

Conference Paper

**Small is beautiful? Small Hydro Power and the paradox of the
Water-Energy Nexus in China**

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Abstract

The small hydropower provides the demands of electricity for about one-third of the counties (about one-fourth population) in China, especially in most rural areas. The Chinese government regards it as a method of poverty alleviation for the rural areas. This paper aims to evaluate the above intrigue question. This paper will argue that the SOE reform and the opening of the electricity market in 2002 have resulted in the SOEs' and private companies' pursuing for short term monetary interests that have created a large extent of ecological damages. Even worse was that the electricity reform has divided the SOEs into power and grid companies and demanded that electricity power has to be hooked up by grid networks region-wide. As a consequence, the purpose of small hydropower station in providing electricity to nearby rural areas for poverty alleviation was totally neglected. The market reform has resulted in not only the devastation of natural environment but also the negligence of poverty alleviation purpose.

Keywords: China, Small Hydropower, Water Governance, electricity

1, Introduction

The rapid economic growth of China in recent decades has generated a dramatic increase of electricity demand. However, it is estimated that as high as 80% of China's electricity is currently generated from coal which inevitably creates an enormous amount of greenhouse gas (GHG) emission. As China has become the largest GHG emission country in the world, the global pressure on China to reduce GHG emission has radically increased (Yu, 2008; Chen, 2009). Indeed, President Hu Jintao promised at the UN convention in 2009 to increase the non-fossil energy resources to as high as 15% in its total energy consumption in the year of 2020. Accordingly, the Chinese central state has been eagerly looking for alternative energy resources that have the potential to reduce GHG emission.

Under this situation, hydropower is naturally the best choice that the Chinese state can have ever selected (Lewis, 2009; Cann, et al., 2005). In fact China is already the largest user of hydropower in the world, 15% of its electricity has been generated from hydropower. Nevertheless, in order to speed up the reduction of GHG emission, China is aiming for developing even more hydro electricity power. The South-West region of China which has 75% of hydropower resources where the Yangtze (金沙), Lancang/Mekong (澜沧) and Nu (怒) and other three rivers run through is naturally the best resourceful area to develop large dams so as to generate hydroelectricity power to supply the national demand.

Indeed, the Chinese state had built large dams in the past two decades because large dams, for example the Three Gorge Dam of the Yangtze River, were able to generate large amounts of electricity to feed the enormous demand created by China's rapidly economic development. However, large dams now create colossal disputes not only in domestic politics but also in the international arena. Especially when the river is transnational, for example the Lancang River flows into Myanmar, Cambodia, Thailand, and Vietnam, building large dams may cut the water flow of the rivers and trigger international disputes (Hensengerth, 2009; Liebman, 2005; Mosert, 2000; Onishi, 2007). Therefore, the Chinese state now is seriously considering building even more small hydropower stations, whose main purpose was designed not only for electricity but also for poverty alleviation in the rural areas, in the provinces where

hydro resources are abundant, to balance the large dam construction.

Small hydropower in China refers to those hydropower stations whose installed capacity is not more than 50MW. There are four grades below the 50MW installed capacity: 0.5–5MW, 5–10MW, 10–25MW, and 25–50MW (Zhou, et al., 2009). Due to its characteristics such as small size, investment and construction flexibilities, clean energy, and easy access to remote rural areas, small hydropower is regarded by the Chinese state has the possibility to perform multiple functions for rural poor areas such as generating electricity, improving living conditions, and protecting natural environment from deterioration, etc. Therefore, small hydropower is not only assigned the responsibility of clean energy to reduce GHG emission, but is also expected to perform the function of poverty alleviation for rural areas (Chen, 2009.). Building more small hydropower stations was thus regarded by local state officials as a political mission which would fulfill the demands from the central state. A craze for small hydropower has thus occurred in China in the first decade of the new millennium. Thousands of new small hydropower stations were built in remote mountain areas and the electricity that they generated had doubled the installed capacity in less than one decade since 2000 (table 1). Nonetheless, the craze for small hydropower has created serious environmental damages due to the competition among firms for demarcating the rivers (跑馬圈水) for building the power stations. Even more surprisingly, many of those small hydropower firms have neither been able to gain profits from selling the electricity, nor have they been able to sell the electricity to the adjacent rural areas. Many private owned small hydropower firms went bankrupt in recent years (Cao, 2008; Zhou, 2010). Why has the state-promoted small hydropower not been able to ‘protect’ the environment and to provide electricity to rural areas? Why has the state policy on small hydropower not been able to perform the functions it had been designed?

We will argue in this paper that the problems of small hydropower have faced is rooted in the paradox of China’s water-energy nexus. The paradox has been generated from the contradictions inherited from two bureaucratic logics in the post-Maoist Chinese authority. The first one was the politics of “fragmented authoritarianism” (Lieberthal and Oksenberg, 1988; Mertha, 2008) in Chinese state bureaucracy, and the second is the local state corporatism (Oi, 1995) at the lower levels, which we will

discuss in the next section. We argue that the institutional arrangements after the electricity reform in 2002 in China have created this paradox. First of all, the market reform of the electricity industry have generated a complex intertwining interest that bounded state-owned electricity enterprises with provincial governments on the one hand, and lower levels of local governments with private-owned small power companies on the other. The first bundle interest aimed at building large dams along major rivers, whereas the second bundle sought to construct smaller dams along branches of major rivers. They together cut China's major rivers in pieces with little comprehensive planning. Secondly, although the Chinese state intends to enhance its small hydropower stations to reduce the GHG emission, the institutional arrangements of the electricity reform had actually reversed the tendency. It is because all types of electricity generated from power stations had to be hooked up with the national or regional grids controlled by SOEs. However, the power grid SOE had little interests in buying unstable electricity generated from small hydropower stations, or bought it in much lower price than the cost, which in consequence have evacuated some of the private companies from the market in recent years. We will use Yunan Province as an exemplar area to investigate the institutional factors inherited in the paradox of water-energy nexus.

Yunnan Province is located in the southwest of the country, bordering Myanmar, Lao and Vietnam. The province has more than 600 rivers, has 24% of the country's hydropower potential, and already provides more than 10% of China's hydropower. There are many large dams already being built along the the Yangtze (Jinsha) and Nu Rivers, and currently there is a huge dispute on the issue of building even more dams along the Nu River (also Mertha, 2008). In addition, the Lancang River is also China's major target for hydropower development. The construction of an eight-dam cascade is already well underway, with four large dams completed and another four dams currently under construction or in the planning process¹. In addition to that, a large amount of small hydropower stations have already been built which were fully supported by lower levels of local governments. It is because the small hydropower project on the one hand is one that can largely perform the function of poverty

¹ The construction of many large dams along the Lancang river however provokes anger from the bordering countries, especially when serious draught occurred in the area in the summer of 2009, the neighboring countries accused China of building too many large dams that have cut the water flow to the downstream countries of Vietnam, Thailand and Cambodia.

alleviation in rural areas; and on the other hand can form public-private alliance to help the development of local economy. Indeed, many of the existing small hydropower station in Yunnan were run by private businessmen from other provinces, such as Sichun and Zhejiang. But as will be discussed later, these small hydropower stations currently have faced serious problems that the state has not foreseen and in consequence have not been able to perform the functions that the state designed.

The paper is organized as follows. The first section is introduction. Then in the second section, we discuss the fragmented authoritarianism and local state corporatism theses; The third section lays out the statistic figures of electricity industry and the hydropower development in China. The fourth section discusses the institutional logics behind the electricity reform in 2002 and how it affects the development of China's electricity market. The fifth section discusses the governance structure of small hydropower and the problems that small hydropower stations have faced under the current institutional frameworks. The sixth is conclusion and discussion.

2, Fragmented authoritarianist vs. local state corporatist theses

The contradictions inherited in the development of small hydropower have been mainly generated from two bureaucratic logics in the post-Maoist Chinese authority. The first one was the “fragmented authoritarianism” state structure and the second is the local state corporatism. The former indicates that the central state's policy is always in a bargaining and malleable condition that leads to diverse types of policy implementation, whereas the latter designates the features in which local states are very active in pursuing for economic development sometimes even disregarding the central state's policy.

The “fragmented authoritarianism” framework first raised by Lieberthal and Oksenberg in 1988 which still remained the most durable heuristic tool to study the Chinese politics. This thesis asserts that Chinese authority is fragmented, ‘the structure of authority requires that any major project or policy initiative gains the active cooperation of many bureaucratic units that are themselves nested in distinct chains of authority.’ (Lieberthal and Oksenberg, 1988: 22). Therefore, the decision making process has to go through bargaining and consensus building among various agencies and spatial regions. The decision making and process thus was protracted,

disjointed, and incremental. As a result, due to the incorporation of parochial organizational and political goals of various agencies and spatial regions charged with enforcing that policy, policy made at the center becomes increasingly malleable and shaped by those bureaucratic units. Thus the decision making process in China was both fragmented and authoritarian.

The “fragmented authoritarianism” framework was first published in 1988 and since then Chinese politics has changed dramatically. On the one hand, due to long term economic development, the rise of the middle class has nurtured the emergence of a civil society in China that sustained many active civil organizations to engage in civil actions. On the other hand, the State also becomes much more adaptive to the new situations by learning the lessons from the collapse of East European communist regimes (Shambaugh, 2009) in order to prevent itself from the downfall. Indeed, Mertha’s study on major dams projects and constructions in China has found that the Chinese State is now much tolerant to the rising civil protests and adaptive to these protests by changing its policy. Mertha argues that the fragmented authoritarianism framework still could partially explain the current decision making in Chinese politics with minor revision. Mertha (2008) found that the fragmented features of Chinese bureaucracy was still prevailed, however, the authoritarian characteristic has been diluted. He uses the term “fragmented authoritarianism 2.0” to indicate the change of Chinese authority (Mertha, 2009).

Following the fragmented authoritarianism framework, our case will show that the electricity power reform in 2002 has led the state-owned power companies, under the State Investment and Production Management Commission since 2003, to pursue for their own interests that disregarded the state’s aims to alleviate rural poverty. Although the poverty alleviation policy, in which the building of small hydropower was a part, which was administrated by the Ministry of Water Resources, it had contradictory with the interest of the powerful state-owned electricity power and grid companies. This led to the deterioration of financial situation for the private owned small hydropower companies at the local level.

Local state corporatism is the concept depicting the active economic role of local state to pursue for economic growth (Oi, 1995). This phenomenon has been very salient in China’s economic development in which local state bureaucrats were assigned the mission to develop the local economies and evaluated accordingly for

promotion. As a result, each level of state bureaucracy has its own goals, and those at the lower levels are subject to the directives of the higher levels. As our case will show, local states tended to collaborate with private company to develop small hydropower station that may fulfill both the state's policy demand and the mission of local economic development. Nonetheless, the suppression of electricity price by state owned grid company deteriorated the financial situation of private small hydropower. This might create problems for local state's alliance with private capital. The local states thus tended to use other policy measurements to compensate for those private owned small hydropower, for example, real estate development.

This kind of public and private collaboration thus has elements that are beyond the local state corporatism thesis has depicted, in which the major constituting actor were state actors at various levels. As Oi (1995) describes, China's local development is distinguished by its reliance on existing bureaucratic networks, "somewhat akin to a large multi-level corporation, the county can be seen as being at the top of a corporate hierarchy as the corporate headquarters. The township as the regional headquarters. And the villages as companies within the larger corporation. Each level is an approximate equivalent to what is termed a "profit centre" in decentralized management scheme used in business firms. Each successive level of government is fiscally independent and is thus expected to maximize its economic performance" (P. 1138). Our finding showed that the local corporatist structure now has not only limited at the state bureaucracy but has now reached out to the private sector.

The above two principles indeed determined the route of the development of the small hydropower from flourishing to crumbling. Also, due to the competition of power development, both principles of the state together created disastrous effects on environment, which we will discuss below.

3, Hydropower in China

Although the Chinese government has faced serious accusations on its massive GHG emission and responded by announcing cutting down the supply of the coal generated electricity, the proportion of hydroelectricity power has not increased much in the last two decades. In 2010, the hydraulic and coal generated power composed of 17.17% and 79.2% respectively; compared to those of 1990, hydraulic and coal consisted of 20.4% and 79.6% respectively (table 1). Hydraulic power in fact has decreased more than 3 % in less than two decades. The Chinese government's policy

in fact has not been realized.

On the other hand, small hydropower has been regarded as one of the main construction projects that was supported by the central state to alleviate poverty condition in rural China. Thus from 1949 on, China has built over 45,000 small hydropower stations, covering over half of the counties or cities in the whole country. The designed capacity has increased from 3,634 (kW) in 1949 to 55,121,211 (kW) in 2009. The actual realized capacity also increased from 523 (10⁴kWh) in 1949 to 15,672,470 (10⁴kWh) in 2009². The rapid increase of small hydropower has supplied over 300 million rural people's demand on electricity and covering 99% of rural areas in 2009. Nonetheless, although the installation capacity of small hydropower in 2009 has been increased four times of the 1990, it constantly consisted of around 30% of the whole hydropower in the electricity industry (table 2). Therefore, the large hydropower stations and dam construction are still the main components that sustain the growth of China's hydropower.

Table 1: Energy sources of China

(unit: MW)

	Total		Hydropower		Coal		Nuclear		Wind		others	
	Value	%	Value	%	Value	%	Value	%	Value	%	Value	%
1980	3006.3	100.00%	582.1	19.36%	2424.2	80.64%	0	0.00%	0	0.00%	0	0.00%
1985	4106.9	100.00%	923.7	22.49%	3183.2	77.51%	0	0.00%	0	0.00%	0	0.00%
1990	6212.0	100.00%	1267.2	20.40%	4944.8	79.60%	0	0.00%	0	0.00%	0	0.00%
1995	10077.3	100.00%	1905.8	18.91%	8043.2	79.82%	128.3	1.27%	0	0.00%	0	0.00%
2000	13556.0	100.00%	2224.1	16.41%	11141.9	82.19%	167.4	1.23%	n.a.	n.a.	22.6	0.17%
2005	25002.6	100.00%	3970.2	15.88%	20473.4	81.89%	530.9	2.12%	n.a.	n.a.	28.1	0.11%
2006	28657.3	100.00%	4357.9	15.21%	23696.0	82.69%	548.4	1.91%	n.a.	n.a.	55.0	0.19%
2007	32815.5	100.00%	4852.6	14.79%	27229.3	82.98%	621.3	1.89%	n.a.	n.a.	112.3	0.34%
2008	34668.8	100.00%	5851.9	16.88%	27900.8	80.48%	683.9	1.97%	n.a.	n.a.	232.2	0.67%
2009	37146.5	100.00%	6156.4	16.57%	29827.8	80.30%	701.3	1.89%	n.a.	n.a.	461.0	1.24%
2010	42071.6	100.00%	7221.7	17.17%	33319.3	79.20%	738.8	1.75%	446.2	1.06%	345.6	0.82%

Source: Statistics of China's Energy, 2011.

² Because of the factors from the supply of water due to rainy or dry seasons, demands of electricity market, and price policies, the actual delivery of small hydropower is less than 30% of the designed level, sometimes even is as low as 50% (Zhou, et al., 2009:1079).

Table 2: Development of small hydropower

Year	1949	1978	1990	2000	2009
Designed Capacity (kW)	3,634	5,266,500	13,180,300	24,851,721	55,121,211
Realized capacity (100kW)	523	997,300	3,928,300	7,998,249	15,672,470
% SHP in hydropower	N.A.	22	31	33	30

Source: China Water Statistical Yearbook 2010.

The pattern of the growth of hydropower industry in China has to be traced back to its institutional logics of market reform in the electricity sector. In a nutshell, there are three major elements in the market reform that have largely determined the patterns of hydropower development.

The first element is the principle of separating business from governmental functions (政企分離) so as to let SOEs to run like a business that follows basically the market principle. Thus, in the process of the reform of the electricity sector, many SOEs were separated from the Ministry of Electricity to become independent companies. Although they still were SOEs that have to perform functions that the central state assigned for fulfilling public interests, they nonetheless tended to go public and listed in either Shanghai ,Hong Kong, or even New York stock markets. Therefore, these big SOEs have both market monopoly status and powers in the domestic electricity market. As we will see, they have become the dominant players in the Chinese electricity market that the small hydropower are to be subdued.

Secondly, due to the decentralized nature of the Chinese market reform, local states have the incentive to pursue for economic development. Especially after the 1993 tax reform, local officials have the motivation to pursue for extra-budgetary revenue and economic investments as to seek for upgrading their own political carrier as well as enhancing their own economic interests (Oi, 1995). In the electricity sector, those localities that have resourceful rivers whose officials thus have the incentives to collaborate with either big SOEs or smaller hydropower companies to ‘develop’ the

potentiality of hydropower of the rivers. This collaboration included not only at the provincial level where provincial governments worked closely with big SOEs to build big dams along big rivers; but also occurred at the lower levels of government in cities or counties where local officials cooperate with smaller private firms to develop small hydropower along the branches of those rivers. In these years, the close alliance between local governments and hydropower companies has created a phenomenon called 'demarcating the river' (跑馬圈水), indicating the rivers have been cut into pieces by different parties for building large and smaller dams as well as hydropower stations. Many of those constructions were not pre-planned or received approval from the above-level of governments which thus have created a phenomenon in which the development of hydropower of the rivers has no comprehensive planning. As a result, the hydropower stations in the upper, middle and lower streams of the rivers may belong to different companies that have conflict of interest in utilizing the rivers for generating electricity power, not to mention the fulfillment of the irrigation obligation or other state-designated missions (Zhou, 2010: 163)。

Thirdly, due to the power asymmetry between big SOEs and smaller private-owned hydropower companies in the electricity sector, the latter has to depend upon the former for residual interests. In the process of market reform, the big SOEs have occupied most of the main sections of the major rivers, the remaining smaller branches of the rivers were left to those small private companies to develop. Moreover, as will be discussed later, because all generated electricity power has to be hooked up with the state-owned grid company, those small hydropower companies have relative weak bargaining position against the big state-owned grid company in terms of determining electricity price, they therefore have been hijacked by the grid SOEs or even forced to be acquired by the grid companies.

In sum, the market reform has created an electricity regime in China in which the big SOEs have become dominant monsters in the domestic market. They not only collaborated with local governments in building big dams and developing hydropower of the major rivers, but also dominated the market and determined the electricity prices. The small private owned hydropower companies emerged due to the market reform, however, they are the weakest part of the electricity industry. Although the state designated some very important missions to the hydropower stations, they

nonetheless did not have the capability to fulfill the obligations which we will discuss later.

4, Market reform of the electricity industry

In the pre-reform era, the electricity industry was totally managed and controlled by the state sector. The economic reform started from 1978 has also greatly transformed the electricity industry. Before the 2002 electricity reform, there were few important strategies that the state had adopted to reform the industry, including the separation of SOEs from the Ministry of Electricity through which the management function was retained by the state while the business operation was handed over to the newly established the State Power Corporation in 1997. As a result, the State Power Corporation owned 46% of the country's electricity generation assets and 90% of the electricity supply assets (Xu and Chen, 2006). At the same time, the Chinese government began to allow foreign and private-owned companies to invest into the electricity sector in order to meet the rapidly increase of electricity demand generated from rapid economic growth (Liu, 2006). In this period, there were various types of power grid in the whole country, including regional and rural grids which were controlled and managed by provincial governments and lower levels of local state (Zhou, 2010; Liu, 2006). However, the state had invested very few budget to maintain the existing power grid, especially into remote rural areas, the rural areas were terribly equipped with electricity capacity.

From the year of 2002, China has begun another stage of market reform in the electricity sector. The Chinese government in this period also intended to use the reform to respond to the international pressure of reducing GHG emission. The basic principles of this reform included: (1) In the electricity power sector, the state would give more policy incentives to promote hydropower, nuclear power than fossil power; (2) The state separated the grid sector from the power operating industry and established regional competition market in the later sector; (3) the state has invested even more budgets to the construction of national grid system in order to support the policy of inter-regional electricity market such as 'sending electricity of the west to the eastern coastal areas (西電東送)'. (4) The state also established a new governing body, the State Power Regulatory Commission on December 30, 2002, to supervise market competition and issue licenses to operators in the power industry. (5) All the

power operators have to hook up with the national and regional grids and the sold prices of electricity are determined by market competition mechanism (Zhou, 2010; Liu, 2006). The principles of “the division of operator and grid; price competition for connecting with the grid” and “forced hookup” in the electricity reform have largely determined the fate of small hydropower after 2002.

On December 29, 2002, the Chinese government dismantled the State Power Corporation and set up few new companies so as to end the corporation's monopoly of the power industry. The new companies include two power grid operators, namely the State Power Grid (covering mainly northern, northeastern, northwestern, eastern, and central China areas) and China South Power Grid (covering Yunnan, Guizhou, Guangxi, Guangdong areas)³; five state-owned electricity operators such as Huaneng, Datang, Guodian, Huadian, and Electricity Investment Corporations. Each of the five electricity generation companies own less than 20% of China's market. They would compete with each other for signing contracts with the power grid operators. At the same time, four consultant and construction companies were also split from State Power to make them more efficient. In addition, a ministerial-level industry watchdog, China Electricity Regulatory Commission, was founded (Yang, 2009).

The governance structure of the new electricity regime has been changed to the following system since 2003 (fig 1). The National Development and Reform Committee is responsible for determining the policy, reviewing investments and setting electricity prices; The State Investment and Production Management Commission is responsible for managing the national assets of those SOEs. The hydropower development along major rivers were undertaken by these big power generating SOEs in alliance with respective provincial governments⁴. In addition,

³ Accordingly, the existing regional and rural agricultural grids were incorporated into the two newly established national grid systems.

⁴ The close alliance between big power generating SOEs and provincial governments has been the major factor that facilitated the construction of large dams and big hydropower stations. For example, Huaneng Corp. established a new branch in Yunnan province, called ‘Yunan Huaneng Lancang Hydropower Development Corp.’, in corporation with Yunan Province’s major SOEs, called Hongta Tobacco Holding, to develop dams and run big hydropower stations along the rivers of Lancang and Jinsha. Huaneng Corp. hold 56% of the share of the new company, whereas Yunnan Province Development Corp. hold 31.4%, and the rest 12.6% was held by Hongta Holding.

different from the above features that mainly deal with big hydropower projects and big SOEs, the Ministry of Water Resources is responsible for the development of small hydropower; whereas the administrative works of investments of hydropower stations were allocated to different levels of local governments (Zhou, 2010 ; Liu, 2006) .

Similar to the power generating SOEs, the power grid companies have also been expanding their market territories in the designated areas. They not only have gradually acquired the existing regional grids, building high voltage transmission networks across provinces to construction national grid system, but also had the institutional capability to determine whether or not to buy the electricity that power operators had generated. They enjoyed the monopoly position in the market in which the small private-owned hydropower stations had no other choice but to subdue to their rules, which we will discuss later.

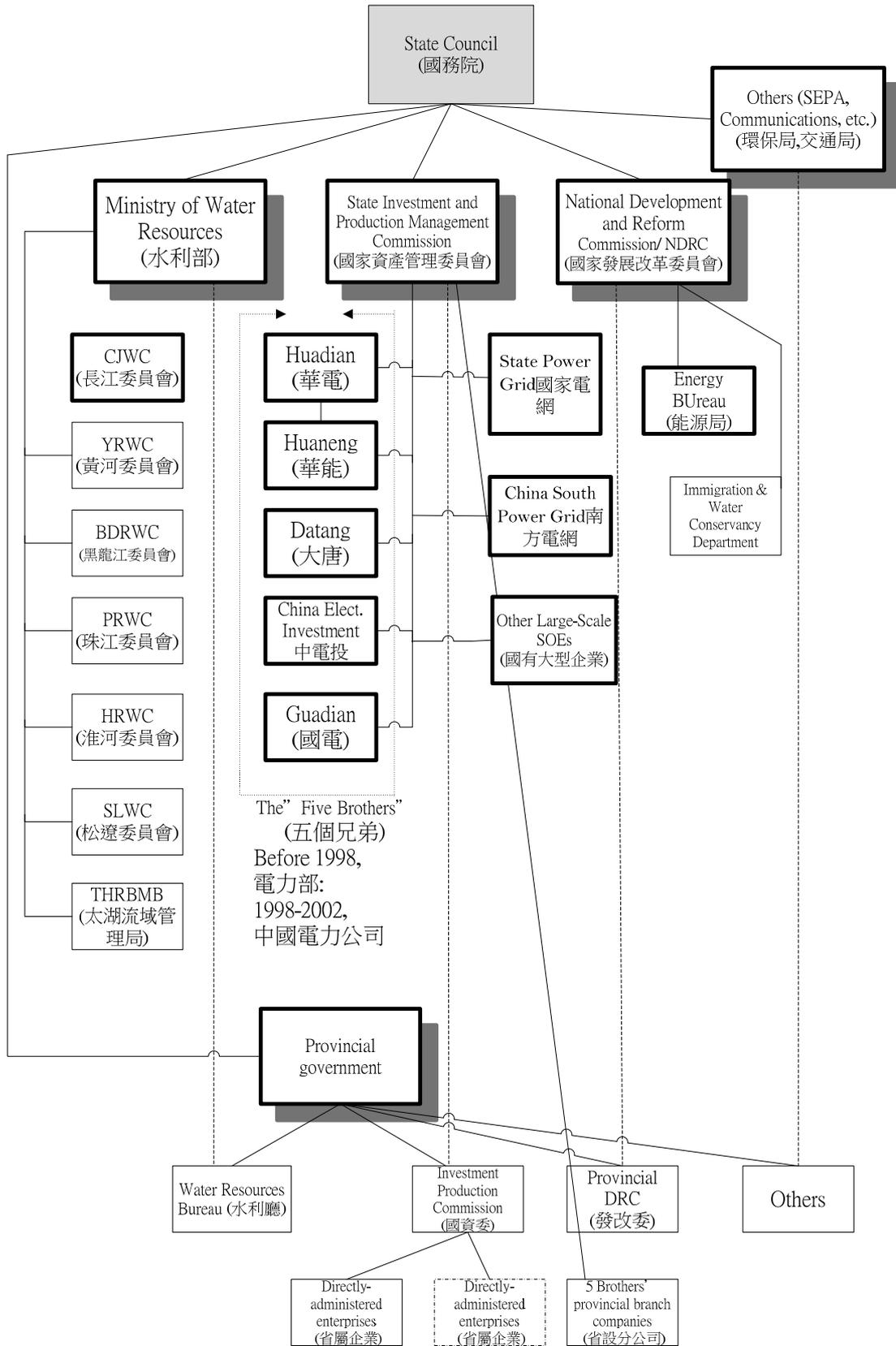


Figure 1: the governance structure of China's electricity industry

5, The governance structure of small hydropower

Different from big power generating and grid SOEs that were managed and controlled by the central state and they tended to collaborate with provincial governments, small hydropower station' application procedures were directly coordinated at the local state levels. Although the Ministry of Water Resources is still nominally the highest administrative agency in the central state, its function is mainly on policy making rather than for those detailed administrative works. The application of a small hydropower starts from a private company's investigation of the possibility to develop a power station along a river. The company then has to prepare all the necessary documents and applies to the bureau of water resources at the local level. The review and approval were done by the local level's and provincial level's Development and Reform Commission (fig. 2). The capability of the small hydropower will determine what level of local government has the final say. For example, the city level can only approve the capability up to 25 thousand KW, above this level to 50 thousand KW has to be approved by the provincial level. Although the official requirements of the approval procedure demand that the application of a small hydropower have to have the environmental impact assessment report, many have started the construction without even having done this assessment. Some argue that it was due to the local officials' arbitrations (based on self interest) that have led to the chaotic situation of small hydropower in China.

In addition, all small hydropower stations have to be connected to the national grids. The prices of the electricity which a small hydropower generates is determined by each province or local government's Bureau of Commodity Price and which also has to be approved by the local government's financial department.

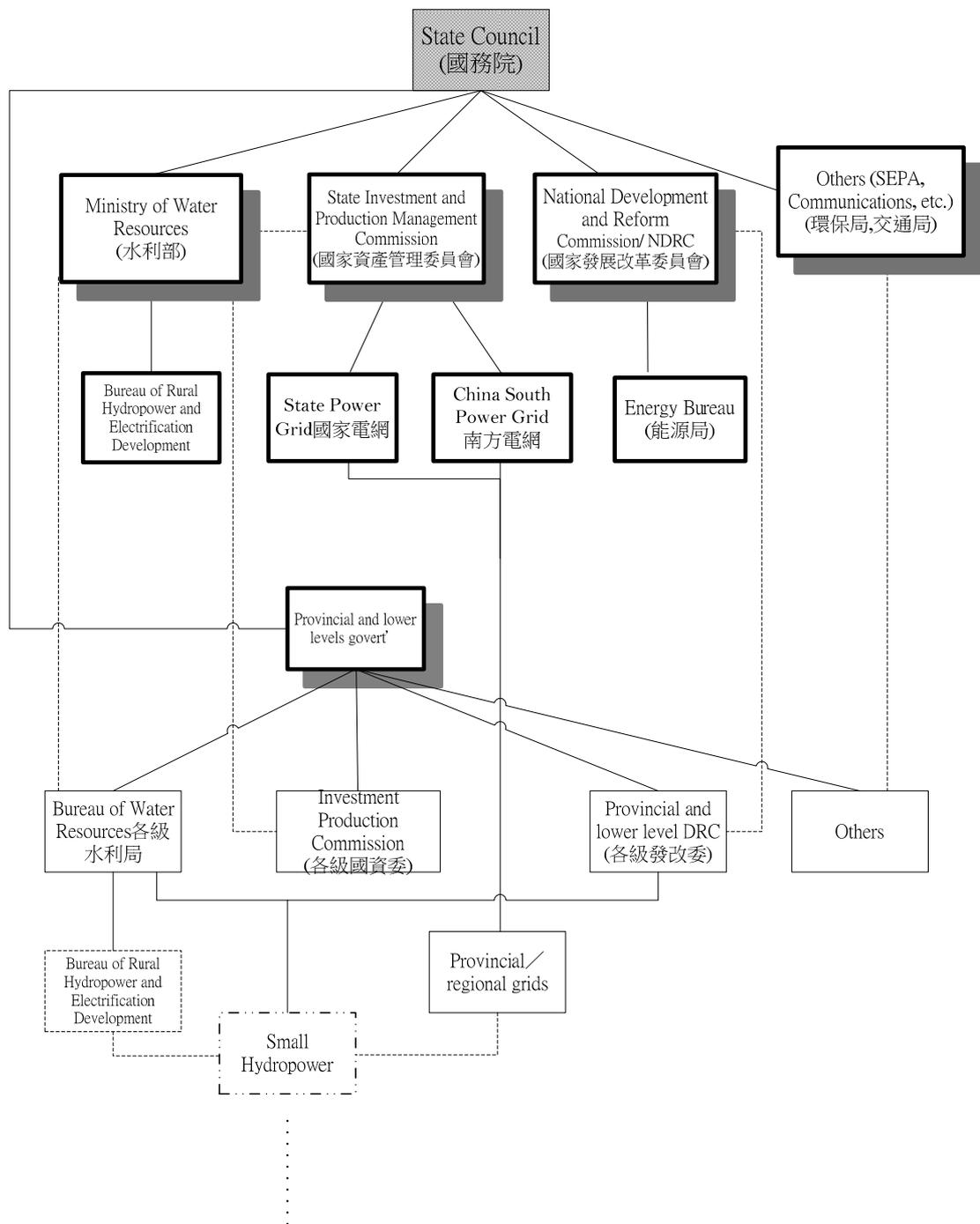


Figure 2: the governance structure of small hydropower

The marketization of power generation has led to the booming of private investment into the small hydropower sector, especially during the years between 2003 and 2006 when there was a power shortage nationwide and the new policy was just in its initial stage. There are four types of private capital in this sector: individual

owned, joint stocks, private capital allied with SOEs, as well as rent & run the existing local state owned hydropower. All these investments have brought about market competition, and have brought some measures of fiscal incomes to local governments. This market reform was especially beneficial for those local governments that had no financial resources to repair and maintain the existing hydropower stations. Some of the local governments also offered financial incentives to attract private investment into this sector, for example, local tax rebate for five years⁵.

There are two forms of power connection by small hydropower with the national grid system. The first form is that the small hydropower is directly linked with the national grid to serve regional needs. The other is to connect with national grid but serving mainly isolated local rural areas. However, the tendency has been that the national power grid company has gradually acquired and merged regional and local grids that in the long run will acquire those still isolated local rural grids into a national one (Cao, 2008; Wang and Chen, 2008). In the case of Yunnan province, it is the South Power Grid that has the dominant position in the market (who decide whether or not a small hydropower can be connected into the national grid or not), whereas the small hydropower has to cooperate with it in order to survive in the market.

The new governance structure since 2002 has created some structural weaknesses that the small hydropower has been suffering from (Chen, 2006; Wang and Chen, 2008). These problems mainly derived from the institutional arrangements in which the monopolized power grid SOE has the dominant position in the market and who still has strong incentive of market profit; whereas the small hydropower is not only weak in facing the big SOEs, but also is it private owned and still has to perform the functions of public interests for the rural areas. As such, the contradictions show in the following features:

5.1 National grid vs small private hydropower

⁵ The value-added tax was 17% in a city where the authors had visited in Yunnan. In this 17%, 75% went to the central state and the rest 25% was local tax. The local state would return this 25% to the investor for five years.

One of the main reasons that the national grid does not like to buy the electricity power generated from small hydropower is its instability nature. One of our interviewee called it as garbage electricity⁶. It is because the small hydropower has been constrained by the water flow of the river. In the rainy season, it can generate more power as similar to the big dams; nonetheless, the electricity of the latter already is enough for the grid to supply the market demand. As a result, the electricity that small hydropower station has generated has to be sold in a much lower price or be given up. On the other hand, in the dry season, the flow of the river is not abundant enough to be used for the power generator, therefore the small hydropower station is not able to supply electricity power to the grid. In addition, the quality of the electricity is low and the operation cannot be optimized under the electricity load curve, therefore, the grid company lacks interest in small hydropower and even takes some measures to prevent it from entering the grid. (Zhou, et al., 2009: 1079).

In general, the grid company, based on its own interest, is much interested in linking electricity power generated from stable and abundant sources such as from big dams and from coal power plants, and thus is very supportive to build big dams along major rivers in Yunnan⁷. In some cases, due to the forced hookup policy, some remote rural areas are still not able to enjoy the electricity generated from adjacent small hydropower plants (Cao, 2008: 92). The marketization of the electricity industry has created the paradoxical problem in which the adjacent small hydro power plant is isolated from the needed community. It had not had happened before even in the socialist era when the local small hydropower was designed to supply local needs.

5.2 Multi-purpose vs profit making of the small hydropower

As described above, small hydropower is regarded by the Chinese state as one that can perform multiple functions to benefit poor rural areas, such as poverty alleviation, improving living conditions, and protecting natural environment, etc. Nonetheless, the purpose of private investment from small hydropower owner is

⁶ Interview data, engineer of South Grid Corp. 7/11/2011.

⁷ Ibid; also, Interview data, engineer in Bureau of Water Resources, Puer city, 7/10/2012

simply for monetary profit. Which therefore creates some contradictions, especially in the situation in which the price of electricity cannot be too high to harm economic development of rural areas and against the poverty alleviation policy. The average annual profit rate of small hydropower currently is about 8-10%, however it was much higher in the late 1990s and early 2000s, which was estimated reaching as high as 20% (Zhou, 2010). It was due to the fact that the government then was not so serious about the environmental impact, neither did it had formal procedures in the application of small hydropower construction. As long as the applicant found the water resource, the firm could then draw the construction plan and received approval in a very short period of time. But after 2006, the central state announced a new measurement 'Notification Regarding Orderly Develop Small Hydropower in order to protect Ecological Environment', all the necessary procedures were set up in the application, including environmental impact assessment. From then on, the state began to check those 'four no' small hydropower stations - no registration, no construction plan, no acceptance certification, and no management- and forced most of them to close down. From then on, a series problems began to emerge, particularly about the issue of profit margins.

The shrinking of profit margins of the small hydropower, however, was mainly due to the low purchasing price from the power grid company. According to a report (Cao, 2008: 43-44), there were as high as 12 provinces in which the cost of power generation was higher than that sold to the Grid company, which thus led to the deficit of the companies in these areas. For example, in Guizhou province, the Grid paid the small hydropower only 0.15 dollar each KW/hour, sometimes it was even lower to 0.12 dollar each KW/hour; in contrast, the grid sold the electricity price for rural enterprises at 0.318 dollar each KW/hour, thus the grid company earned a large amount of profit margins from this transaction. Sometimes those state-run coal power plant could even receive better price than could those small hydropower plants, which was contradictory with the national climate change policy. One hydropower developer says, 'hydropower has seven advantages, including the raw material (no need to worry about the sources and prepare money to buy it), the market, the transportation, the quality, the inventory and the state's support. However, these seven advantages are less important than one disadvantage; that is, it is a highly monopolized industry that in practice is manipulated by the state at lower price. Whether or not to raise the price

is not what we can say' (Guan, 2012). In fact, our field trip in Yunnan has approved this observation, the developers are now complaining the lower purchasing price by the power grid company which may lead them to go deficit. Some firms are even expecting to use the CDM mechanism to compensate their currently very lower profit margins⁸.

Another reason that the small hydropower has been suffering from deficit is its multiple purpose which the state has designated to it. The main motivation that the owner of small hydropower steps into this industry is to make money, however the state wants it to do as many as possible missions for public interest at the same time, such as flood prevention, irrigation, and water supply. The multiple functions of public interest has created pressure for the hydropower especially in recent years when the profit margins have been shrinking. This occurs particularly in the rural areas where the sold electricity price is already very low and the hydropower station does not have the financial capability to sustain itself, no to say to serve the public interests (Zhou, 2010: 164).

5.3 Local state corporatism and private sector

One of the puzzles that we do in our field study in Yunnan about small hydropower is why so many private companies are still interested in investing into this sector, given the fact that many have suffered from financial deficit? We found in our field trips and from our interviews that local governments would compensate those companies by other administrative methods, such as real estate development projects whose profits are much larger than the small hydropower in order to maintain the alliance.

In our field trip in Yunnan, we found that many of the small hydropower stations were built by businessmen from Zhejiang, Fujian, or Sichuan. These businessmen from other provinces came to Yunnan province for business opportunities. Because of their limited capital, they tended to invest into sectors that did not have higher

⁸ Interview data, owner of a small hydropower plant, 07/08/2012, Puer City, Yunnan. Also, CDM (The Clean Development Mechanism) is a type of flexibility mechanisms that provides trading schemes for emissions reduction projects that generate Certified Emission Reduction (CERS) units. The CDM allows industrialized countries to buy CERS and to invest in emission reductions where it is cheapest globally. Of course, China is one of the largest countries that benefit from CDM mechanism.

financial barrier, for example, groceries, small shops, and real estate sectors. Those businessmen came from the same province would attend the Provincial Business Association, such as Sichuan Business Association in Yunnan, to make friends and collect information. The local government also would assign a retired official as the party secretary to do the organizational works for the association as well as to serve as the liaison for the local government and business association.

The business association we visited most of the time serves the social gathering function, but it also is the place for business networking. When there is a development project, the association becomes the place to collect interested partners. The party secretary then would be the person to communicate with local officials about the project and other related bureaucratic procedures, including tax. Although not all projects about small hydropower were discussed in the association, the owners were involved in the association and engaged in many real estate projects. According to our interviews, the owners of the small hydropower usually have more than one stations. The profit margins of the hydropower has been indeed shrinking over the years. However, they still continued to invest more stations due to the fact that one the one hand there still have some amount of profits and the stations can run for a long period of time; on the other hand, they helped the local officials to fulfill the required jobs given from upper levels of government, which later will have other returns from the local officials⁹. This may explain the paradox of deficit-investment phenomenon in the small hydropower sector.

5.4 Environmental problems

Small hydropower is regarded by the Chinese state as a clean energy that can partially replace large dams and coal generating power. However in reality the picture is not as good as the government has drawn. The unruly construction of small hydro power has created very serious environmental disaster for many areas. The small hydropower can cut a river into pieces where fishes are not able to survive in the dry segments of the river. Those fishes that remain in the river flow still cannot survive from the wheeling of high speed turbines. Together, the small hydropower may dry up

⁹ Interview data, owner of a small hydropower station, 07/07/2012, Puer City, Yunnan. The returns may have different types, one of them may be the project of real estate development which has much larger monetary profits.

some parts of the river and kill the river's fishes (Zhou, 2010: 166) . According to a recent news report, there are over 90 small hydropower stations, and another 12 are still waiting to be approved in Shennongjia 神農架 forests' four major rivers in Hubei province,. Because of these constructions, many segments of the rivers have dried up. This also occurs in Sichuan and Yunnan provinces where river resources are abundant. Small hydropower has become the killer, not the savor, of the environment. One of a major newspaper focusing on energy issue, the "China's Energy Daily" 《中國能源報》 even uses the title 'Dame the Hydropower' (『萬惡』的小水電?) to describe the environmental damages that small hydropower has created.

In the 1980s, the Chinese government has implemented a series of policy to promote small hydropower in the rural areas, including 'self construction, self-management, and self-use', 'small hydropower should have its own grid and supply base', 'self support system', '6% of value-added tax', etc. These policy measurements have been given up in the process of market reform, through which local government regards pursuing for economic development as its own legitimacy, and SOE also seeks to maximize its economic profits disregarding its public responsibilities. As a result, SOEs become the monopolize market power that ally with local governments to develop large dams and to lead to environmental damages. Many lower level governments also allied with small hydropower companies to develop the electricity power potentiality of small branches of the rivers. As a consequence, the booming of the small hydropower has brought with it a series of environmental damages and dried rivers.

5, Conclusion and Discussion

This paper discuss how the Chinese government wants to use the hydropower sector to reduce it GHG emission and results in the booming of small hydropower after late 1990s. Nevertheless, our paper shows that the market reform of the electricity industry in 2002 has created a paradox that led to the mission become impossible. On the one hand, the market reform has ushered major electricity power related SOEs to pursue for profit maximization which in consequence squeezed the profit margins of small hydropower company. On the other hand, the Chinese state's

assignment of the missions to small hydropower has disregarded the real motivation which private company really has is to make profits. The squeeze of profits by big power grid SOE, plus the multi-functional purposes vs profit making policy design, has led the small hydropower to become a sunset industry in the current Chinese hydropower industry. Most of our interviewees have not regarded the future of small hydropower highly¹⁰.

Theoretically, we explain the energy-water paradox by both fragmented authoritarianism framework and local state corporatism. The electricity market reform in 2002 has created the situation in which state-owned power and grid companies are pursuing for their own interests, which undermines the national goal of poverty alleviation by promoting small hydropower stations. In addition, local state has strong incentive to promote small hydropower to fulfill the jobs of economic development and poverty alleviation for the rural areas. Although the profit margins of small hydropower have been shrinking, local state officials were able to attract new investment due to their administrative maneuver that can compensate for private companies.

We regard that the Chinese government's promotion of small hydropower is still a positive act in its climate change policy. What the Chinese government has not yet recognized or hard to deal with is the fact that its marketization of the electricity industry has merely resulted in its policy goal on small hydropower being doomed to failure. As a clean energy, the small hydropower should be put into the framework of clean energy, by using tax incentive to promote its growth, and should not let it to be dominated by the big SOEs. As a policy tool to support rural development and alleviate poverty, the state needs to subsidize the small hydropower, to let them receive some adequate level of profit in order to survive from the teeth of the SOEs. Finally, regarding the environmental damages that small hydropower stations have created, the Chinese government has to have a more coherent bureaucracy to coordinate the development of hydropower. At the current stage, the application and approval of small hydropower belongs to the local development and reform commission. Although the bureau of environmental protect is responsible for the

¹⁰ Interview data: Officials of Bureau of Water Resources, Development and Reform Commission in Puer city government, 7/09/2012; Engineers, Institute of Detection and Design of Water Resources and Hydropower, Puer City, Yunnan, 7/10/2012.

review of environmental impact, the final say is always based on economic interest. This creates less coherent view on environmental impact. China needs to have a more coherent bureaucratic procedures to review the applications of small hydropower and pays more attentions to the functions that small hydropower can perform to save rural economy from bankruptcy.

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