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Introduction

1 Background and Motivation

As the world's largest emitter of CO₂ (see Table1), China has substantially scaled up its unilateral commitment to emissions reduction: by 2020 carbon intensity will have decreased to 40-45% below 2005 levels. Since this is such an ambitious target, the concern from the international climate community is how this target can be achieved.

In the Eleventh Five-Year Plan (FYP), 2006-2010, China reduced energy intensity by 19.4% against a target of 20%, largely by means of direct regulation and top-down administrative orders. Despite the fact that some provinces were forced to shut down their industrial capacity towards the

Table 1: CO₂ emissions and emissions per capita by country in 2011

Country	CO ₂ emissions (in 1,000 tons*)	Emission per capita (tons per capita)
World	33,376,327	4.9
China	9,700,000	7.2
United States	5,420,000	17.3
India	1,970,000	1.6
Russia	1,830,000	12.8

Source: EDGAR (2013)

*Remarks: U.S. ton is a unit of measurement equaling 2,000 pounds. In non-U.S. measurements, a ton equals 2,240 pounds. A tonne, also known as a metric ton, is a unit of mass equaling 1,000 kilograms.

end of 2010 to meet their assigned energy-saving targets, the target of 20% was not achieved. Since China is transiting from a planned economy to a kind of market economy, a national carbon emissions trading system naturally arose on China's national agenda.

An emissions trading system (ETS, also known as the emission cap-and-trade system) is one of the instruments of China's policy, offering incentives to reduce emission. Compared with other taxable economic instruments, an ETS allows government authorities to determine and set the total quantity of emissions for a certain period before the introduction of the system. The initial concept of emissions trading can be found in Crocker (1966) who referred to "air pollution permits." The main idea behind emissions trading is to initially allocate emission permits to firms either by auction or by a free-of-charge grandfathering mechanism. Firms are then allowed to trade permits among themselves, with the intention that a firm should hold a number of permits at least equal to its emissions. Hence, firms that have surplus permits can sell them on the market, whereas firms that need additional permits can purchase those available on the market. Obviously, firms need to make their abatement decisions by considering the difference between the marginal abatement costs and the market price of the emission permits.

The first large-scale ETS was implemented in the United States electricity sector concerning SO₂ emissions under the 1990 Clean Air Act Amendments. Emissions trading was later adopted in the U.S. for NO_x. In Europe, the Kyoto Protocol (1997) allowed burden sharing among the fifteen European Union (E.U.) countries with a total emissions reduction target of 8% compared with the emissions level in 1990. The E.U.'s current reduction target is 20% by 2020. To meet these goals, the E.U. has adopted an ETS for the greenhouse gas CO₂. There are three periods of emissions trading: 2005-2007, 2008-2012, and 2013-2020. The E.U. is now proposing a 40% reduction by 2030. All countries participating in the ETS present their individual national allocation plan, which determines the emission allowance a major emitter, such as an electric power plant, will be allotted in this period (Georgopoulou et al., 2006). It should be noted that the

volumes of other greenhouse gases are rated with a weight reflecting their potential global-warming damage compared with CO₂.

Carbon trading is one of the key energy and environmental policies of the Twelfth FYP. The short-term goal was to establish a small-scale multi-regional ETS (Beijing, Chongqing, Shanghai, Shenzhen, Tianjin, Guangdong, and Hubei) in 2013 which would transition to a national scheme by 2015. The idea was that this small-scale ETS would be used to resolve some vital issues concerning the design of emission allocations systems, including transparency, transaction cost, the effect on the international competitiveness of affected industries, mechanisms designed to stabilize prices such as price ceilings, the value of “banking” schemes to buffer annual variations in emissions, and efficiency implications of different ways to dispose of auction revenues. In practice, the first cross-region emission trade was carried out in the end of 2014 between Beijing and Hebei and a national ETS is now expected to be functioning in 2017.

Until it has established a reliable national ETS, however, China still needs to rely on direct regulations and top-down administrative orders to achieve energy conservation and CO₂ emissions targets. In the Twelfth FYP, China aimed to change its energy-mix by using more clean primary energy to achieve the targets of energy security and environmental protection simultaneously. The belief was that changing the energy mix alone could not achieve the CO₂ emissions reduction targets. However, changing the energy mix seems to be the most suitable strategy until the national ETS is ready to be implemented.

In this book we summarize the energy policies and the environmental policies related to the energy mix with some observations and discussion. We start with the results of the energy policies from the Eleventh FYP and then describe the energy policies of the Twelfth FYP, while analyzing the environmental effects of these policies. Since the changing energy mix makes China more reliant on importing primary energy sources, like oil and natural gas, it may also affect the energy security of other nations. The international relations issues in the energy field are also addressed as an important part of this book.

2 Preliminaries

2.1 “Visible Hand” and “Invisible Hand”

To understand China's energy policies, we need to recall the critical time when China was transforming its planned economy to a socialist market economy after the economic reforms of 1978. During his Southern tour in 1992, Deng Xiaoping (the architect of the Chinese economic reforms) said, firmly and confidently:

Planning and market forces are not the essential difference between socialism and capitalism. A planned economy is not the definition of socialism, because there is planning under capitalism; the market economy happens under socialism, too. Planning and market forces are both ways of controlling economic activity. (*People's Daily*, February 3, 2012).

The core of the socialist market economy is the harmonious combination of the “visible hand” of government with the “invisible hand” of the market. Hence, the evaluation of China's energy policies follows the proportion of the combination of visible hand and invisible hand. This will change with the degree of economic development. In the energy sector, it has changed with the development stages of successive FYPs.

2.2 Energy Security, Economic Growth and Environmental Protection (3Es)

Following the economic growth trend, energy policies were designed to support economic growth (EG), and then when the energy sector could not be self-sufficient, energy security (ES) became an issue. Finally, environmental protection (EP) came to be an important factor in the energy policies due to too much energy consumption. Of course, the weighting of EG, ES, and EP depend on the stage of economic development.

2.3 Areas and Administrative Regions in China

“Region” is a general term used to refer to geopolitical units in China, including provinces, counties, cities, and districts. It should be noted that this specific geopolitical unit in China includes provinces, autonomous regions and the municipalities directly under the national government. These regions can be classified into three areas, as shown in Table 2.

It should be noted that there are different classifications in the literature. For instance, Chen and Fleisher (1996) divide China into two areas, coastal and non-coastal, to study regional income inequality and national economic growth. Hu and Wang (2006) adopt the old “three belts” scheme (eastern, central and western China) of the Seventh FYP to examine the energy efficiency of China’s different regions. Gelb and Chen (2004) use the designation of the official western area to provide a progress report of the Great Western Development Strategy promoted by the Chinese government.

In order to make the results more relevant to policymaking, we adopt the official classification from Hu and Wang (2006). That is, the classification of the thirty administrative regions to be investigated is shown in Table 2. Using the three belts scheme, we can simplify our discussions when necessary.

Table 2: The distribution of thirty-one administrative regions

Area	Administrative regions (i.e., provinces, autonomous regions and municipalities; Hong Kong, Macau and Taiwan not included)
Eastern	Beijing, Tianjin, Hebei, Liaoning, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong, Guangdong, Hainan
Central	Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan
Western	Sichuan, Chongqing, Guizhou, Yunnan, Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Guangxi, Inner Mongolia, Xizang

2.4 Geographies of Economic Development

There are significant differences between the various parts of China. In the Seventh FYP (1986-1990), the three belts scheme was used to classify the three major areas in China: eastern, western, and central. Each area consists of different administrative regions (i.e., provinces, autonomous regions, and municipalities). In 2000, Inner Mongolia and Guizhou were classified as parts of the western area because their average GDP fell under the western area's administrative regions. The three areas are characterized as follows: (1) the eastern area has a higher growth rate and more direct foreign investment than most of the central and western provinces; (2) the central area is largely rural and agricultural and is the home base for a large sector of the population; and (3) the western area has comparatively low population density and is the least developed area.

2.5 Administration

Traditional Chinese institutional structures are flexible enough to accommodate local contexts, and were constructed to seek compromise between top-down policy approaches, and local, social and business interests. The objectives of Chinese energy efficiency and conservation (EE&C) policy have been transformed, adapting to governing purposes, combining commitments to the general political and social goals with local interests and business incentives.

2.6 Energy Efficiency

Technical improvements have been proceeding successfully over the past two decades, spread over hundreds of companies in China. The broader use and lower cost of investments in energy efficient developments will be decisive in achieving greater energy efficiency. Two sets of factors—the need to be competitive on a world level and the necessity to comply with the government-set energy intensity standards—are the impetus for Chinese firms to increase efficiency.

3 Gaps in Understanding Key Notions

There are big gaps in understanding key notions in energy between outsiders, especially Westerners, and the Chinese. China has its own energy culture with distinct characteristics based on its specific cultural viewpoint, its stage of development, political system and institutions of ownership.

Removing these gaps in understanding can facilitate research in the international arena of the energy and environmental issues of China, and shape a more accurate perception of an energy culture with particular Chinese characteristics. This section tries to clarify some of these gaps in understanding in energy between Chinese people and foreigners, taking the notion of energy security as an example.

3.1 Energy Security v Energy Safety

As mentioned in APERC (2007), the definition of energy security has changed over time. After the oil shocks of the 1970s, the definition of energy security was related to the risk of oil supply from the Middle East. With the diversification of energy sources, oil security evolved into energy security, however, the security of supply was still the priority. According to the International Energy Agency (IEA), "Energy security, broadly defined, means adequate, affordable and reliable supplies of energy," and many Westerners have the same point of view as the IEA.

APERC classifies the elements relating to security of supply into: availability (elements relating to geological existence), accessibility (geopolitical elements), affordability (economic elements), and acceptability (environmental and societal elements). A similar definition is provided by Muñoz Delgado (2011): "Energy security can be classified into security of energy demand for energy exporters and security of supply (SOS) for energy importers."

After the 1970s oil shortage, most of the then developed nations endeavored to reduce their national dependence on external supplies, through diversifying supply sources, energy conservation and using alternative fuels as much as possible. With the self-sufficiency rate

increasing, the key point of energy security has moved from supply security to the balance of the 3Es, which is the balance between economic development and energy, the balance between energy and the environment, and also the balance of environmental concerns and economic development, which creates a triangle.

A revolution in understanding happened after the Fukushima tsunami catastrophe awoke even advocates of nuclear energy to the realization that there is a serious safety issue. Yamashita (2011), from the standpoint of safe nuclear power, pointed out in 2011 that there are four elements of energy security, i.e., 3E+S (Safety).

For China, the concept of energy security has also been evolving as above, from oil supply to energy supply with 4As, and from 3Es to 3E+S, however, the current understanding of energy security is more akin to energy safety and officials of the Chinese government use this term instead of "energy security." "Energy safety" includes the concept of energy security (*Global Times*, 2012). As Lundin (2013) states, "China is committed to the development of renewable energy in order to ensure the safety of national energy, according to Liu Qi, deputy director general of the National Energy Administration."

After more than half a century of development of the energy industry in China, a new vision of energy security has matured. At the G8 summit in St Petersburg in July 2006, China's former president, Hu Jintao promoted this new vision in these terms:

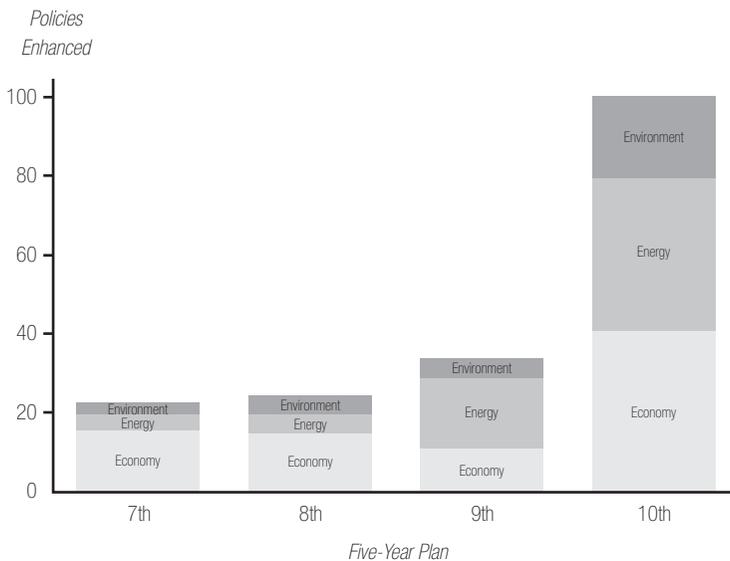
The fundamental content of energy strategy of China is that keep making energy use efficiency as the top priority, center on the domestic condition, make diverse development, protect environment, strengthen the international mutually beneficial cooperation and make effort in building up the stable, economic and clean energy supply system to jointly maintain the global energy security.

Therefore, there are three elements in the new vision of energy security in China:

- energy security: reduction of energy intensity is embraced as the primary means of overcoming energy-related obstacles and is considered of national strategic importance;
- environmental protection: slowing the growth of energy usage and eliminating inefficient and heavily polluting energy users are the cornerstone of China's approach to addressing environmental challenges;
- long-term economic growth: to depart from a resource-intensive growth trajectory, energy efficiency is considered necessary to sustain long-term economic growth.

As Figure 1 shows, energy policy orientation during the period from the Seventh FYP to the Tenth FYP shifted from focusing on the economy to energy itself and environmental protection.

Figure 1: Policy orientation change, 1986–2006



3.2 Energy Policy v Energy Law

It is well known that energy policy refers to the statement of national policy regarding energy planning, generation, transmission and usage. Energy policy includes legislation on commercial energy activities (trading, transport, storage, etc.) and fiscal policies related to energy products and services (taxes, exemptions, subsidies; instructions for state owned energy sector assets and organizations, etc.).

Energy laws govern the use and taxation of energy, both renewable and non-renewable, and are the primary authorities for all case laws, statutes, rules, regulations and edicts related to energy. Energy policy is not equivalent to energy law, but can be transformed into law.

In China, up to now there has not been an energy law. There is a draft, but it is still at the review and public hearing stage, though there are laws in place on renewable energy and energy conservation. China's energy development is thus governed by policy but not by energy law. Hence, policies are often ad hoc or temporary.

The differences with other nations are not only between policies and laws. Even regarding the policies, the natures or the objectives of the energy sector, China is not the same as others, for example, the U.S. or the E.U.

3.3 Nature of Energy Policy

The energy policy of the U.S. was established in statutory form under the Energy Policy Act of 2005. However, individual states may adopt differing policies that best meet their interests, e.g., the California Global Warming Solutions Act 2006. The E.U. energy policy is based upon the Treaty of Lisbon of 2007, which mandates solidarity in matters of energy supply and changes to the energy policy within the E.U. Hence, E.U. countries adopt uniform regional energy rules.

China's energy policy, in contrast, is a set of goals, objectives and instructions, which may never become laws. If necessary, laws will be

amended to achieve the policies. The energy policies are issued following the guidelines of each FYP. The provinces must follow and meet the targets of the energy policies set by the central government.

3.4 Objectives of Energy Policies

The basis of the U.S. energy policy is to ensure domestic jobs for the future with secure, affordable, and reliable energy (see Energy Policy Act 2005). The E.U. energy policy aims to provide a sustainable, secure and affordable energy system while protecting the environment and in particular combating climate change and improving energy grids (European Commission 2012). China's energy policy under the Eleventh FYP was to support economic development while considering energy security and protecting the environment.

3.5 Energy Efficiency (EE) v Energy Efficiency and Conservation (EE&C)

Energy efficiency measures extend to the elimination of outdated plant capacities on a relatively large scale; thus making way to introduce more efficient plants. Energy conservation introduces a cap on the quantity of energy use that may in fact induce energy efficiency.

Energy conservation refers to reducing energy through using less of an energy service. Energy conservation differs from efficient energy use, which refers to using less energy continuously. China is still using the entire suite of policies and activities to meet the objective of reducing energy consumption. However, one interesting point is that both EE and EE&C are pronounced *jie neng* (節能) in Chinese Pinyin.

3.6 Going Out v International Cooperation

China's Going Out policy contains a double meaning. On the one hand, it means Chinese enterprises going out to make direct investments in other countries; on the other hand, it also means attracting foreign direct

investment into China. Misconceptions and misunderstandings about China's quest for energy security exist both inside and outside China.

Inside China, criticisms of investment in overseas oilfields in order to strengthen energy security are: that China's oil imports outpace China's overseas equity oil production; it is not cost effective to transport oil to China; and that there is no evidence that overseas equity oil would be cheaper or more accessible to Chinese consumers in a supply crisis.

Outside China, the unnecessary fear exists that China will exhaust the world's energy supply. This is a misconception, however, for the following reasons:

- China's entire overseas production is less than that of just one of the major oil companies;
- Chinese overseas investments contribute to stability in the global market as they are more willing to take risks and operate in more hostile environments;
- about 75% of the Chinese companies' output is within China. China's domestic oil production is currently the fourth largest in the world.

If the Going Out Policy could be understood as an international energy/resources cooperation policy, there might not be as much domestic criticism or unnecessary fear from abroad.

3.7 Energy Dependence Rate v Oil Dependence Rate

Energy dependence refers to a country's reliance on imports of oil and other foreign sources of energy. Different from energy independence, the energy self-sufficiency rate is the ratio between national primary energy output (coal, oil, natural gas, nuclear, hydraulic and renewable energies) and consumption of primary energy in a given year. This rate may be calculated for each of the broad energy types or overall for all types of energy. A rate of over 100% (as is the case for electricity in China) indicates a national production surplus in relation to domestic demand and therefore net exports.

In China, the energy dependence rate is less than 11%, much less than the oil dependence rate which is around 60%. When the oil dependence rate is used to judge China's energy dependence rate, it is not surprising that expressions like "China energy threat" have become popular internationally. We can clarify the matter by comparing Figures 2 and 3.

3.8 Energy Independence v Energy Interdependence

Although almost all the economies in the world seek national energy independence, absolute energy independence is impossible. While China, like the U.S., has an interest in becoming less dependent on imported fossil fuels, the two countries share with most if not all countries an interest in stable world energy markets, a more sustainable environment and climate, a prosperous and growing world economy, and peaceful relations with their neighbors. In a word, we are all interdependent, however much any country decides that it would like to be more independent. Policies must therefore strike the right balance between self-reliance and creating the

Figure 2: China's oil dependence rate

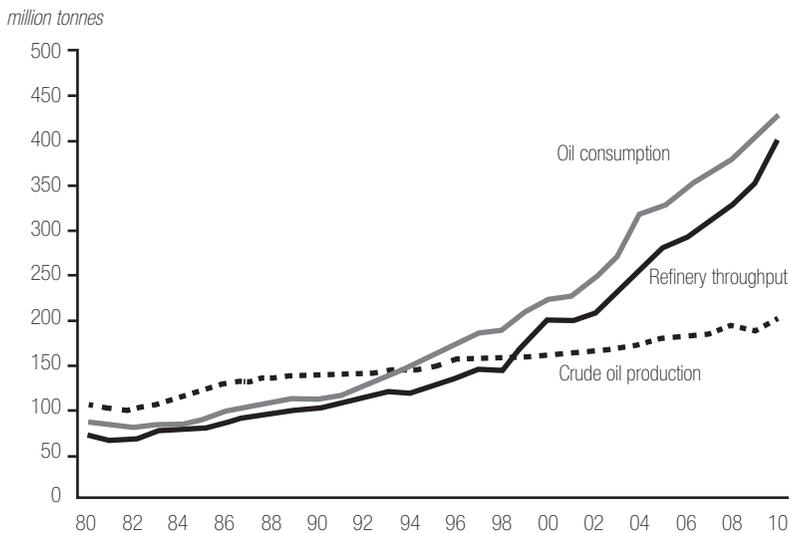
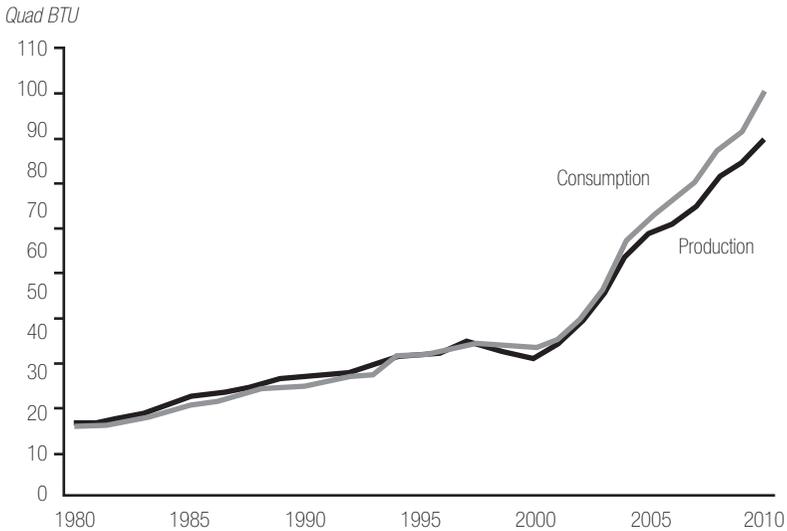


Figure 3: China's energy dependence rate

governance arrangements that allow for a stable global economy, energy market and environment.

3.9 State-owned Enterprises v National Companies

In China, the system of property ownership is complicated. The main types of ownership include; state-owned/state-holding, collective-owned, cooperative, joint ownership, shareholding, private, joint-venture and sole foreign investment. After 1998, China's petroleum industry split its productive assets from a holding company to create CNPC (PetroChina Ltd.; vertically integrated), Sinopec (Sinopec Ltd.; vertically integrated) and CNOOC (CNOOC Ltd. with initial public offering for 10-20% of shares). Thus, the three large oil and gas companies do not fall within the traditional meaning of state-owned enterprises (SOE), in which the government has the majority of shares but the company does not always follow the government's orders. The companies' strategy is usually a middle road

resulting from negotiation. They cannot be accurately called SOEs as some of them are publicly traded.

3.10 Energy Foreign Policy (Energy Diplomacy) v Foreign Energy Policy

Energy diplomacy means the employment of tact to gain strategic advantage or to find mutually acceptable solutions to a common challenge in the energy business and politics. Foreign energy policy means dealing with energy relations in an international context and a range of policies to gain various national benefits by means of deployment of energy supply and demand. China has energy diplomacy but has not established a mature foreign energy policy. Since the new leader, President Xi Jinping, has proclaimed the so-called "Belt and Road Policy," both on land and sea, China seems ready to realise the potential of its foreign energy policy.

