from coal to oil and gas.

With the sustained increase in the economic and social demand for energy and the advent of low-carbon society, the third major transformation from traditional fossil fuel to non-fossil new energy will become inevitable. In recent years, ecological and environmental problems caused by the use of coal, oil and other high-carbon energy resources have become increasingly prominent. The intensive use of coal and other high-carbon energy resources is the major reason for the fog in London in the early 20th century and the serious fog and haze in China now. With the increased demand for green ecological environment, natural gas and new energy as clean energy resources will take up a higher share in the primary energy mix.

Oil, gas, coal and new energy resources will each account for a quarter of global energy consumption. However, it is important to clearly realize that new energy can hardly play a vital role in quite a long time to come.

1.2. Three trends in energy development

In types, production methods and utilization methods of energy resources, the world energy development has shifted from high- to low-carbon, from simple production to technological production, and from one-time utilization to multiple one.

- 1) Energy types: from high- to low-carbon, or from fossil to non-fossil energy sources. The carbon content of calorific value per unit is 26.37 t/TJ in coal, 20.1 t/TJ in crude oil, and 15.3 t/TJ in natural gas. Hydropower, wind power, nuclear energy and solar energy are almost carbon-free. In the transition from coal to hydrocarbon and from hydrocarbon to new energy sources, pollutants and carbon emissions generated by various types of energy sources has been increasingly reduced which has met the needs of green development of ecological environment.
- 2) Production methods: from original to technological production. According to the general trend of energy development, primitive humans got wood from nature directly, and importance of engineering technology became increasingly prominent from coal mining to oilfield development. The development of nuclear, wind, solar and other new energy resources is technically intensive. The importance of technology is also highlighted in the development process of any type of energy. For example, in early years vertical well drilling was used for oil exploitation, and the application of horizontal well drilling and hydraulic fracturing technology enabled a large number of low-yielding wells to achieve effective development. In recent years, the application of staged fracturing in horizontal wells has promoted a “shale oil and gas revolution” in the energy sector.
- 3) Energy utilization: from direct use to energy transformations. Before the First Industrial Revolution, firewood and coal were used only for heating. With the invention of steam engine in 1769 and of internal combustion engine in 1875, energy was used for power generation. Following the discovery of electromagnetic induction by Faraday in 1831, energy was used for electric power, ushering in the era of energy use for electrification.

1.3. Three patterns of energy development

With the advances in social civilization and science and technology, a new pattern of coordinated development between “oil” and “natural gas”, “conventional energy” and “unconventional energy”, and “fossil energy” and “non-fossil energy” is taking shape [1].

Download English Version:

<https://daneshyari.com/en/article/1747739>

Download Persian Version:

<https://daneshyari.com/article/1747739>

[Daneshyari.com](https://daneshyari.com)