

Current Legal and Institutional Frameworks for Investing in Lower Carbon Electricity in China

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Abstract

The economic and policy framework for investment decisions in the power generation sector in China are investigated. Our analysis combines a review of the existing legal framework with a survey of stakeholders in industry and government. Based on interviews with over 60 stakeholders, we find a consistent picture emerges of the role of the major institutions and the decision criteria used in investment decisions for conventional thermal power technologies. In contrast, the evolving legal framework for investment in lower-carbon technologies, as reflected primarily in the renewable energy law, produces no clear consensus regarding decision criteria from either government or industry stakeholders. The overall objectives are widely acknowledged, but there is considerable disagreement amongst stakeholders over its implementation. From an investment analysis of risks versus returns, most respondents perceive advanced thermal power investments and small hydro as being more attractive than lower carbon alternatives such as wind power and solar photovoltaic (PV) power.

Keywords

Investment decisions, Institutions, Power sector, Lower-carbon electricity, China

JEL Classification

N75, L94, Q42, Q58, Q54

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1. Introduction

1.1 The Chinese Electricity Sector

China has undergone rapid growth in its electricity sector over the past thirty years. Fifteen years of sustained economic growth at an average rate of 10% has not only resulted in a three-fold rise in China's GDP, but also a doubling of total installed electricity generation (NBSC, 2006). As the second largest electricity sector in the world, total installed capacity reached 622 GW by the end of 2006 (CEC, 2007). In 2006 alone, China added over 100 GW of installed capacity, and overall electricity production increased by 13.5% to 2834.4 billion kWh between 2005 and 2006 (CEC, 2007). At the end of 2006, total installed capacity of conventional thermal power was 484 GW (77.8% of total), of which over 450GW was coal-fired capacity. Hydropower constitutes virtually all of the remainder (128.6 GW or 21%) while nuclear (6.8GW and 1%) and wind (1.9 GW or 0.3%) each contribute very small shares.

1.2 Evolution of Institutional Framework

In the past ten years, China's electricity market has experienced major reforms to promote the role of markets and create effective regulation in the electricity sector. Measures have

included separating power plant ownership from the electricity grid operators; restructuring central generation and distribution assets, developing regional electricity markets, and establishing a professional, independent electricity regulator (SERC et al, 2007).

China has managed to build over 400 GW of installed capacity in the past 10 years (CEC, 2007), equivalent to the last three decades of capacity additions in the US (EIA, 2007). How did China decide on and execute the necessary investment decisions? To approach this question, we begin by analysing the legal obligations of the various government and private sector bodies involved in investment decisions for the power sector and the functions they are expected to take.

Most of the institutions have evolved over time and have frequently adopted new functions, responsibilities and relationships in order to deliver the required outcomes. To understand this evolution, we asked stakeholders in both government and industry which institutions they consider most important for their investment decisions, and which criteria these institutions apply in their decision process. We initially focused on conventional thermal power technologies as these have constituted over 75% of total generation investment over the last decade.

1.3 Carbon Emissions from Chinese Power Industry

The US Energy Information Administration (EIA) has estimated that China's total emissions from consumption of fossil fuels has already exceeded that of Europe and reached 17.5% of the world total, although emissions per capita (head) were only two-fifths of the OECD European level (EIA, 2006). Total emissions from power generation are not known precisely, as the most recent official inventory of China's carbon dioxide emissions dates back to 1994 (Gao, 2007). China is a developing country party to the UN Framework Convention on Climate Change, and, as such, has no binding emissions targets for greenhouse gases. Some large power companies such as Huaneng Group, are however beginning to assess the potential impact on its business prospects if China were to agree to binding commitments to limit emissions (Huaneng Intl. Inc., 2007) and are developing lower-carbon technology projects such as the Greengen project, which is a IGCC (gasification) plant that will later be fitted with carbon dioxide capture technologies (Greengen, 2006).

The Chinese government has expressed a strong interest in the following technologies: (i) coal bed methane resource with side benefits like reducing mining accidents, (ii) biomass

power which may benefit farmers, and (iii) wind power which has significant cost reduction by equipment localisation (Li et al, 2007, page 29).

1.4 Development of Lower Carbon Emissions Electricity in China

In the second part of the paper, we focus on lower carbon technologies. The legal framework to deliver lower carbon technologies differs significantly from the framework that is currently used to deliver investment in conventional technologies. Many of the legal provisions governing lower carbon technologies have only been passed recently. Hence, some of the stakeholders had very little information, even where they had opportunities to be directly involved in lower carbon projects.

Furthermore, even though more than three quarters of stakeholders from power generation firms claimed a willingness to build renewable power capacity, most expressed caution about renewable power investments as they ranked low carbon generation technologies as being less desirable investment opportunities compared to conventional thermal power.

The paper is structured as follows: In section two we describe the research approach. Section three outlines the institutional framework for investment decisions in conventional technologies, followed by a comparative analysis of low carbon technologies in section four. Section five then offers some conclusions.

2. Research Approach

2.1 Interview Methodology

A total of 62 carefully selected stakeholders were consulted from March, 2007 to January, 2008, as shown in Table 1. Their institutions were located at Beijing, Henan province and Guangdong province (Figure 2). 33 key stakeholders were interviewed face-to-face, while the others were interviewed by telephone. All interviewees were asked twelve questions regarding their attitudes towards technology, decision-making, implementation of the current incentive mechanism, expectations for coal prices and carbon prices, and risk/return perceptions in different generation technologies. We then asked a few additional questions, which were tailored to the type of organisation, followed by a broader discussion.

Type of organisation	Number (Percent)
Government	16 (26%)
<i>State Government</i>	6
<i>Local Government (Guangdong and Henan)</i>	10
Industry	46 (74%)
<i>Power Generation Companies (total 27 firms)</i>	37
(19 respondents from firms with both renewable and thermal investments, 5 with hydro only, 10 with thermal power only, 2 with renewable only and 1 with nuclear only)	5
<i>Grid Firms</i>	4
<i>Others (Banks, Equipment Vendors)</i>	
Total	62

Table 1 Distribution of Key Stakeholders Interviewed

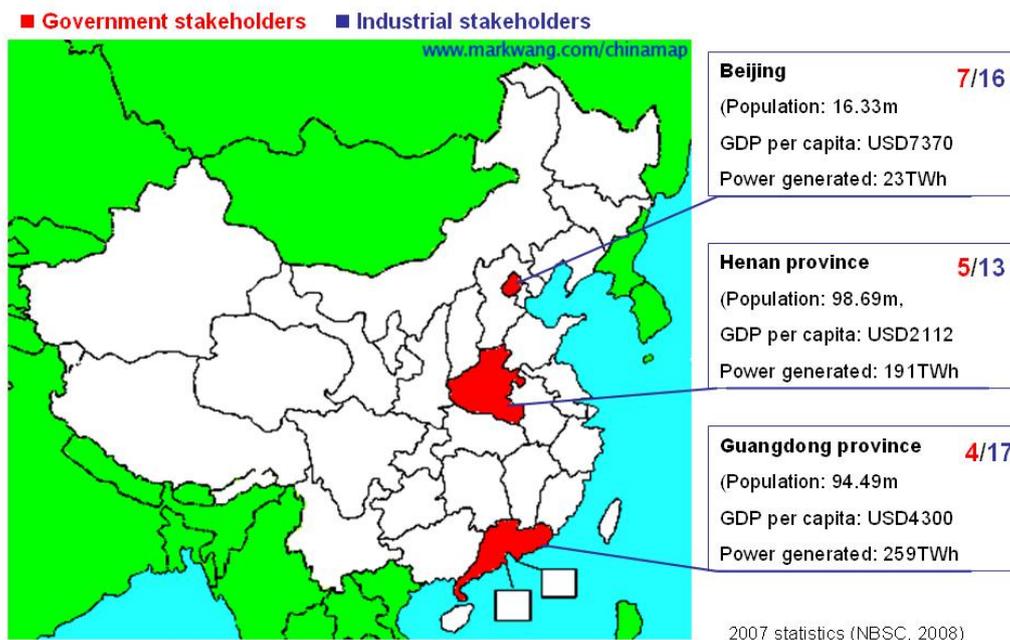


Figure 2 Geographical Distribution of Stakeholders Interviewed

2.2 Defining Lower Carbon Electricity Technologies

In our study, a ‘lower carbon electricity technology’ is defined as a technology that, when applied, results in lower carbon emissions than using baseline technology. Thus, ‘Lower Carbon Technologies’ here are not restricted to zero or near zero carbon emission technologies. Popular lower carbon electricity technologies are classified into three categories: lower carbon fossil fuel power, renewable power and nuclear power, as shown in Table 2.

Lower Carbon Fossil Fuel Power	Ultra-supercritical pulverised coal power (USC-PC) *
	Combined heat and power (CHP) *
	Replace coal or oil by natural gas in electricity generation *
	Power from enhanced coal bed methane (ECBM) recovery
	Carbon dioxide Capture & Storage (CCS)
Renewable Power	Large hydro power (i.e. installed capacity >30 MW)
	Small hydro power
	Wind power
	Solar photovoltaic (PV) power
	Biomass power
	Wave & tidal power (ocean power)
	Geothermal power
Nuclear Power	

* may lower carbon emissions relative to reference emissions but are not classified as low carbon/near zero emissions technologies

Table 2 List of Lower Carbon Electricity Technologies

2.3 Key Research Questions

Contrasting the formal legal and institutional structures with a focus on two key

- What is the perception of division of power between state and local governments?
- What is the difference between the legal and institutional framework for conventional versus renewable technologies?

3. Institutional Framework for Investment Process in Conventional Power Technologies

3.1 Formal Institutional Structure

In China, the official procedure to build and operate a conventional thermal power project involves three main steps: (i) proposing a project (including feasibility research, siting, and designing), (ii) acquiring the necessary approvals (including approval for construction and approval for operation), and (iii) management during operations (including electricity pricing and despatch, environmental regulation etc) (Zhang, 2003). Before investigating how stakeholders perceive the overall process to function, we review the formal roles of each of the main institutions involved in the investment decision process for the power sector.

The National Development and Reform Commission (NDRC) is the agency responsible for macroeconomic activity under the State Council. Its functions include approving major power projects, formulating plans for the development of the energy sector, and promoting a sustainable development strategy (NDRC, 2007c).

The State Electricity Regulatory Commission (SERC), established in October 2002, is empowered by the State Council to perform administrative and regulatory duties with regard to the power sector (SERC, 2007b). The official functions of the SERC involves developing and exercising laws and regulation in the electricity sector, formulating development plans, monitoring market operations and proposing tariffs (SERC, 2007b).

The main tasks of the State Environmental Protection Agency (SEPA) with regard to the power sector are to reduce environmental pollution from power plants and strengthen supervision of nuclear safety by formulating and implementing specific policies, laws and regulations (SEPA, 2004).

The local NDRC and local EPA are classified here as ‘local government’, since they are currently under the direct supervision of, and also appointed by, local government. In this context, all power projects require approval by local government (Zhang, 2003).

China Power Engineering Consulting Group Corporation (CPECC), which is a state-owned and state-controlled enterprise, is the largest electric power planning and engineering corporation in China, having undertaken the survey and design of 60% of power generation and delivery projects in China (CPECC, 2007).

Other institutions can also affect investment decisions. A large number of different institutions at national and local levels share the responsibility for making and implementing energy policy in China, as described in Figure 3 (IEA, 2007). In our stakeholder survey, the following institutions were named by some stakeholders, but were perceived to have less direct involvement in the investment decision process: Ministry of Finance (MOF), Ministry of Science and Technology (MOST), Ministry of Land and Resource (MOLR), commercial bank, power companies, grid companies, Ministry of Water Resource (MWR, for hydro projects only), and Commission of Science Technology and Industry for National Defence (COSTIND, for nuclear power projects only).

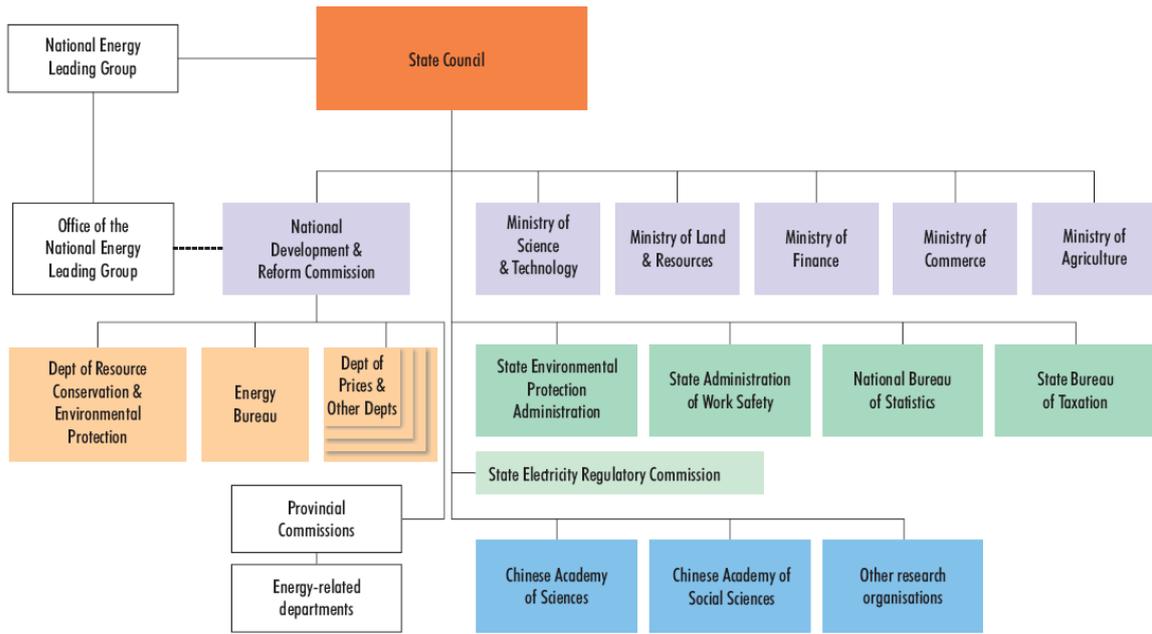


Figure 3 Energy Policy Decision Making Structure in China (IEA, 2007)

3.2 Stakeholder Views on the Importance of Institutions

National Planning

More than 80% of interviewees named NDRC as the primary institution for planning how much new capacity should be built in China over the next decade, while about 70% of interviewees believed local governments were also important on planning new capacity (Figure 4). Though a large number of stakeholders selected SERC in addition to NDRC, most of them perceived SERC as less important than NDRC.

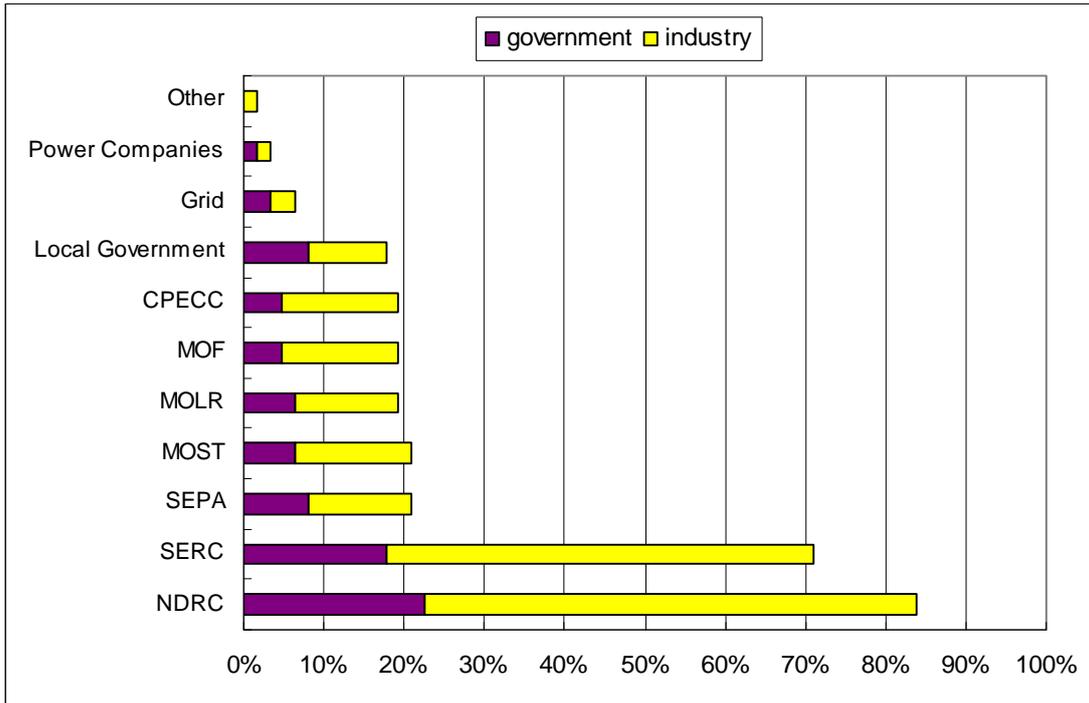


Figure 4 Stakeholder Views on Most Important Institutions in Planning New Capacity

Technology Policy

Concerning technology policy or the electricity technology mix, most stakeholders described NDRC and MOST as the leading decision maker for the next decade, as shown in Figure 5, and half perceived that SEPA as being influential as well.

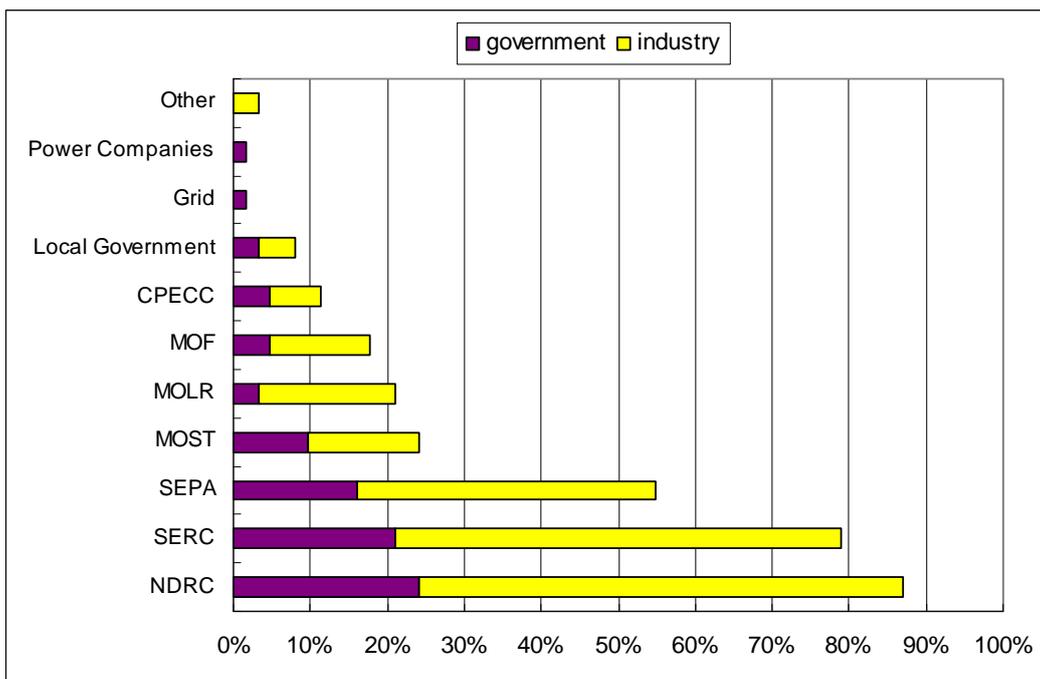


Figure 5 Views on Primary Decision Makers in Power Sector Technology Policy

3.3 Main Criteria Applied in the Decision-making Process

Stakeholders were asked to identify the main criteria used by different organisations when deciding on a power project. NDRC was identified as the only organisation taking all named factors into consideration, as shown in Table 3, whereas local government was seen as considering most factors except for ‘environmental impact’ and whether the equipment was ‘made in China’, i.e., focusing more on a project’s economic returns.

According to our survey, the top criterion used by power companies, the Ministry of Finance, and to a lesser extent local governments was economic returns, whereas this factor was lowest for NDRC. Stakeholder views on the criteria applied by SERC and grid companies were largely uncertain and divergent. In addition, ‘resource consumption’ was cited as an important criterion in decisions for five of the nine institutions, which may be a response to the national energy conservation policy and rapidly increasing energy prices.

List of Criteria (total 62 stakeholders)	Economic Performance	Resource Consumption	Environmental Impact	Social Impact	Technology Maturity	Produced Domestically
National Development and Reform Commission (NDRC)	48%	90%	68%	77%	69%	95%
State Electricity Regulatory Commission (SERC)	16%	3%	6%	16%	5%	3%
State Environment Protection Agency (SEPA)	2%	53%	98%	18%	5%	5%
Ministry of Science and Technology (MOST)	11%	11%	10%	29%	60%	45%
Ministry of Land and Resources (MLR)	3%	73%	40%	24%	3%	2%
Ministry of Finance (MOF)	79%	3%	2%	0%	2%	3%
Local Governments	66%	53%	44%	61%	60%	8%
Grid Companies	8%	8%	16%	21%	15%	18%
Power Generation Companies	97%	66%	26%	5%	81%	6%

Table 3 Main Criteria Different Organisations are Believed to Apply in the Decision-making Process for Individual Power Projects
(shaded box indicates the response was listed by more than half of the 62 surveyed stakeholders)

3.4 Insights for Investors in Conventional Thermal Power

Authorising a Large Conventional Thermal Project

Most stakeholders perceived NDRC and local government as being the two most important organisations responsible for proposing and authorising or approving a large thermal power project (unit installed capacity >300MW), while State Environment Protection Administration (SEPA) and grids companies were seen as assisting them in approving a project (Figure 6).

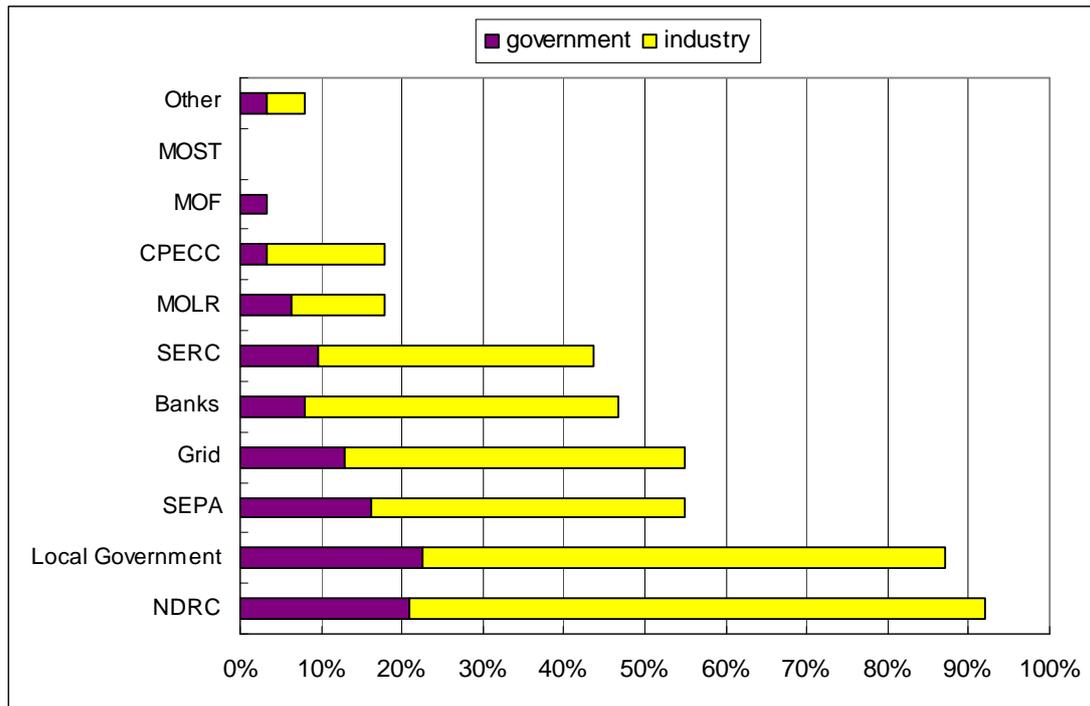


Figure 6 Views on Primary Decision Makers in Authorising a Large Thermal Project

Although the importance of NDRC was not questioned, quite a few industry stakeholders believed local government normally had a greater influence when proposing or approving an individual thermal power project. One senior local government official described how local governments acted in the interest of both national government and local firms by sometimes ‘educating’ local firms on how to deal with the national government. Though SERC is legally the primary licensing institution in the power sector, its importance was not confirmed by the stakeholder survey. Regarding the importance of grids, an official commented that ‘grids are roads while plants are cars; therefore, cars are useful only if roads have been built’.

How important is the availability of investment capital in authorising a project? Interestingly, slightly more than half of stakeholders believed that acquiring project approval was much more important than a bank’s credit line, but about 45% did claim bank support was essential in the authorising process.

Negotiating On-grid Electricity Price and Quotas

In China, an integrated electricity market is still not operating, thus we asked stakeholders which institutions were central to the process of pricing and dispatching on-grid electricity, which influences power project profitability. A large majority of respondents said that NDRC was in charge of determining a benchmark on-grid electricity price annually. Local governments and local grids subsequently fine-tune the on-grid price around the benchmark guide price. Accordingly, local governments, grids and NDRC were identified as the three most important institutions in deciding on-grid electricity prices (Figure 7).

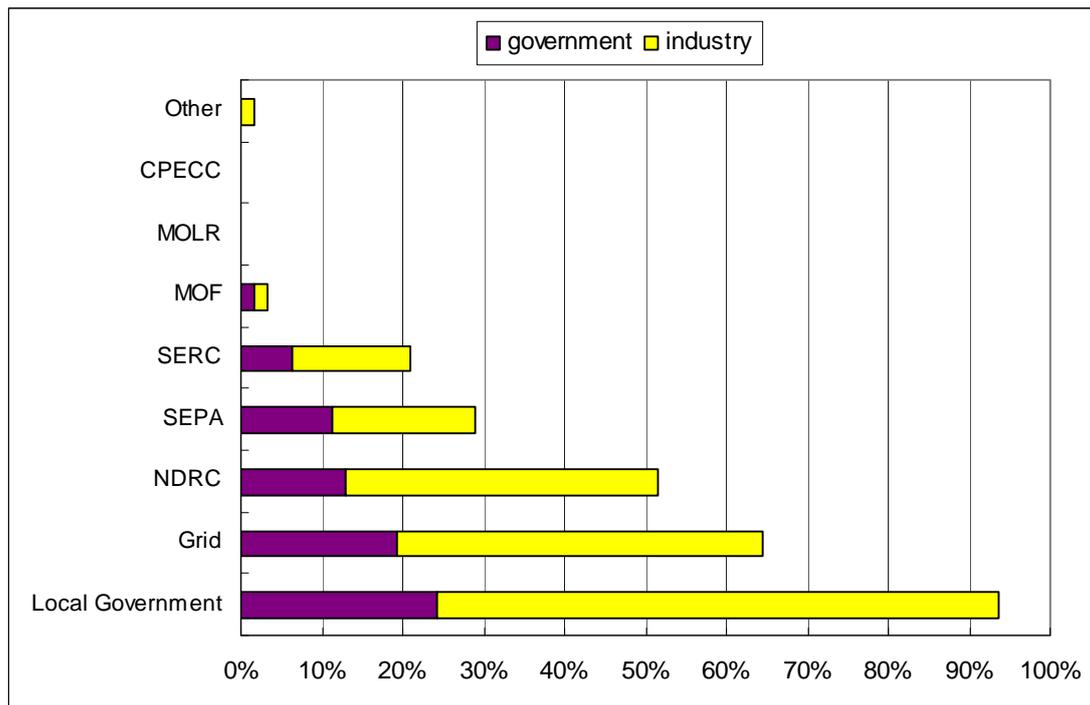


Figure 7 Views on Primary Decision Makers On-grid Electricity Pricing and Dispatching for a Large Thermal Project

Furthermore, a quarter of stakeholders indicated that the environmental impact of a plant was gradually reflected in the regulated power off-take price received by plants, and some claimed the State Environment Protection Administration (SEPA) was gaining influence in determining the power off-take price. A vast majority of stakeholders presumed that the ‘on-grid quota’ was mainly dispatched by local grid companies. While national stakeholders tended to assume that the policies of NDRC and SEPA affected quota arrangements, local stakeholders suggested that the national government had little influence on the quota arrangements of a power project. As an illustration, a local stakeholder provided the example of a case where “although oil-fired units had been strictly regulated to only allow for generating peak-load electricity for the last two years, one oil-fired unit was utilized more

than 6500 hours while advanced coal-fired units in the same city were utilized less than 6000 hours.” Two national officials and one official at a power exchange office of a local grid company indicated that SERC may gradually take more power in regulating electricity pricing and contract activity (quota arrangements).

Environment and Operation Monitoring

About four-fifths of stakeholders believed local government (including the local environment protection agency) and SEPA exercised the primary influence on the operation of a large thermal power project (Figure 8). A few officials said the role of SEPA in monitoring local environment pollution was being enhanced by on-going reforms.

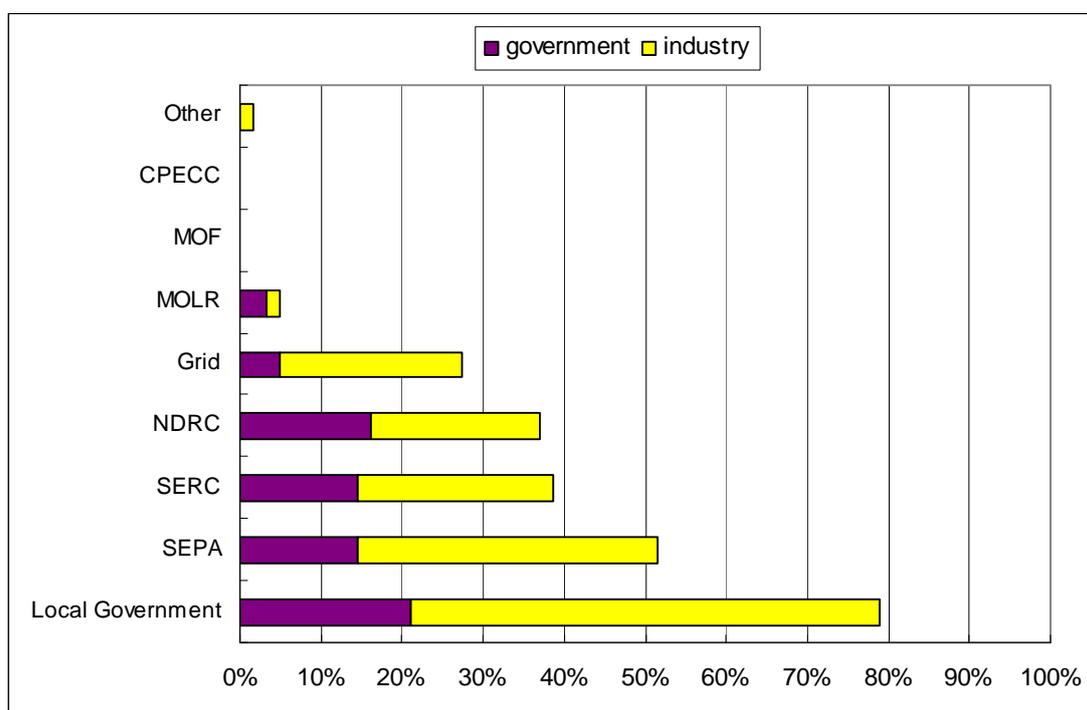


Figure 8 Views on Important Institutions in Environment and Operation Monitoring

The overall views of stakeholders was that NDRC currently had much greater influence than SERC in all aspects of policy, whether electricity planning, project approvals or deciding benchmark electricity prices and formulating the power dispatch policy. This result confirms the findings of a recent study, *Capacity Building of the Electricity Regulatory Agency*, co-authored by SERC (2007a), MOF and the World Bank. Their study indicated three current functional distribution problems in electricity regulation: (i) the overlap in regulatory functions between SERC and NDRC, (ii) both planning and specific approvals of investment being handled by NDRC even after the establishment of SERC, and (iii) tariff regulation remaining under the control of the NDRC whereas SERC can only influence tariffs indirectly by offering advice (SERC et al, 2007b).

Investments also had an important local and regional dimension. Local governments were identified by more than three-quarters of respondents as being very important in authorising projects, pricing and monitoring operations. When key stakeholders from power generation companies were asked about their rationale for reinvesting their profits, only the large national power companies were willing to invest in power generation assets anywhere in the country. Two provincially-owned power companies and two foreign investment power companies felt it was extremely difficult to invest outside their local city or province. An overseas-Chinese owned power company in Guangdong claimed that they were planning to invest in the unfamiliar IT industry rather than in power projects in other cities. A provincially-owned power company in Zhejiang expressed concern over the ‘barriers of going to other provinces’ in a very straightforward manner: ‘when considering opportunities of power projects in another province, we perceive it to be very difficult to compete with incumbent local power companies who already have gained a good relationship with the local government and grid companies’.

3.5 Stakeholders’ Expectations about Future Prices of Coal and Carbon Dioxide

In the first quarter of 2007, coal imports of China exceeded exports for the first time ever (Wu, 2007). Very few stakeholders could offer a numerical estimate of future coal prices or carbon prices, especially for the long term, but respondents who did respond all held bullish views on both coal and carbon prices in the short term, as shown in Tables 4 and 5. Some supported their predictions of coal prices by referring to the combined drivers of rising health and safety costs, increasing resource taxes, strong electricity demand due to rapid economic growth, transportation bottlenecks and ‘replacing tax rebates with export duties on coal’. Only one national government official suggested the need for starting to evaluate the impact of a carbon price on coal prices.

Variable	Obs	Mean	Standard. Deviation	Min	Max
base_2010	8	556	51	500	620
high_2010	8	616	137	420	800
low_2010	8	488	138	400	720
base_2020	3	817	28	800	850
high_2020	3	960	52	900	1000
low_2020	3	600	0	600	600
base_2030	2	1100	141	1000	1200
high_2030	2	1350	212	1200	1500
low_2030	2	900	141	800	1000

2006 reference price = CNY400/ton, summer 2008 price = CNY850 - CNY900/ton for 5500Kcal coal

Units: Chinese Yuan (CNY)

Table 4 Coal Price Expectations by Subset of Stakeholders (Summer 2007)

Variable	Obs	Mean	Std. Dev.	Min	Max
c2010_base	5	16	3.11	12	20
c2010_high	5	23.6	5.90	18	30
c2010_low	5	8.4	4.78	0	12
c2015_base	3	22.7	6.43	18	30
c2015_high	3	31.7	7.64	25	40
c2015_low	3	10.7	10.07	0	20
c2020_base	1	30	.	30	30
c2020_high	1	45	.	45	45
c2020_low	1	20	.	20	20

Stakeholders were told that the reference carbon price (for 2008 to 2012) in China should be assumed to be the reference CDM price of €8-12/tCeq. Units: Euros

Table 5 Carbon Price Expectations by Subset of Stakeholders

4. The Role of Lower Carbon Electric Power Technologies

4.1 The National Objective of Encouraging Lower Carbon Technologies

The national 'Energy Conservation' objective is already incorporated in the medium- and long-term (2020) plans for China and mandates a lower proportion of fossil fuels in power

generation. To support the plan, policies such as ‘replacing small units by large units’ and ‘regulations on managing renewable power’ have been put forward. In principle, financing lower carbon electricity including higher efficiency coal-fired pulverised coal (PC), CHP, various forms of renewable power, and nuclear power could be supported through the energy conservation policy.

Renewable power is highlighted in the current energy conservation policy and respondents anticipate the growth rate to be very high. The Office of the National Energy Leading Group indicated the proposed target share of renewable power in primary energy in 2020 would be 16%, including 300 GW of hydro power, 30 GW of wind power, 30 GW of biomass power, 1.8 GW of solar PV, etc, according to ‘The Medium and Long Term Development Plan of Renewable Power’ proposed by NDRC (Xu, 2006). Zhang (2006) confirmed that the target for nuclear power was 40 GW or 4% of total installed capacity in 2020.

4.2 Stakeholder Opinions on Alternative Power Generation Technologies

As illustrated in Figure 9, wind, advanced supercritical pulverised coal, combined heat and power, and biomass were selected as the four top priority areas by the stakeholders interviewed. Most industrial stakeholders believed that the impetus for large scale deployment of wind power in China would be the national renewable incentive policies and wind’s cost advantage relative to other renewable technologies.

USC-PC was recognised as a practical and important generation technology to assist the policy of ‘replacing small units by large units’. There were significantly divergent opinions on wind power, some were very optimistic about the potential contribution, but others believed that high cost and variability would limit its potential. Nuclear power was described as an important technology in diversifying energy sources over the long term. Benefits associated with biomass included saving energy, disposing of agricultural waste and increasing farmers’ income, although some concern was voiced about potential food shortages.

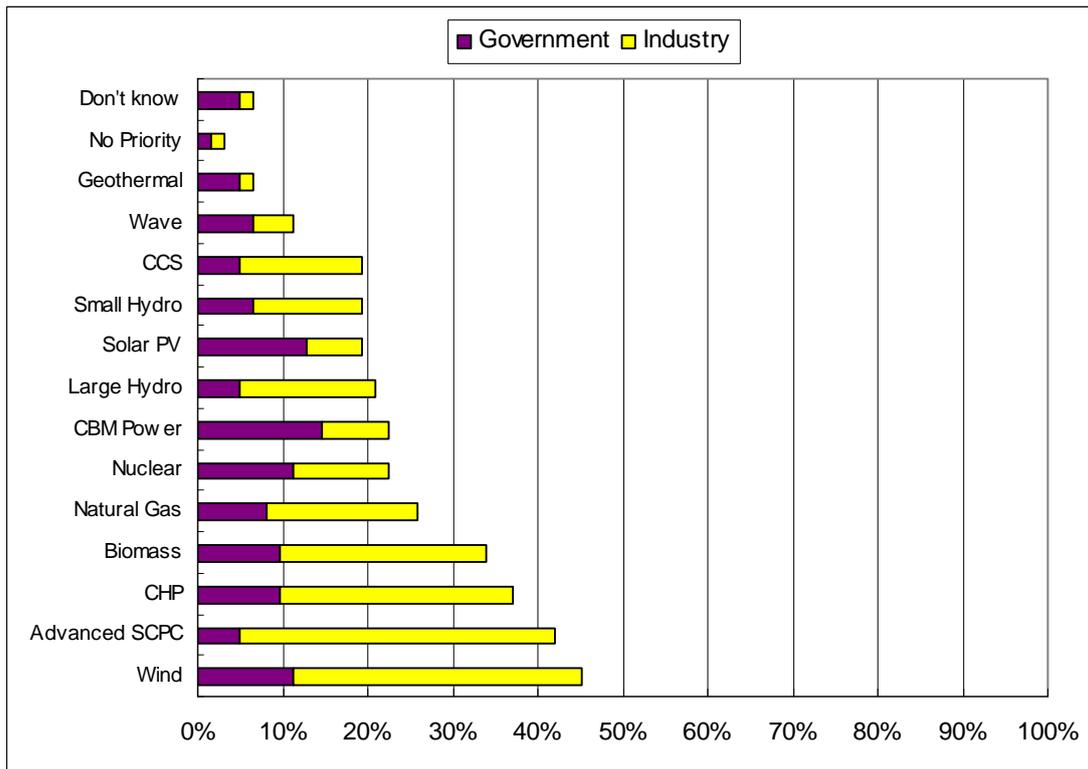


Figure 9 Priority Lower Carbon Power Technologies Identified by Stakeholders

Commenting on other technologies, many stakeholders felt wave, tidal and geothermal power were too expensive. The majority of stakeholders interviewed had not heard about or had heard very little about ‘carbon capture and storage’, despite foreign expectations that it might be the only promising way to achieve near zero carbon emissions in the dominant thermal power sector in China (DTI, 2003). A few stakeholders were concerned about the potential environmental hazards of building more hydroelectric power capacity.

4.3 The Legal Framework to Support Policy of ‘Replacing small thermal units by large units’
 China’s eleventh five-year plan clearly establishes an ambitious target: to lower energy consumption per unit of GDP by 20% and reduce the total emissions of major pollutants by 10% in 2010 relative to 2005. With the addition of new power capacity in the three years from 2004 to 2007, concerns over electricity shortages eased significantly (Zhang, 2007) and the average utilization hours of generation units were expected to continue to drop (CEC, 2007). Therefore, in January 2007, NDRC announced its policy of ‘replacing small thermal units by large units’. Successful implementation of the policy would result in all oil-fired units being closed, representing about 10 GW of generation capacity, as well as most small coal-fired units (about 50 GW) (NDRC, 2007a). The policy also encourages retrofitting thermal units to include combined heat and power (CHP) plants or to co-fire with biomass (NDRC, 2007a).

The implementation of the policy of ‘replacing small units by large units’ provides opportunities for ultra-supercritical (USC) coal units, CHP, and biomass power, since they enjoy the advantages of higher efficiency or lower fossil fuel consumption. The policy may also encourage retrofitting oil-fired power plants to natural gas which would emit about 50% less carbon dioxide compared to oil.

Policy on ‘Utilising coal bed methane (CBM) to generate electricity’

Coal bed methane is a form of natural gas found in coal seams, but one that, to date, has been underdeveloped in China. In 2005, although China’s coal production reached twice the level of the US, the second largest coal producer, total production of CBM was only 4% of the US level and half of China’s CBM produced during coal mining operations is simply emitted to atmosphere (Pan, 2006). In 2006, the State Council issued a policy to encourage CBM, since capturing coal bed methane improves coal mining safety, conserves energy and protects the environment by reducing methane emissions.

In April 2007, NDRC released a new policy on ‘utilising coal bed methane to generate electricity’. The policy encourages operators of CBM power to collaborate with domestic or foreign equipment manufacturers to achieve technology advancement, and allows coal bed methane power to sell electricity at a favourable price, referring to benchmark local biomass power price (NDRC, 2007b). All coal bed-methane projects are subject to certification by local government (provincial or lower) only.

In 2006, an official from the State Administration of Coal Mine Safety suggested it would be necessary to ‘separate CBM resource mining rights from coal resource mining rights’, because CBM exploitation lifts utilisation rates and lowers coal mining costs (Pan, 2006). However, current policy has not solved the problem regarding mining rights, which potentially hinders the financing of CBM power projects.

Measures to Stimulate Renewable Power

Article 5 of the ‘Electricity Law of the PRC’ released in 1996 states that ‘renewable power is supported and encouraged’, however, the 1996 Electricity Law did create financial incentives for renewable power. In 2004, a serious energy shortage affecting the entire Chinese economy triggered greater attention to renewable energy and resulted in detailed policies being developed to simulate renewable power generation (Yang, 2005).

The ‘Renewable Energy Law’ has been in effect since 1 January 2006. Since then, six relevant measures have been developed by NDRC to promote renewable energy. It launched

the medium and long term development plan for renewable energy, created a renewable industries category (which serves as a development guideline for investors) with a comprehensive set of renewable policies covering resource evaluation pricing mechanisms, technology development programmes, and an allocation plan assigning renewable obligation quotas to large energy companies.

A temporary method for pricing renewable electricity and cost-delivering mechanisms was announced by NDRC in January 2006. Under this 'method', the on-grid price of wind power would be determined by a public tender mechanism; biomass electricity decided by either a benchmark price given by the State Council or a public tender mechanism; hydro electricity continues to apply current mechanisms; and prices for solar, ocean and geothermal power are set based on a 'cost plus reasonable profit' mechanism (NDRC, 2006a). The 'method' also clarifies that the price difference between the price of renewable electricity and the benchmark price of local coal-fired electricity is apportioned to all national electricity consumers (NDRC, 2006a). Furthermore, grid companies are required to develop relevant facilities and purchase all renewable electricity produced (NDRC, 2006b).

A policy to support electrification of remote areas, released in 2005 by NDRC (2005b), allows for the use of renewable power generation if the extension of the grid is not economic. Such development of renewable power in remote areas and construction of isolated power systems is supported by a special fund for renewable energy released by MOF (2006).

Research, development and demonstration of renewable technologies is to be supported by the 'special fund', as stated in article three of 'Measures of Special fund for renewable energy' by MOF (2006).

Clean Development Mechanism (CDM)

CDM is a project-based mechanism under the Kyoto Protocol, which allows developed countries to invest in developing countries in order to meet part of their GHG emission reduction obligations by acquiring 'certified emissions reductions' (CERs) generated by the projects in developing countries. NDRC (2005a) released 'Measures for Operation and Management of Clean Development Mechanism Projects in China' which took effect as of 12th October 2005. Article 4 lists energy efficiency improvement, development and utilization of new and renewable energy, and methane recovery and utilization as priority areas, and article 24 states that the Chinese government will only apply a tax of 2% on CERs produced in CDM projects in priority areas, a much smaller levy than in non-priority areas where the tax rises to as high as 65% in HFC and PFC projects, and 30% in N₂O projects (NDRC, 2005).

This differential 'tax-rate' also reflects the low marginal cost of emission reductions for HFC and N₂O projects.

As of August 2008, China was, by far, the largest CDM host party in terms of CERs with over 50% of total CERs (51.7% compared to 14.1% for India and 8.8% for Brazil). In terms of number of projects, China was second (22% of total CDM projects compared to 31.1% for India and 12.6% for Brazil).

As noted by Liu (2007), so far the number of projects (and resulting CERs) in the priority areas are small. About 90% of CERs for Chinese CDM projects are either for HFC or N₂O projects. This can be attributed in part to a lack of understanding of national CDM goals by local and regional governments, CER prices that are too low for low carbon energy projects with their high up-front costs, financing difficulties for capital-intensive projects, and uncertainty regarding the role of CDM after 2012 (Liu, 2007).

4.4 Stakeholders' Views on the Legal Framework for Lower Carbon Technologies

Even though most firms and government officials claimed they had some experience in regulating or managing lower carbon generation plants, when asked about the decision processes used in wind, small hydro, or nuclear power projects, their views were often contradictory and the non-response rate was higher than for thermal power projects.

Large Scale Wind Power

Which institutions influence feasibility studies and siting decisions? Local governments, grids, MLR, power firms and NDRC each obtained 25% to 40% of the responses, as shown in Figure 12. Less than half of the stakeholders were aware that local departments of Land and Resources (under local governments) are responsible for wind farm siting and feasibility studies (NDRC, 2005c).

Most stakeholders were not aware of the formal differences in the authorisation process for wind power projects and thermal power projects. Of the 62 stakeholders consulted, only two officials from the national government and one manager at a local power company developing a wind power project, reflected in their answers the different provisions that the energy law envisages for different renewable technologies. Large scale wind-power projects are subject to approval by both the NDRC and the local government, while other projects only require authorisation from the local government.

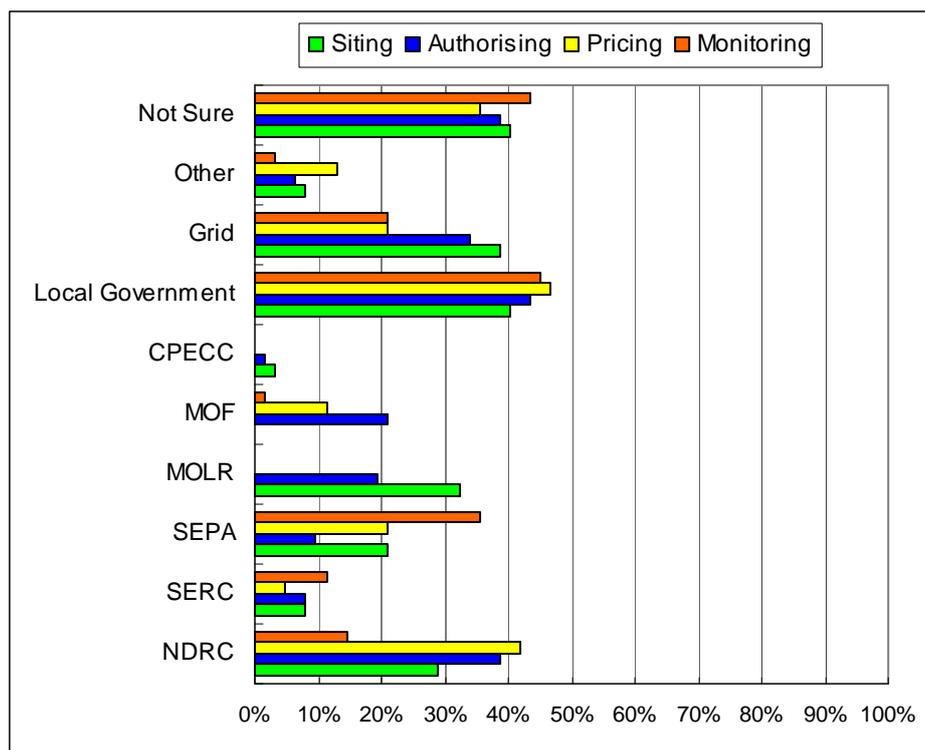


Figure 12 Views on Most Influential Institutions in Developing Wind Power Projects

Answers on the preferred pricing mechanism for wind power diverged: a few indicated a ‘cost plus reasonable profit’ method and others suggested a ‘public tender mechanism’. Regarding the question of which institutions had the strongest influence on the pricing and despatch of wind-power, most respondents mentioned local governments and NDRC as most influential in pricing on-grid electricity. About half of all respondents (including all respondents from grid companies) referred to the NDRC (2006b) policy requiring grid companies to accept any electricity generated by wind power projects. Wind power was perceived negatively by grid companies; for example, one senior manager thought wind-generated electricity was not competitive given its price and variability.

Small Hydro Power (<30MW)

There was no consensus on which institutions were most important in siting a small hydro project – power companies, NDRC, SEPA, and local governments obtained 29%, 21%, 14%, and 11% support respectively, as shown in Figure 13.

Regarding the authorisation of small hydro projects, 46% of stakeholders perceived local governments were most important and a quarter of respondents selected the Ministry of Water Resources (MWR). Among respondents, three actors involved in hydro power projects claimed that the local NDRC and the local department of water resources (part of local

government) were influential in licensing small hydro projects, and that relations with the local grid operators were also essential.

Overall, there was a notable lack of agreement on which institutions were formulating electricity tariffs for small hydro power, but relatively more stakeholders opted for local governments (32%) and grids (15%)

Three-fifths of stakeholders considered local government to be most important in monitoring operations of hydro power projects and a minority of stakeholders (including three in hydro-related posts) believed MWR (21%) and SEPA (19%) were important as well.

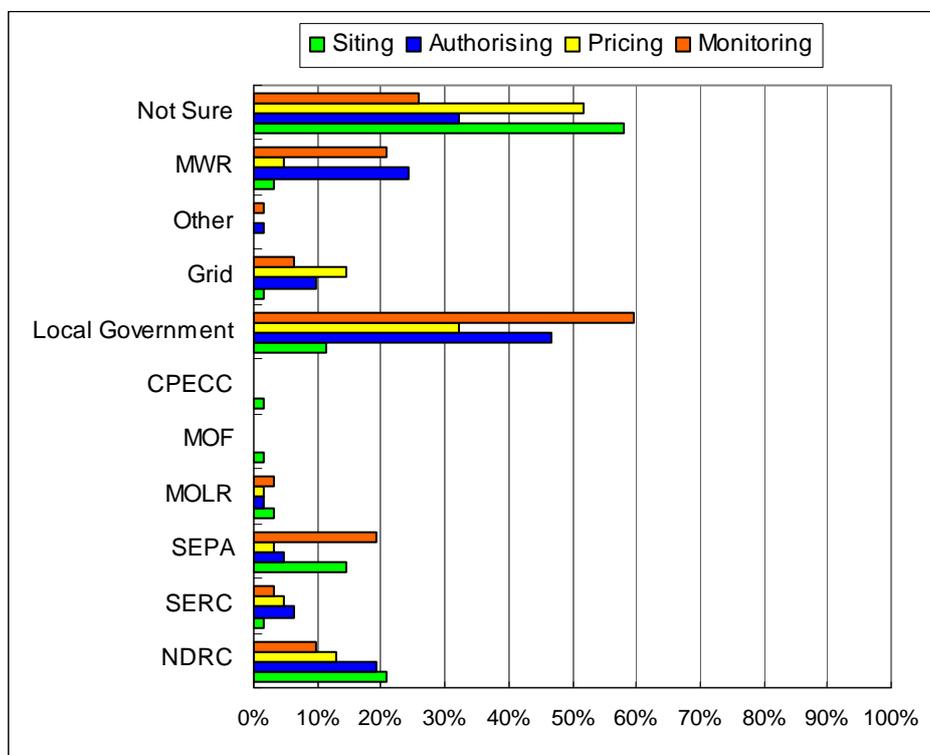


Figure 13 Views on Most Influential Institutions at Stages of Developing Small Hydro Power Projects

Nuclear Power

Less than a third of interviewees could describe the legal and institutional framework governing nuclear power with confidence, as shown in Figure 14.

Slightly more than 20% of stakeholders believed COIND, NDRC and local governments were all important in sitting nuclear plants. When asked which institutions authorised new nuclear projects, a majority of those that could describe the approval framework for nuclear projects

believed both NDRC and COIND were important. One official from a nuclear power company indicated that local governments were influential in project licensing as well.

Views on the decision process regarding pricing nuclear electricity were as diverse as opinions about authorising plants. Those offering an answer mostly perceived NDRC (19%) and local governments (13%) as central.

With regard to monitoring operations of nuclear projects, 24% believed NDRC was the main institution, followed by COIND (18%) and SEPA (15%).

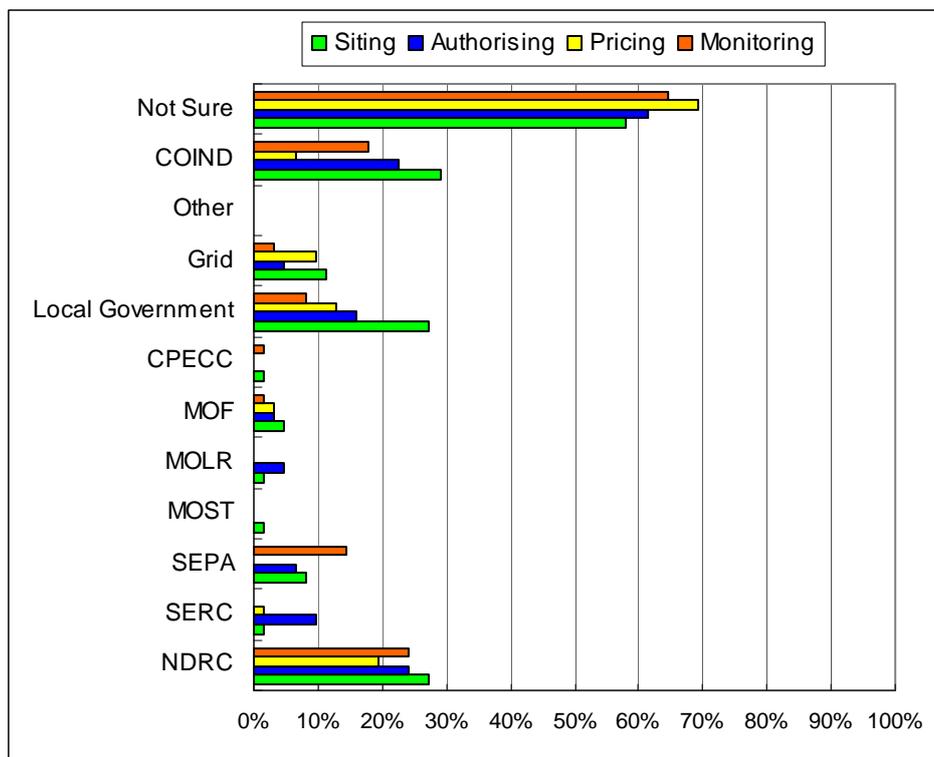


Figure 14 Views on Most Influential Institutions at Developing Nuclear Power Projects

Additional Views on Renewable Power

Most stakeholders disagreed as to the desirability of subsidizing the ‘much higher’ cost generation technologies such as solar PV, geothermal power and ocean power. Some stakeholders at power firms repeatedly referred to the fact that only ‘1.8 GW of solar PV power in 2020’ was planned according to ‘the Medium and Long Term Development Plan of Renewable Power’.

During discussion sessions, two senior officials from national government emphasised the importance of developing adequate research capability and competitive power equipment

manufacturing plants in China. Using the example of wind power as an illustration, An official described how three years earlier: ‘we were able to subsidize only 1 kWh wind power with RMB0.5, but now we can subsidize 3 kWh with the same amount of money’.

4.5 Foreign Investment Framework for Lower Carbon Technologies

Renewable power is listed as an industry targeted for encouraging foreign investment based on the ‘foreign investment industries’ categories’ (NDRC, 2004). However, a large number of domestic industrial responses suggested that the Chinese government does not need to offer incentives to foreign investors in generation capacity that exceed the incentives given to local investors, as the Chinese economy already was perceived as having a ‘serious surplus’ of capital. A few key stakeholders supported offering special incentives to foreign technology and equipment vendors in order to build equipment manufacturing lines or to develop research and development capacity in China.

Subsequently, stakeholders were asked about commercial aspects of six generation technologies (nuclear, solar PV, wind, small hydro, SCPC, advanced SCPC). The expected rate of returns (or required?) in % per year for the total invested capital and the risk level on a scale between 0 and 10 are depicted in Table 6 and Figure 15.

Variable	Obs	Mean	Std. Dev.	Min	Max
risk_nuke	21	5.24	1.61	2	9
Return_nuke	21	5.86	1.35	3	8
risk_solar	21	6.71	1.95	3	9
return_solar	21	3.19	1.40	1	6
risk_wind	21	5.14	1.77	3	9
return_wind	21	5.10	1.26	3	7
risk_hydro	21	5.52	1.78	3	9
return_hydro	21	8.95	1.24	6	10
risk_apc	21	3.43	1.47	1	6
return_apc	21	8.33	0.66	7	9
risk_cpc	21	3.81	1.60	2	8
return_cpc	21	7.29	1.10	5	9

Table 6 Risk and return level of different technologies

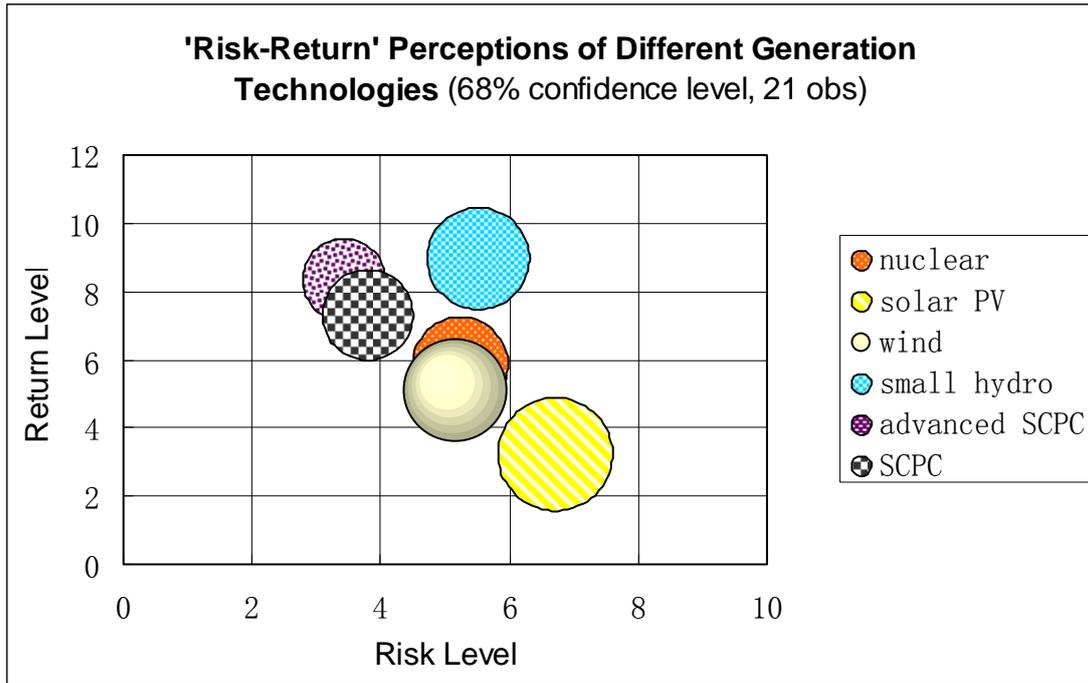


Figure 15 A Comparison of perceptions on ‘Relative Risk and Return Level’ by 21 key stakeholders

Figure 15 illustrates that many of the technologies lie on an efficient frontier, while solar PV, wind and nuclear are, according to this metric at least, less efficient or attractive as they are above the perceived efficient frontier. Small hydro is notable for having significantly higher returns for the same amount of (or slightly lower) risks, and was therefore regarded as more attractive than other renewables such as solar PV and wind.

Most stakeholders were familiar with conventional thermal power investments. The internal rate of return (IRR) for new PC projects was perceived by stakeholders as ranging from 8% to 15%. In addition, most respondents suggested that more advanced supercritical projects (higher efficiency) would result in higher returns but lower risks, due to growing fuel costs and a potential efficiency-based on-grid quota allocation policy.

Regarding small hydro power, very attractive return levels (IRR from 12% to 20%) were claimed by stakeholders who offered an answer, because of the low levelized cost and more attractive renewable energy policies in China. However, small hydro was generally identified as riskier than conventional thermal power, mainly owing to uncertainties such as the stability of water supply.

Nuclear power projects were perceived as less profitable investment opportunities compared to coal and hydro. However, stakeholders expressed a lack of experience and information in projecting risk-return levels for nuclear, thus the estimation may be subject to aversion to ambiguity bias (fear of unknown). One official involved in a nuclear power project suggested the projected IRR of nuclear power in China was between 8% and 12%.

The perceived return from future wind power projects does not reflect the dramatic growth of wind power installed capacity from 2004 to 2007, because stakeholders believed the wind tariffs decided through the bidding mechanism in place are not helpful in incentivising wind. In the meanwhile, respondents claimed the uncertainties with respect to both wind resource and wind turbine reliability result in a highly risky profile.

To compensate for the high capital investment (per kW) of solar PV, a ‘feed-in tariff’ policy provides generators with high prices per kWh electricity produced. However, apparently trust of stakeholders in the continuity of the support was still weak, and therefore PV was described as the highest risk and the lowest return option among the six generation technologies described.

With regard to the methodologies for evaluating power projects, most industry respondents claimed IRR (Internal Rate of Return) and NPV (Net Present Value) based on a static estimated cash flow profile were the most common means of evaluation. A few government stakeholders perceived IRR as the single most important criterion in judging a project’s economic feasibility and government respondents generally agreed the threshold IRR was approximately 8%.

5. Conclusions

We have focused on two central questions regarding the role of different government and private sector organisations in the investment decision process for power stations: (i) the difference between the legal and institutional framework for conventional versus lower carbon technologies including renewable, nuclear and advanced coal-fired generation; and (ii) the perception of the division of power between national and local governments.

For conventional power stations a well-established process is in place, and this was reflected in our interviews: A wide set of stakeholders provided a consistent picture – they attributed

similar levels of importance and decision criteria to the different organisations. In contrast, stakeholders offered widely differing perspectives on the decision process for investing in lower carbon projects. The difference reflects the fact that the legal framework governing renewables has only been in place since the beginning of 2006.

The National Development and Reform Commission (NDRC) is the most important organisation in place for planning and regulating the electricity sector, while local authorities largely influence a project's profitability. The primary decision criteria considered by NDRC in its decision-making process were equipment localisation, resource consumption and resource availability, while local governments attributed more importance to the economic prospects and social impacts.

Renewable power has been encouraged by aggressive energy conservation and energy diversification policies. The focus is on the deployment of wind, biomass and hydro, as they currently exhibit lower cost than other non-hydro renewable power sources. It is generally perceived that government attributes importance to both research and development capacity and deployment of renewable technologies. However, stakeholders were less clear as to how exactly the policy to finance the extra costs of renewable power works and which organisations have to make the relevant decisions.

There has also been rapid growth in the deployment of wind and other renewable power technologies, albeit from a tiny base. Although most stakeholders expressed a strong interest and willingness to participate in the development and deployment of lower carbon technologies in China, some investment opportunities (solar, nuclear and wind) was regarded less efficient than conventional thermal power technologies.

At the moment, coal bed methane, advanced CHP and replacing oil by gas are encouraged by Chinese government. Coal-fired power stations will remain the dominant technology in China for the foreseeable future. Carbon Capture and Storage (CCS) is the only currently available technology to reduce CO₂ emissions of coal stations below the levels that can be achieved by efficiency improvements or biomass co-firing, but it may be difficult to achieve widespread domestic support for CCS since it increases the coal consumption per MWh of electricity produced, which conflicts with the national objective of increasing energy efficiency.

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References

CEC (China Electricity Council), 2007, *Analysis and Forecast of National Electricity Supply & Demand and Economic Situation: 2006-2007*

CEC, 2008, Quanguo Dianli Tongji Kuaibao (A preliminary statistical report of national electricity industry in 2007), available at:

<http://www.cec.org.cn/images/2008114121656344.doc>

CPECC (China Power Engineering Consultant Group Company), 2007, *Our Group Corporation*

Available at <http://www.cpecc.net/xasp/english/corporation.htm>

DTI (UK Department of Trade and Industry), 2003, *Our Energy Future: Creating low carbon economy*, London: TSO.

EIA (US Energy Information Agency), 2006, *Total Emissions*, International Emissions Data, Available at <http://www.eia.doe.gov/pub/international/iealf/tableh1co2.xls>

EIA, 2007, *Electricity Net Summer Capacity: Total (All Sectors), Selected Years, 1949-2006*, Annual Energy Review, Available at http://www.eia.doe.gov/emeu/aer/pdf/pages/sec8_42.pdf

Gao, Guangsheng, 2007, *China won't be top CO2 emitter this year-official*, Reuters, 25th April 2007, Available at, <http://www.alertnet.org/thenews/newsdesk/PEK91020.htm>

Greengen, 2006, webpage available at:

<http://www.greengen.com.cn/>

Huaneng Intl. Inc., 2007, *Huaneng Power International, Inc.'s Annual Report on Form 20-F 2006*, SEC (US Securities and Exchange Commission), p 6

Available at <http://www.sec.gov/Archives/edgar/data/929058/000134100407001245/hpi20f-ar.txt>

IEA (International Energy Agency), 2007, *World Energy Outlook 2007*, Chapter 8 – Overview of the Energy Sector

Li, Junfeng et al, 2007, *China Wind Power Report*, China Environmental Science Press,

Liu, Lancui, Wu, Gang, 2007, *The current status and considerations of CDM projects in China (in Chinese)*, *Energy of China*, 29: 34-40.

MOF (Ministry of Finance), 2006, *Temporary Measures on Management of Special Fund of Development of Renewable Energy (in Chinese)*

NBSC (National Bureau of Statistics of China), 2006, *China Statistical Review 2006*

Available at <http://www.stats.gov.cn/tjsj/ndsj/2006/indexch.htm>

NBSC (National Bureau of Statistics of China), 2008, *Tongjigubao*,

Available at <http://www.stats.gov.cn/tjgb/>

NDRC (National Development and Reform Commission), 2004, *Foreign Investment Industries' Categories (Guideline)*

Available at, http://wzs.ndrc.gov.cn/zcfg/wszjtzp/t20050714_36199.htm

NDRC, MOST et al, 2005a, *Measures for Operation and Management of Clean Development Mechanism Projects in China*

NDRC, 2005b, *Notice on Electricity Construction in No-electricity Area*, available at, http://nyj.ndrc.gov.cn/ggtz/t20050810_40582.htm

NDRC, 2005c, *Measures for Environment Protection Administration and Land Occupation for Wind Farm construction*, available at, <http://nyj.ndrc.gov.cn/zcfg/zywx/W020050816422057033843.doc>

NDRC 2006a, *Temporary measures on Pricing Renewable Electricity and Delivering Additional Cost*, Available at, http://jgs.ndrc.gov.cn/zcfg/t20060120_57585.htm

NDRC, 2006b, *Regulations on Managing Renewable Energy Electricity*
Available at http://nyj.ndrc.gov.cn/zywx/t20060206_58763.htm

NDRC, 2007a, *Several Opinions on Speeding up Closing Small Thermal Generation Units*, Available at, http://www.gov.cn/zwgk/2007-01/26/content_509911.htm

NDRC, 2007b, *Policy on Utilising Coal Bed Methane to Generate Electricity*
Available at, http://nyj.ndrc.gov.cn/mtwsfz/zywj/t20070413_129443.htm

NDRC, 2007c, *Brief Introduction of NDRC*,
Available at <http://en.ndrc.gov.cn/brief/default.htm>

Pan, Weier, 2006, *Strategies and Economic Policies Options of Coal Bed Methane Exploitation in China*, *Energy of China*, Vol.28 No.11 Nov.2006, 13-17

SERC (State Electricity Regulatory Commission), MOF, World Bank, 2007a, *Study of Capacity Building of the Electricity Regulatory Agency*

SERC, 2007b, *Brief Introduction of State Electricity and Regulatory Commission*, available at: <http://www.serc.gov.cn/openems/export/serc/english.html>

State Council, 2007, *Opinions on strengthening reform in electricity sector during eleventh five-year plan*, available at:
http://www.gov.cn/zwgk/2007-04/12/content_580305.htm

UNFCCC (United Nations Framework Convention on Climate Change), 2007a, *Expected average annual CERs from registered projects by host party*, Available at:

<http://cdm.unfccc.int/Statistics/Registration/AmountOfReductRegisteredProjPieChart.html>

UNFCCC, 2007b, *Registered project activities by host party*, available at:

<http://cdm.unfccc.int/Statistics/Registration/NumOfRegisteredProjByHostPartiesPieChart.htm>

[1](#)

WRI (World Resources Institute), 2006: *Climate Analysis Indicators Tool (CAIT) on-line database version 3.0*, Washington, DC: World Resources Institute

Available at: <http://cait.wri.org>

Wu, Jiao, 2007, *Coal Import Hits New High*, China Daily, 19th April 2007, Available at:

http://www.chinadaily.com.cn/china/2007-04/19/content_853963.htm

Xu, Dingming, 2006, *Speech in the Forum of China Renewable Power and New Energy Industry*, 17th June 2006, Available at:

http://news.xinhuanet.com/politics/2006-06/18/content_4712495.htm

Yang, Jianxiang, 2005, *China's Energy: Continuous Struggle with Shortage*, China Features, available at: <http://www.chinese-embassy.org.uk/eng/zt/Features/t214555.htm>

Zhang, Guobao, 2006, *Nuclear Installed Capacity Reach 40GW in 2020*, available at: http://news.xinhuanet.com/politics/2006-06/08/content_4663693.htm

Zhang, Guobao, 2007, *CEC 2007 Yearly Conference on Forecasting Economic Trend and Electricity Market*

Zhang, Kui, 2003, *Zhongguo Nengyuan Touzi Daolan* (translation: A guide for investment in Chinese Energy Sector), China Yanshi Press