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China's approach to nuclear safety — From the perspective of policy and institutional system

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HIGHLIGHTS

- China's Approach to Nuclear Safety.
- Policy and Institutional System for Nuclear Energy Development.
- A Benchmark for the Peaceful and Safe Utilization of Nuclear Power.
- Further Efforts for Specific Laws and Administrative System.

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ABSTRACT

Nuclear energy plays an important role in the energy sector in the world. It has achieved a rapid development during the past six decades and contributes to over 11% of the world's electricity supply. On the other side, nuclear accidents have triggered substantial debates with a growing public concern on nuclear facilities. Followed by the Fukushima nuclear accident, some developed countries decided to shut down the existing nuclear power plants or to abandon plans to build new ones. Given this background, accelerating the development of nuclear power on the basis of safety in China will make it a bellwether for other countries. China assigns the top priority to the nuclear safety in nuclear energy development and has maintained a good record in this field. The policy and institutional system provide the necessary guarantee for the nuclear energy development and safety management. Furthermore, China's approach to nuclear safety provides a benchmark for the safe development and utilization of nuclear power. This research draws an overall picture of the nuclear energy development and nuclear safety in China from the policy and institutional perspective.

1. Introduction

Since 1950 s, more than 430 commercial nuclear power reactors have been operating in 31 countries (Yim and Li, 2013). With over 370 GWe of the total capacity, these nuclear power plants supply some 11% of world's electricity. At the same time, a number of nuclear power plants with an installed capacity of 74 GWe are under construction (WNA, 2014a). Fig. 1 shows a constant growth of nuclear electricity generation between 1971 and 2006. However, the nuclear electricity generation slowed down since 2005 (see Fig. 1) (WNA, 2014b). IAEA estimates the nuclear electrical generating capacity will reach 421 GWe, 456 GWe and 469 GWe by 2020, 2030 and 2050 respectively (IAEA, 2011).

However, there have been a growing public concerns on nuclear facilities, arguably due to the nuclear power plant accidents such as the Fukushima nuclear disaster (2011) and Chernobyl disaster (1986) (Ramana, 2009). These accidents have significantly negative impacts on the attitudes of governments and industry toward the nuclear power. Hayashi and Hughes, (2013a) presented a detailed examination of the crisis-driven changes to both short- and long-term energy security policies as well as regulations post the Fukushima accident. This accident resulted in the loss of public acceptability of nuclear power and led countries, such as Germany, Italy and Switzerland, to change their nuclear power development strategies by either shutting down nuclear power plants or calling off new developments (Hayashi and Hughes, 2013b). Similarly, the

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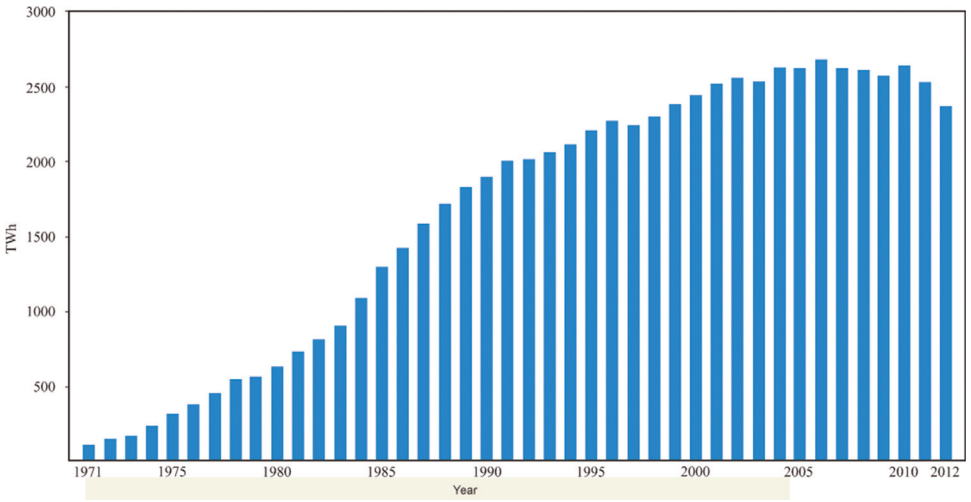

Fig. 1. Nuclear electricity production in the world from 1971 to 2012.

policies of nuclear energy also changed significantly in many other countries (Fütterer et al., 2014; Kunsch and Friesewinkel, 2014; Wittneben, 2012). It is projected that the total generating capacity of nuclear power in 2030 will drop by 8–16% compared to the 2011 level (Rogner, 2013).

The rapid urbanization and economic development has created massive amount of energy supply, which is largely met by traditional fossil fuel at the cost of escalating carbon emissions as well as global warming (OECD and NEA, 2012; Wang et al., 2013; Yuan et al., 2013). It is recognized that nuclear energy plays a vital role of change of paradigm to the low-carbon electricity generation (Yuan and Zuo, 2011). Nuclear energy helps to deal with effects of climate change and to satisfy the energy demand however with a certain level of risks derived from nuclear accidents (Karakosta et al., 2013; Santos et al., 2013). Given this background, nuclear safety is deemed as the core for the further development of nuclear energy (Xu, 2014).

Taking "strengthen nuclear security and prevent nuclear terrorism" as the theme, the third nuclear security summit (NSS) was held in Hague, the Netherlands on March 24, 2014. During this summit, the Chinese President Xi Jinping elaborated China's approach to nuclear security for the first time, urging a global cooperation for the long term security and development of nuclear energy. China has maintained a good record of nuclear safety in the development of nuclear industry for over 50 years. This paper carried out a detailed analysis of China's approach to the nuclear security. The laws, policies, regulations related to nuclear power as well as the associated government authorities were critically analyzed. The existing issues and the countermeasures were discussed. China's approach to nuclear safety provides an important reference for the peaceful and safe utilization of nuclear energy in the world.

2. Research methodology

In order to investigate China's approach to nuclear safety, content analysis approach was employed to critically review related policy and institutional system. These policies and institutional system are retrieved from the official websites of related authorities such as State Council, National Energy Commission, etc. These policies include national laws, regulations of the State Council, and provisions of the ministries under the State Council, as well as the development plans for nuclear energy. Policy review will identify the applications of the laws, regulations and provisions in the different stages of nuclear power plant, the deficiencies in current policy system. The institutional system for nuclear energy includes the high-level deliberation and coordination agencies and the ministries and commissions under the State Council. The review of these government authorities will examine the administration system for nuclear energy and the potentials that need to be further improved. Emerging themes are identified and discussed as below.

3. China's nuclear energy development

By the end of 2013, there are 17 nuclear power units of commercial operation in China (see Fig. 2), with a total installed capacity of 14.83 million kW, accounting for 1.19% of the national power generation capacity (CNEA, 2014; NRDC, 2014). In 2013, 110.71 billion kWh of electricity were generated from nuclear sources, which accounts for 2.11% of the total amount of electricity generated in China (CNEA, 2014). The pace of nuclear power development in China is leading in the world, having 28 units with a total installed capacity of 30.55 million kW under construction. Fig. 3 shows the nuclear power units commencing construction since 1985. All these units are located in the eastern coastal areas. The technology adopted is mainly the advanced pressurized water reactor at million kW scale. High temperature gas cooled reactor will also be developed actively. It is anticipated that inland nuclear power developments along the big rivers will be approved in the near future.

Chinese government has stopped the approval of new nuclear power plants for a long period of time with the focus shifted to the safety supervision of the existing plants. A series of plans have been released specifically for nuclear power development (see Table 1). There are common characteristics associated with these plans. Firstly, the target of nuclear power development becomes even more ambitious. The long-term plan for nuclear power development specified that the installed capacity in operation will be 40 million kWh by 2020 (NDRC, 2007). The mid-term goal of the installed capacity in operation specified by the Chinese government is to reach some 25 million kWh by 2015. However, the momentum of nuclear power development is strong in China. The 12th Five-year plan of energy development determines that the nuclear power capacity in operation and under construction will be 40 million kW and 18 million kW respectively in 2015 (CSC, 2013). This is the original goal of nuclear power capacity in operation of the year 2020. Secondly, much attention was paid to the