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Developments of the Energy Policy of China: A Long March not a Short Run

Introduction

China is a rapidly developing economy whose role for the global affairs has grown significantly over the years. These circumstances are confirmed in many areas. This situation also occurs in the energy sector where China holds is a global leader. However, it has a twofold nature. China leads in terms of growth of renewable generation as well as in the field of CO_2 emissions. Nevertheless, this problem is becoming more noticeable by Chinese policy makers than in the past. An example of a more pro-environmental attitude are Chinese strategic plans concerning improvements covering renewable energy sources, energy efficiency, and reduction of emissions.

Seen in this light, this paper is aimed at presenting the basic conditions of the Chinese energy sector analyzed with a reference to actions conducted to optimize the energy mix of China. In this context, the paper includes a general description of China's energy situation, a presentation of the Chinese national economic plan, as well as remarks on CO_2 emissions in China, development of renewable energy sources in China, Chinese nuclear energy policy, and an evaluation of the action taken with an assessment of the future prospects of China's energy industry.

Keywords:

China, energy industry, energy policy, CO_2 emissions, renewable energy sources, strategic plans

Insight on China's Energy Sector

Chinese energy sector is based on coal. According to the U.S. Energy Information Administration (EIA) data the majority of China's total energy consumption in 2011 (69%) was coal consumption (EIA, 2014). Second place belongs to an another fossil fuel – oil. It accounts for 18% of the country's total energy consumption (EIA, 2014). If one add to this the natural gas (4%) which is fourth in the order, the share of fossil fuels in total China's primary energy consumption is 91%. Apart from it the primary energy consumption mix of China consists of hydro (6%), nuclear (approximately 1%), and other renewable energy sources (1%) (EIA, 2014).

With respect to the installed capacity of Chinese power sector, at the beginning of 2013 it was estimated 1145 GW, what was approximately equivalent to that of the United States (EIA, 2014). It rose 8% from 2012, and according to EIA more than doubled from 524 GW in 2005. At the end of 2014, Chinese energy sector broken down by source was as follows: coal 820 GW, hydropower 300 GW, wind 90 GW, natural gas 50 GW, solar 30 GW, nuclear 20 GW, biomass and waste 9.2 GW (China Daily, 2015). These data provided by the National Energy Administration China's show that installed electricity capacity reaches almost 1320 GW.

A turning point for the Chinese electricity generation sector was the year 2011. It was then that China has become the largest power generator in the world. The former leader – the United States – had to settle for second place (EIA, 2014). According to BP, Chinese power generation of 2011 was 4713 TWh, what represents a 12% increase compared to 2010. At the same time, the United States produced "only" 4302, 4 TWh (BP, 2014a). In 2013, the difference between these two largest world producers of electricity was even greater. China generated 5361, 6 TWh, the United States 4260, 4 TWh (BP, 2014a). Furthermore, by achieving this result China reached 23, 2% of the whole electricity produced in the world, surpassing North America (5180, 8 TWh in total), as well as Europe together with Eurasia (5324, 1 TWh in total) (BP, 2014a).

A notorious increase of electricity generation enables to assume its continued growth. EIA projects Chinese total net generation will increase to 7295 TWh by 2020. By 2040 this generation will reach 11595 TWh (EIA, 2014). By analyzing the historical data and combining them with an increase in demand for energy, it not difficult to conclude that the Chinese installed capacity will grow over the next decades. The problem is to determine the size of this growth. E.g. according to World Nuclear Association in 2020 there will be about 1600 GW installed, and 2000 GW in 2025 (WNA, 2015). On the other hand EIA predicts that by 2040 China will reach 2265 GW of power installed (EIA, 2014). One may find even more progressive scenario. For instance, Bloomberg New Energy Finance (BNEF) projects that by2030 China's total electricity generation capacity will amount to approximately 2700 GW (BNEF, 2013).

In terms of the structure of energy sector, as BP indicates, coal will remain the dominant position as a fuel source (although its market share drops from 77% today to 59% in 2035). On the other hand, BP notices that renewable energy sources will increase from 3% to 12% (BP, 2014b). EIA forecasts that in the future China will rely more on nuclear, renewable, and natural gas sources that coal power plants (EIA, 2014). This has its environmental background linked with the pollution and CO_2 emissions.

12th Five-Year Plan (2011-2015)

Chinese five-year plans are the important instrument for the implementation of Chinese economic policy. They outline directions and steps to be taken in order to achieve set objectives. Due to the increasing importance of energy for the functioning of the Chinese economy and the needs for improvement of the environment, in the plans a growing attention is given to issues related to the energy and climate. An example of this approach is currently in force the 12th Five-Year Plan covering the period of 2011-2015 (12FYP, 2011). Among its main principles one may find that:

> [i]n transforming the economic development mode, the importance of building a resource-saving and environment-friendly society should be stressed to save energy, reduce greenhouse emissions and actively tackle global climate change. We should develop circular economy and low carbon technologies Through striking a balance between economic development and population growth, sustainable development will be enhanced (p. 3).

This quotation indicates a change in the approach to energy and the environment in China. Not only has the development of the energy sector enable the stable, uninterrupted and cheap energy production that serves the needs of the Chinese economy, but also lead to the achievement of the environmental and climate goals. Seen in this light, the Chinese government has decided to improve energy efficiency and reduction of emission, optimize the structure of energy consumption, improve the pricing mechanism and environmental taxation, as well as strengthen the related laws, regulations and standards (12FYP, 2011, p. 5). A part of this agenda is setting goals covering different fields. For instance, "[n]on-fossil fuel resources will rise to 11.4% of primary energy consumption [and] [e]nergy consumption per unit of GDP will decrease 16% and CO_2 emissions per unit of GDP will decrease 17%" (12FYP, 2011, p. 4). Apart from these targets, the government of China has planned other pro-environmental goals. They are included in the table below:

Target		2010	2015	Change over 5 years (%)	Forecast or Binding
Farmland reserves (billion mu)		1.818	1.818	0	binding
Decrease in water consumption per unit of value-added industrial output (%)				30	binding
Increase of water efficiency coefficient in agricultural irrigation		0.5	0.53	0.03	forecast
Increase of non-fossil fuel usage in primary energy consumption (%)		8.3	11.4	3.1	binding
Decrease in energy consumption per unit of GDP (%)				16	binding
Decrease in CO_2 emissions per unit of GDP (%)				17	binding
Target		**2010**	**2015**	**Change over 5 years (%)**	**Forecast or Binding**
Total decrease in emissions of major pollutants (%)	Chemical Oxygen Demand (COD)			8	binding
	Sulphur Dioxide (SO_2)			8	
	Ammonia Nitrogen			10	
	Nitrous Oxides			10	
Forest Increase	Forest coverage rate (%)	20.36	21.66	1.3	binding
	Forest stock (m^3)	137	143	6	

(12FYP, 2011, p. 4)

The 12th Five-Year Plan assumes building “the new energy industry” based on “the development of new-generation nuclear energy and solar energy utilization, photovoltaic and photo-thermal power generation, and wind power technological equipment, intelligent power grids and biomass energy” (12FYP, 2011, p. 9). Herein, the Chinese government planned to construct industrial bases for new-generation nuclear power equipment, large wind power generating sets and parts, new assemblies of efficient solar power generation and heat utilization, biomass energy conversion and utilization technologies, and intelligent power grid equipment, and implement exemplary large-scale application projects of marine wind power, solar power and biomass energy (p.10).

To implement this policy steps China decided to continue its policy in terms of hydro energy and build next large-scale installations, as well as to “develop medium and small river waterpower resources based on local conditions, and plan and construct pumped storage power stations scientifically” (12FYP, 2011, p. 10).

These actions in the field of power sector are correlated with “the new material industry” where China has to “focus on the development of new functional materials, advanced structural materials, high-performance fibers and compound materials, and common basic materials”, as well as “the new energy automobile industry” where actions are aimed at “the development of plug-in hybrid electric vehicles, pure electric vehicles and fuel cell automobile technologies” (12FYP, 2011, pp. 9-10). Both of these two latter components can be linked with improvement of energy efficiency (in the construction sector or transport sector). As the Chinese government assumed the added value of mentioned new strategic industries to GDP of China should account for 8% (12FYP, 2011, p. 10).

On the other hand, the current Chinese Five-Year Plan covers a broad usage of traditional energy sources. These concern development of coal mines and restructuring the coal industry (coal enterprise groups and coal mine enterprises), further exploration of oil and natural gas (with shale gas and coal-bed gas), and development of “clean and efficient large-capacity coal-fired generating sets, ” where the priority is given to combined heat and power units in cities and industrial zones as well as large coal-fired power plants near coal industry sites (12FYP, 2011, p. 11).

Nevertheless, the use of coal is inevitably related to greenhouse gas emissions. This issue has a special meaning in China, as the country holds the first place in CO_2 emission rankings.

Carbon Dioxide Emissions in China

China is the world's leading energy-related CO_2 emitter (EIA, 2014). In 2007, it overtook the United States in total annual CO_2 emissions (Botzen, Gowdy, & van den Bergh, 2008, p. 570). According to the Netherlands Environmental Assessment Agency (PBL), in 2013, the top 3 emitting regions were China (10.3 billion tonnes of CO_2), the United States (5.3 billion tonnes of CO_2), and the European Union (3.7 billion tonnes of CO_2), which together account for more than half (55%) of the total global CO_2 emissions (PBL, 2014, p. 4). Although, a large share of China in global CO_2 emissions is clearly visible (29%). Moreover, one may notice that the United States together with the European Union (EU28) emit less that China alone. What PBL underlines is the fact that "China increased its CO_2 emissions by 4.2% in 2013, compared to 2012, which is much lower than the annual increases of about 10% over the last decade, but higher than the increase of 3.4% in 2012" (PBL, 2014, p. 4). This highlights a shift in the Chinese approach to greenhouse gas emissions. On the other hand, the issue of air pollution in China still needs a broader debate and improvements.

However, in this discussion the Chinese energy policy should not be forgotten. As authors of a report on China's carbon emissions by 2050 (Zhou et al., 2011) trace:

> [i]n recent years, China has taken serious actions to reduce its energy intensity (energy consumption per unit of gross domestic production) and carbon intensity (CO_2 per unit of GDP). China's 11th Five Year Plan announced in 2005 outlined a goal of reducing energy intensity by 20% from 2006 to 2010. The announcement was followed with extensive programs to support the realization of the goal. China also announced a commitment to reduce its carbon intensity by 40% to 45% below 2005 levels by 2020 in late 2009. In 2011, China announced dual goals of reduction of energy intensity by 16% and carbon intensity by 17% during the 12th Five Year Plan period (2011-2015) (p. VIII).

The mentioned 12FYP assumes "[m]assive reductions in energy consumption intensity and carbon dioxide emissions" reached, *inter alia*, by decreasing the growth of industries with high energy consumption, and increasing the energy efficiency, revising the energy consumption structure, and development of the use of non-fossil energy resources (12FYP, 2011, p. 29). Moreover, the plan includes establishment and improvement of the emissions monitoring, with building a carbon emission trading market (12FYP, 2011, p. 30). The extensive Chinese agenda for climate action is well described in the following quotation from the 12th Five-Year Plan:

> We must carry out comprehensive adjustments to the composition of the industrial and resource structures, save energy and improve energy efficiency and increase forest carbon sinks, amongst several other measures. We must significantly reduce the intensity of our energy consumption and CO_2 emissions, as well as effectively regulate greenhouse gas (GHG) emissions. We must rationally regulate our total energy consumption levels, carry out serious management of resource usage, accelerate the formulation of resource development plans, clarify total regulatory targets and define a workable mechanism. We will promote the planting of trees and forestation to increase the national forest-cover area to 12.5 million hectares. We will accelerate research, development and application of low carbon technologies and regulate GHG emitting sectors such as industry, construction, transportation and agriculture. We will look into creating low carbon product standardisation, labelling and authentication systems, establish an effective system for calculating GHG emission statistics and gradually create a carbon emissions trading system. We will advance low carbon pilot projects (12FYP, 2011, p. 30).

Apart from these actions, China addressed willingness to "launch international cooperation in response to global climate change" (12FYP, 2011, p. 30). China declared active participation in the international climate negotiations, as well as developing cooperation in areas covering scientific research and supporting "developing countries in confronting the challenges of climate change" (12 FYP, 2011, pp. 30-31).

PBL assesses that to meet the 12th Five-Year Plan target for 2015 of a cumulative 17% reduction in its energy intensity relative to GDP China will need to take more efforts to decrease consumption in 2015 (PBL, 2014, 4). This may be linked with measures to achieve a fuel shift, i.e. by implementing Provincial Environmental Plans with coal consumption limits (PBL, 2014, 4). This may also cover actions regarding investments in the field of renewable energy sources, mainly hydro, wind, or solar power.

Renewable Energy Sources in China

China has become a global number one in renewable energy development. The country took a position of the world leader in renewables manufacturing and their installed capacity – over the past decade it has been increasing investment in the sector nearly every year (Renewable Energy Policy Network for the 21st Century [REN21], 2014, p. 6). According to the International Renewable Energy Agency [IRENA], in 2013, China installed more new renewable energy than Europe and the rest of the Asia Pacific region taken together (2014). As BNEF reckons, Chinese investments in "clean" energy, including renewables and energy efficiency, rose 32%, reaching record level of $89.5 billion (Financial Times, 2015). For comparison, the United States with $51.8 billion and 8% growth was in second place (Financial Times, 2015). In this context, it is worth recalling the provisions of the 12th Five-Year Plan, where with strengthening of the grid, the effective development of wind power, solar energy, biomass energy, geothermal energy and other new energy sources has been assumed (12FYP, 2011, pp. 10-11)

China's renewable energy figures are impressive. For instance, country's annual installed PV capacity grew from 0.3 GW in 2009 to 3.3 GW in 2011 (REN21, 2014, p. 11). In 2013, it reached 13 GW, what means that almost one-third of global capacity was added by China (REN21, 2014, p. 11). In terms of the wind power industry between 2004-2010 China doubled its annual wind installations from 0.5 GW to 19 GW, with a drop in 2012 (approximately 13 GW of wind power installed per a year), and a grew to 16 GW in 2013 (REN21, 2014, p. 12). According to the NEA, the Chinese wind power industry broke capacity record installing additional 19.8 GW, what made it possible to reach 96, 4 GW of total installed capacity in wind power, accounting for 7% of country's total power capacity, producing 2.78% of all electricity generated in China (NEA, 2015). What is worth noting, is the fact that the solar photovoltaic (PV) industry is generally privately owned, although the public and private entities, with the five biggest Chinese utilities, are actively involved in the development of utility-scale solar PV power installations (REN21, 2014, p. 26). Also large-scale wind farms are primarily developed by the Chinese public entities (REN21, 2014, p. 26). Besides the wind industry, China has the worldwide largest expansion of hydropower – the economically exploitable hydropower potential in China is estimated to be 402 GW, in comparison to 280 GW installed until now, with an average 20 GW added every year (REN21, 2014, p. 26).

The renewable generation has driven by the increasing cost-competitiveness of their technologies as well as such benefits of their usage as strengthening the energy security and decreasing air pollution (IRENA, 2014, p. 1). This especially concerns Eastern China where air pollution has emerged as an important factor for expansion of the renewable energy sources expansion (REN21, 2014, p. 26). REN21 underlines that "[an equally important driver is the need to foster decentralised/distributed power generation capacities to avoid the enormous financial expenditures associated with relying entirely on long-distance transmission lines, which otherwise would have to transmit power generated in West China to East China" (2014, s. 26). Apart from it, renewable energy sector has a great potential for creating jobs as well as developing technologies.

IRENA predicts that Chinese policies and investments patterns will result in rise of modern renewables (which excludes traditional uses of biomass) to 16% by 2030, from about 7% in 2010 under the business-as-usual scenario (IRENA, 2014, p. 2). Nevertheless, as IRENA (2014) admits:

> [u]nder REmap 2030, however, with the right policies and support, the share of renewables in the energy mix could quadruple to 26% with technologies currently available. That would make China the world's largest user of renewable energy, accounting for about 20% of global use. Hydroelectricity, wind power, solar PV, solar thermal and modern biomass

would constitute most of the renewable energy mix of the country. (p. 2)

According to IRENA reaching this share of renewable energy sources would require annual investments of $145 billion between 2014 and 2030 (2014, p.1). Moreover, IRENA forecasts that in 2030, under the business-as-usual scenario, 30% of China's electricity will come from renewable what in comparison to current situation is a 10% increase (2014, pp. 1-2). In Remap 2030, this growth is even higher – it reaches 40%. However, this scenario assumes an accelerated growth in wind and solar PV, and full deployment of hydroelectricity combined with a significant development of grid and improvements concerning transmission capacity, as well as conducting the power market reform (IRENA, 2014, p. 2).

Also BNEF draws a very "green" scenario of the development of the Chinese renewable energy sector. According to its report, by 2030 installed renewable capacity will be equal to coal capacity. Apart from it renewables will contribute to more than half of new capacity growth, increasing from 27% to 44% in 2030, what gives 47 GW per a year (BNEF, 2013). For comparison, coal-fired power generation capacity will decrease from 67% in 2012 to 44% in 2030, maintaining an annual grow at the level of 25 GW per a year, i.e. one-third of all added capacity (BNEF, 2013).

Chinese Nuclear Energy Programme

Although in terms of the percentage of usage of nuclear energy in China is not impressive – nuclear power contributed 2.1% of the total production in 2013 (WNA, 2015) – one may assume that its role will increase. The reason for this is, *inter alia*, developing economy requiring stable and uninterrupted supplies of energy as well as China's policy on reduction of CO_2 emissions.

The first steps in the field of the non-military usage of the nuclear power were taken by China in the 1960s (Sovacool & Valentine, 2012, p. 197). However these were first plans and programmes and until 1970s nothing significant had happened. Then, in 1970 Chinese prime minister Zhou Enlai delivered a speech on the development of nuclear power plants to supply electricity (Cappellano-Sarver, 2007, p. 118). As he said "[n]uclear power should not only be used for weapons. It should also be used to serve China's economic development" (China Daily, 2008). This declaration resulted in an acceleration of efforts for the Chinese civilian nuclear program, for instance Shanghai Nuclear Engineering R&D Institute – SNERDI (Cheng, 2013) was established. However, the construction of China's first nuclear power plant started a few years later, in 1985 (Chang, 2013). This was Qinshan Nuclear Power Company, designed and constructed by China, with 95% of the plant's components produced within the country (PowerTechnology, n.d.), ready for operation in 1991.

In 1990s, apart from the Qinshan project China managed to open only one nuclear power plant – i.e. Daya Bay, equipped with 2 pressurized water reactors (PWR). By the end of 2001 a total installed capacity of nuclear power in China was maintained at the level of 2100 MW (Yuming, 2002). However, on the basis of plans regarding an increase of the electricity generated in nuclear sources, big-scale investments were conducted. The 9th Five-Year Plan (1996-2000) covered construction of 4 nuclear power projects of 8 reactor units with an installed capacity of 6600 MW (Yuming, 2002). These projects (Qingshang Phase 2, Qingshan Phase 3, Lingao, and Tianwan nuclear power plants) which were expected to be fully operational during the 10th Five-Year Plan (2001-2005) were to lay a foundation for the scheduled integration of grids and power generators (People's Daily, 2000). Moreover, they signified that China was out of the preliminary stages of nuclear power construction, as the China Atomic Energy Authority claimed (People's Daily, 2000). Next Five-Year Plan (2006-2010) included acceleration of construction of nuclear power projects (Weiping, 2007). As the part of that plan China identified sites in 16 provinces, regions, and municipalities for an additional 49 nuclear power plants, accounting for a total generating capacity ranging from 47-52 GW (Kadak, n.d., p. 4). In the following years Chinese government had planned even more significant development of the nuclear generating. As stated in the 12th Five Year Plan the eastern costal region and some areas in central China were designated as main places for development of nuclear installations (12FYP, 2011, p. 11). Projections for nuclear power covered 70-80 GW installed by 2020, 200 GW by 2030 and 400-500 GW by 2050 (World Nuclear Association [WNA], 2015). With respect to implemented technology, China uses French, Canadian, Russian, as well as the United States' (or Japan, as Toshiba is the owner of Westinghouse) installations (WNA, 2015). Besides, it the country develops its own devices, although in this scope China faces some delays (The Wall Street Journal [WSJ], 2015).

After the Fukushima accident in March 2011, the Chinese government suspended approvals for new nuclear power stations as well as hold work on approved units (WNA, 2015). According to WNA (2015), this was aimed at carrying out "comprehensive safety checks of all nuclear projects, including those under construction (with an immediate halt required on any not satisfactory)." A consequence of the accident was a change in the nuclear policy adopted by the Chinese government. In October 2012, it was decided to 60 GW by 2020, and the policy, as the WNA (2015) indicates, "has moved from 'moderate development' of nuclear power to 'positive development' in 2004, and in 2011-12 to 'steady development with safety'." Taken by China actions clearly went in the direction of the latter (i.e. steady development). In 2014 September, NEA announced that China's goal has been to become a world leader in nuclear power by 2020 under an ambitious plan to be elaborated by April 2015 (South China Morning Post, 2014).

Summary

Analyzed in the paper circumstances and factors determining the shape of the Chinese energy sector indicate that China has already started reform of its energy structure. Nevertheless, it is rather a long march than a short run, and much remains to be done to fully meet the ambitious postulates adopted by the Chinese government. On the one hand China emits CO_2 more slowly than it was 10 years ago. On the another hand, these emissions are still rising, or even if one may agree with experts claiming that in 2014 China decreased its coal consumption by 1-2% (Deutsche Welle [DW], 2014), CO_2 emissions in China are at a very high level. Moreover, the impressive development of renewable technologies, even in combination with the large-scale hydroelectricity and nuclear power remains in the minority to the installed capacity in conventional power plants, in which coal is the basic raw material. Therefore, in the future despite the efforts to optimize the energy mix, China will continue to generate electricity mainly with the use of fossil fuels.

However, this does not mean that the policy which the China's government has been introducing is incorrect. The growing eco-awareness of Chinese society and its will to live in a less polluted environment goes in a line with the activities carried out at the central level. This is noticed by local governments and Chinese investors who are increasing their activity regarding development of renewable energy sources and energy efficiency. Seen in this light, China is likely to intensify efforts on national energy and climate agenda adopt tougher coal and CO_2 caps in its next five-year plan (2016-2020) (Responding to Climate Change [RCC], 2015). This is complemented by confirmed plans to establish the largest carbon market and launch it in China in 2016 (International Centre for Trade and Sustainable Development [ICTSD], 2014). Presented approach shows that China exceeds another barrier in relation to its energy policy, moving toward a new model of the energy sector.

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