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Between Fragmentation and Harmony

The Political Economy of Shale Gas in China

Emil Gjeset

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Abstract

The aim of this paper is to explore the evolution of government priorities, strategies and policies towards the Chinese shale gas industry in the context of general theories on policy making in China's energy sector. The report begins with a review of the body of theory related to policy processes in the Chinese energy sector, which describes China's energy sector as consisting of a fragmented set of institutions, where changes are incremental and policy making is disjointed. Flowing from this body of work, the paper draws on Chinese official documents and interviews with industry insiders to expose an inconsistency between the official strategy for development, market structure and entrenched interests in maintaining the current system. It argues that the increasing urgency of limiting coal consumption while expanding domestic natural gas production has created political impetus behind utilizing shale gas resources. Moreover, a consensus has emerged among the most important regulatory institutions in favor of a development strategy assimilating the US experience, consisting of direct government support through subsidies and R&D programs, and market deregulation and restructuring in favor of private and foreign access. However, there is a long way to go before this initiative can become reality. First of all, due to material constraints, including complex geological characteristics and water scarcity, shale gas extraction on the Chinese continental shelf has been more technologically intensive, time consuming and expensive than the case in other more favorable areas. Second, the chosen strategy faces many institutional constraints, including a heavily regulated pricing structure, a monopolized natural gas industry, lacking environmental regulation and a failure to incentivize foreign cooperation. The report concludes that despite coordination of priorities and strategy among energy regulators, they have so far been unable to overcome these institutional constraints, in part due to the strong dominance of the Chinese national oil and gas companies and their entrenched interest in the status quo. Hence, this study argues that the emerging shale gas industry generally supports the assumption that Chinese energy politics are fragmented, but that the most important disjunct exists between the regulators and the NOCs, rather than within the bureaucracy in charge of managing shale gas.

Key Words

Shale gas, energy politics, Chinese NOCs

Preface

This report is based on my Master's thesis in International Relations from Peking University, Autumn 2013. I would like to express my deepest gratitude to my supervisor, Professor Zha Daojiong. Without his expert guidance this report would not have been possible. I also wish to thank those that participated as interviewees, and provided much of the information that the report's conclusions are based on. The work on this thesis also benefited substantially from the support of FNI. Despite the support of these individuals and institutions, any error in this report is my own.

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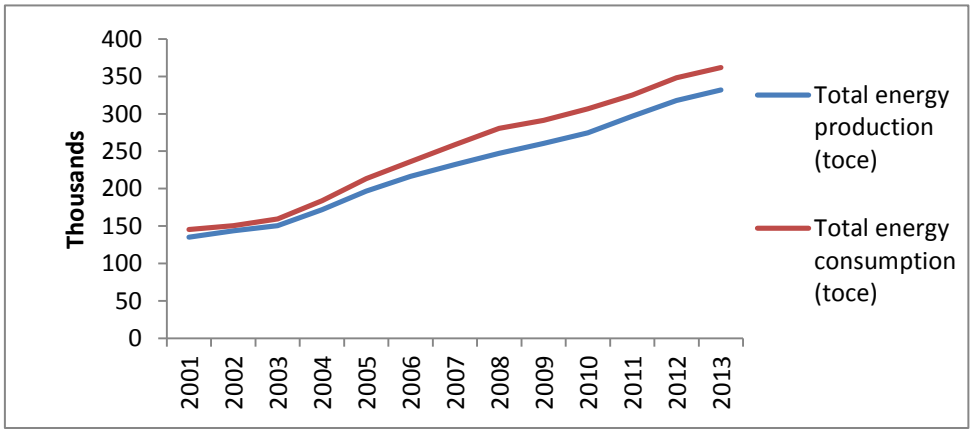
1 Introduction

The world's energy system is going through a gravitational reorientation, where energy demand is shifting towards Asia, a process in which China is the undisputed nexus. Riding a wave of economic growth, China has emerged as both the world's largest producer and consumer of energy,[1] and between now and 2035 the country is predicted to account for about half of the global growth in liquids and 25 percent of growth in natural gas while maintaining its position as the world's largest consumer of coal.[2] Energy production has not increased at a pace capable of matching growth in consumption. China has been compelled to enter global energy markets and as a result energy imports have rapidly expanded since the turn of the millennium (see table 1.1). At the same time, the composition of China's energy mix has had disastrous environmental implications. The relative abundance of coal reserves has supported a long-term predominance of coal in China's energy mix – 69 percent in 2013, currently amounting to more than half of the world's total consumption.[3] While coal has been the cornerstone of energy production and provided China with a domestic source of energy, extraction and combustion of coal has had dramatic environmental and economic consequences, especially in terms carbon emissions and air pollution.[4]

Table 1.1: Total energy consumption and production (2001-2012)

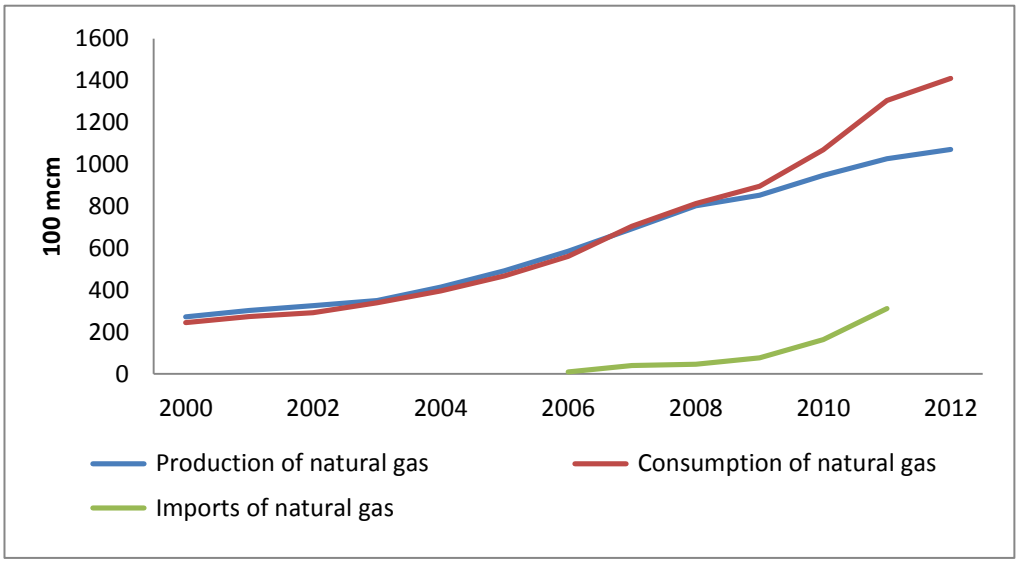


Source: Compiled by the author using data from the National Bureau of Statistics, Statistical Yearbook, 2013, http://data.stats.gov.cn/.

[1] EIA, *China: Country Analysis* (EIA, February 4, 2014), http://www.eia.gov/countries/cab.cfm?fips=CH.
[2] BP, *BP Energy Outlook 2030* (London, January 2013), 43,49,57.
[3] BP, *BP Statistical Review of World Energy* (London, June 2013), 4, http://www.bp.com/content/dam/bp/pdf/statistical-review/statistical_review_of_world_energy_2013.pdf; EIA, *China: Country Analysis*.
[4] Wenying Chen and Ruina Xu, "Clean Coal Technology Development in China," *Energy Policy*, Greater China Energy: Special Section with regular papers, 38, no. 5 (May 2010): 2123–30, doi:10.1016/j.enpol.2009.06.003.

One of the many strategies for curbing air pollution and reducing carbon emissions has been to increase the proportion of natural gas in the energy mix. However, natural gas is a conundrum for energy policy makers. In general, natural gas is considered a cleaner alternative to coal combustion, and accordingly it has become one of the key components of China's energy strategy, with consumption almost increasing by a factor of seven since the turn of the millennium. Nevertheless, as shown in Table 1.2, owing to low conventional reserves and insufficient domestic production, China's demand for natural gas has exceeded its production-capacity. Consequentially China has become more and more reliant on imports, elevating concerns about securing sufficient and steady supplies of natural gas.

Table 1.2: Total natural gas consumption, production and imports (2000-2012)



Source: National Bureau of Statistics, Statistical Yearbook, 2013, http://data.stats-gov.cn/.

Hence, as China faces the twin challenges of satisfying energy demand through a diversity of sources, both foreign and domestic, and minimizing the environmental impact of energy production, the discovery of considerable reserves of unconventional natural gas is of great significance, and especially worthy of review. Estimates place China's unconventional natural gas resources, including coal bed methane (CBM), shale gas and tight gas at 50 tcm, around thirteen times that of its conventional natural gas resources.[5] Among these, at more than 30 tcm, shale gas – an unconventional type of natural gas found in shale formations is the most promising. The potential of shale gas is especially bright, taking into account the limited conventional gas reserves, environmental consequences attributed to producing synthetic, coal-based gas, and the 15

[5] *World Energy Outlook 2012 - Golden Rules for a Golden Age of Gas* (Paris: OECD/IEA, 2012), 115–116.

years of developing CBM without much progress. As a result, shale gas has become a central pillar of government efforts to increase the proportion of natural gas in the Chinese energy mix. However, there are several rivers to be crossed before China can realize large-scale volumes of commercial shale gas, including both natural and institutional constraints and so far, despite localized breakthroughs, progress has been slow.

1.2 Research purpose and scope

This report primarily focuses on the evolution of government priorities, strategies and policies towards shale gas, finding that the fledgling shale gas industry illustrates a contradiction in the Chinese energy sector, exposing a conflict between top-down strategies for reform, market structure and entrenched interests in maintaining the current system. It draws on existing theories of decision-making in the Chinese energy sector, policy papers and strategy documents from relevant government institutions and interviews with industry professionals to tease out some of these contradictions, discuss the material and institutional constraints on China's shale gas development and the implications for the general debate on policy processes in the Chinese energy sector.

The report begins with a review of existing literature on policy processes and institutional developments in China's energy sector. Following this, it discusses the emergence of natural gas as a government priority and the regulatory environment in the natural gas industry. Next, it turns to the shale gas industry, examining the geological, topographical and water scarcity-related constraints and the current status of shale gas extraction. The following section of the report reviews and analyzes the policy framework for shale before turning to the institutional constraints towards both the realization of government strategy and the sustainable development of the industry. Finally, the report discusses the results of the aforementioned analysis, before concluding on the implications for theoretical perspectives on policy-making in the Chinese energy sector.

1.3 Methods

This report draws on a range of primary and secondary sources to explain government priorities and policies, and their effect on the development of the Chinese shale gas industry. Primary sources contain official government documents and interviews with industry insiders. First, the author conducted a thorough scan of official policy and strategy documents both indirectly and directly related to shale gas development. The results of this review were used as an indicator of government strategy, as well as to ascertain the development status and evolution of policies towards the shale gas sector. Second, the author arranged in-depth interviews with energy experts, government officials and industry insiders from international and domestic companies. These interviews were conducted with the purpose of giving the author working-level insight into the shale gas industry, and to improve the author's understanding of the implementation status of reviewed policies. Interviews were especially useful, providing a window into an otherwise opaque

energy sector. To protect their anonymity, the paper will not reveal specific details about interviewees.

The study also draws on an abundant supply of secondary sources, including books, peer-reviewed journal articles, reports and news articles. These sources inform the reports theoretical framework, which shows developments in analytical perspectives on the Chinese energy sector. Moreover, these sources also support the main body of the report, where they are used to review the status of shale gas development, and the challenges that the industry faces. Where necessary, due to the lack of updated and centralized databases, the author also consulted online newspapers.

2 Literature review

2.1 Analytical starting point: fragmented authoritarianism

One of the established frameworks for understanding of decision-making in China's energy sector is the concept of "fragmented authoritarianism," developed by Kenneth Lieberthal and Michael Oksenberg in the late 1980s.[6] The framework was conceptualized when the Chinese economic sector had just begun opening up to the world, providing foreign analysts with unprecedented access to information about decision-making in the Chinese economic sphere.[7] Through a combination of interviews with Chinese and foreign industry insiders and bureaucrats, Lieberthal and Oksenberg gathered information on decision-making processes towards three large-scale energy projects.[8] Their ensuing analysis concluded that the "fragmented, segmented and stratified structure of the state promotes a system of negotiations, bargaining, and the seeking of consensus among affected bureaucracies" leading to a policy process that is "disjointed, protracted, and incremental."[9]

With this work, the authors sought to provide middle ground between understandings of Chinese policy making as either driven by rational choices based on national interest, or as the result of perpetual jostling for power between Chinese political elites. While these two schools of thought differed in their interpretation of leaders' motives, both considered policy to be driven by the very apex of the Chinese polity. The novelty of fragmented authoritarianism was to build the large, monolithic bureaucracy underpinning the apex into the decision-making framework. Drawing on elements from both the power-model and the rationality-model, Lieberthal and Oksenberg aimed to capture "the interaction of the elite with the bureaucracies, the relations within and among bureaucracies and the role of bureaucracies in the policy process."[10] The theory asserts that policy created at the center is influenced by the political goals of vertical agencies and spatial regions that enforce the policy, so that "outcomes are shaped by the incorporation of interests of the implementation agencies into the policy itself."[11]

Thus, the authors paint a picture of an energy sector where the structure of authority necessitates active cooperation between many different bureaucratic units, each of which is located in complex, but distinct lines of authority.[12] However, because of the different inherent interests and

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[6] Kenneth Lieberthal and Michel Oksenberg, *Policy Making in China: Leaders, Structures, and Processes* (Princeton University Press, 1988).
[7] Kenneth Lieberthal and David M Lampton, eds., *Bureaucracy, Politics, and Decision Making in Post-Mao China* (Berkeley: University of California Press, 1992), 23.
[8] These large-scale projects include the process leading up to foreign participation in China's offshore petroleum industry, the three gorges dam and central-provincial and interagency relations in energy development. For a full account of these projects, see Lieberthal and Oksenberg, *Policy Making in China*, chap. 5, 6 and 7.
[9] Ibid., 3.
[10] Ibid., 10.
[11] Andrew Mertha, "Fragmented Authoritarianism 2.0: Political Pluralization in the Chinese Policy Process," *The China Quarterly* 200 (2009): 996.
[12] Lieberthal and Oksenberg, *Policy Making in China*, 22.

equivalent levels of authority between the agencies, the need to cooperate nurtures uncoordinated and disjointed policymaking. The crux of Lieberthal and Oksenberg's argument is therefore that authority underneath the pinnacle of the Chinese political unit is fragmented, and that policy processes, from conception to implementation, are protracted, disjointed and incremental.[13] Protracted, because most policies are shaped over a long period of time; disjointed, because key decisions are made in a number of separate and laxly coordinated agencies and inter-agency decisional bodies; and incremental, because policy changes slowly and is implemented only gradually.

Many changes have taken place since the formulation of fragmented authoritarianism. Export-oriented, investment-driven and energy-intensive economic growth has boosted Chinese energy consumption. China has emerged as both the world's largest consumer and producer of energy, and more recently, it has replaced the United States as the world's largest oil importer. With the speed of development since Lieberthal and Oksenberg first put the idea of fragmented authoritarianism on paper in 1988, the question begs: has fragmented authoritarianism become an anachronistic framework for analyzing decision making in China? To put Lieberthal and Oksenberg's theory into current context, the paper now turns to a review of literature focusing on China's energy sector in more recent years.

2.2 Post-fragmented authoritarianism: analytical developments

The energy sector described in detail by Oksenberg and Lieberthal was one where bureaucratic responsibility was divided between several separate commissions and ministries, and in which the government played the role of both industry and regulator. Ensuing institutional developments in China's energy sector have taken place in an environment of wide-reaching economic change, during which the top leadership has pursued the introduction of market forces, particularly through a budding separation of state and industry. Alongside the evolving Chinese economy a fluctuation between centralization and decentralization of regulatory authority over the energy sector has occurred. However, since 1993, energy authority has not been centralized under a ministry-level authority, and depending on the issue, authority is often shared by a several bureaucratic entities.[14]

In the context of Chinese economic and administrative development, recent attempts at characterizing China's energy sector have produced divergent views. With a similar starting point to that of Lieberthal and Oksenberg, Andrews-Speed Michael Meidan and Ma Xin argue that China's energy sector has a heavy bureaucratic tradition, albeit with weak

[13] Ibid.
[14] The relevant entities in the natural gas/shale gas sector are reviewed in the following chapter.

leadership structures.[15] Their analysis of policy processes in the energy sector therefore finds that the path from perceived problem to specific priorities and solutions requires a lengthy quest for consensus between a number of actors, including ministries and corporate interest groups. However, in their analysis, the number of actors involved has increased, introducing a diversified group of stakeholders and interest groups that feed into the formulation of policies and contribute to redefining the limits of policy implementation, for example by raising social and environmental issues.

Lema and Ruby share the same point of departure, but provide a contrasting and compelling account of coordination, and introduction of market mechanisms in government policy towards the Chinese renewables sector.[16] Their analysis is grounded in the centrally planned wind power industry, a policy environment in which government involvement was disjointed, and energy authorities were in dispute over strategy, issuing "conflicting policy initiatives.[17] The responsible ministry neither had the capacity, nor the authority to coordinate its policies across government levels to create a stable demand structure. Lema and Ruby argue that the slow progress in wind development between 1986 and 1999 was a direct result of his incoherent policy environment. However, following the 2000s, policy in the wind sector has become considerably more coherent. Two initiatives explain this shift: bureaucratic centralization and market decentralization in the power sector. The authors argue that the dissolution of China State Power Corporation separated production from distribution of power, and the establishment of the Energy Bureau under the National Development and Reform Commission (NDRC) centralized energy authority under China's most powerful ministry.[18] In the wake of these initiatives government established a concession system that enabled the rapid growth of both installed and connected wind power. Thus, the wind power sector is an example where regulators have been able to overcome constraints imposed by the fragmented institutional structure of the bureaucracy, with increasingly coordinated policies at the central level and a growing role for market incentives.

After years of market reforms, the relationship between industry and government is also in flux. Following the separation of bureaucracy and industry and the introduction of market elements into the energy sector, the big energy companies have arguably increased their power vis-à-vis their regulators. Bo Kong reasons that the government no longer purely controls the national oil companies; rather, these companies are competing for power and influence in an increasingly complex and

[15] Michal Meidan, Philip Andrews-Speed, and Ma Xin, "Shaping China's Energy Policy: Actors and Processes," *Journal of Contemporary China* 18, no. 61 (2009): 591–616, doi:10.1080/10670560903033885.
[16] Adriana Lema and Kristian Ruby, "Between Fragmented Authoritarianism and Policy Coordination: Creating a Chinese Market for Wind Energy," *Energy Policy* 35 (March 23, 2007): 3879–90.
[17] Ibid., 3879.
[18] Ibid., 3884.

decentralized oil and gas sector.[19] The dissolution of line ministries in charge of the oil and gas sector and the transfer of human capital from the ministries to the NOCs strengthened the companies, but weakened the state. The power has shifted further in favor of NOCs as a result of price decentralization, production decentralization and administrative decentralization.[20] Moreover, the high bureaucratic rank of NOC leaders, and their informal ties with government decision makers, means that these individuals can directly influence policy processes in the energy sector. Thus, Kong argues that, petroleum policy not only requires vertical coordination within the state and its enterprises, but also horizontal coordination among them.[21]

The above contributions share Lieberthal and Oksenberg's starting point of a fragmented energy bureaucracy. However, they describe an energy sector that is in flux on the continuum between command economy and free market, implying a changing role for government regulators. In some cases, such as in the wind power industry, policy makers have arguably been able to overcome institutional constraints and formulate the necessary policy framework for industry development. On the other hand, in the oil and gas sector, the topic of this report, a new potential source of fragmentation has appeared between industry and bureaucracy. Although industry functions have been nominally separated from the state, the NOCs occupy an important role in the policy process in the absence of strong and united bureaucratic agencies.

Although shale gas is a new and hitherto insignificant part of the Chinese energy mix, it belongs within the general energy policy environment that has been reviewed above. Shale gas, considered an independent mineral, is by a certain measure exempt from some of the specific restrictions towards conventional energy resources.[22] However, from wellhead to end user, the value chain of shale gas touches upon many different aspects of the energy sector, *inter alia* upstream drilling operations and related logistics, pipeline infrastructure and natural gas markets. Therefore, shale gas is an extension of the oil and gas sector both through government regulation and industry capacity; shale gas is regulated by the same mix of government agencies who regulate conventional oil and gas, and the shale gas industry is dominated by the very companies that preside over the oil and gas industry. Hence, this paper is located within the broader literature on energy and oil and gas policy in contemporary China.

[19] Bo Kong, *China's International Petroleum Policy* (ABC-CLIO, 2009).
[20] Ibid., 23.
[21] Ibid., 3.
[22] Shale gas' status as an independent mineral will be reviewed in more detail in section 6.2

3 The natural gas sector

Natural gas has traditionally played a miniscule role in China's energy mix compared with consumption of coal, of which China has abundant resources.[23] Coal makes up close to 70 percent of domestic energy consumption, and will continue to be China's main source of energy for the foreseeable future.[24] However, due to the pollution-intensive nature of coal combustion, growth in consumption of coal has had major environmental consequences, raising concerns about the sustainability of a coal-based energy mix. Coal contributes to 90 percent of China's total SO_2 emissions, 70 percent of dust emissions, 67 percent of NO_x emissions and about 70 percent of China's CO_2 emissions. [25] Acid rain, attributed to SO2 from coal combustion is a severe problem; in the year 2000, economic losses caused by acid rain alone were estimated at 176.42 billion RMB.[26] Furthermore, air pollution is a cause of concern in China because of its effect on overall health. A 2013 study found that due to a higher reliance on coal for winter heating, the average particular matter in north China was 55% higher than in South China (below the Huai River). The higher air pollution had a severe impact on life expectancy; according to the study, life expectancy in Northern China was 5.5 years less than in the south, "owing to an increased incidence of cardio respiratory mortality."[27]

In this context, the relatively low carbon- and pollution intensity of natural gas makes it an attractive alternative to coal. As a result, natural gas has moved from being a low priority for policy makers, dismissed as a pricey resource, unable to compete with domestic coal resources during the 1990s, to becoming a key component of energy strategy in China.[28] The long-term strategy for natural gas was developed in the 2004 report *National Energy and Policy*, issued by the Development Research Centre of the State Council (DRC).[29] The report advocated using gas as a clean alternative to coal, especially as a substitute in the power and residential sectors.[30] The 11th FYP, as part of its priority towards environmental

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[23] Junchen Li et al., "Forecasting the Growth of China's Natural Gas Consumption," *Energy* 36, no. 3 (March 2011): 1381, doi:10.1016/j.energy.2011.01.003.
[24] EIA, *China: Country Analysis*.
[25] Chen and Xu, "Clean Coal Technology Development in China."
[26] An estimate by the Chinese Research Institute of Environment, cited in C. F. You and X. C. Xu, "Coal Combustion and Its Pollution Control in China," *Energy*, Energy and Its Sustainable Development for China, 35, no. 11 (November 2010): 4467–72, doi:10.1016/j.energy.2009.04.019.
[27] Yuyu Chen et al., "Evidence on the Impact of Sustained Exposure to Air Pollution on Life Expectancy from China's Huai River Policy," *Proceedings of the National Academy of Sciences* 110, no. 32 (August 6, 2013): 12936–41, doi:10.1073/pnas.1300018110.
[28] Jane Nakano et al., *Prospects for Shale Gas Development in Asia: Examining Potentials and Challenges in China and India* (Washington, DC: CSIS, August 2012); Xueliang Yuan and Jian Zuo, "Transition to Low Carbon Energy Policies in China—from the Five-Year Plan Perspective," *Energy Policy* 39, no. 6 (June 2011): 3855–59, doi:10.1016/j.enpol.2011.04.017; Yanrui Wu, "Deregulation and Growth in China's Energy Sector: A Review of Recent Development," *Energy Policy* 31, no. 13 (October 2003): 1417–25, doi:10.1016/S0301-4215(02)00202-1.Ω
[29] Development Research Center of the State Council, *China's National Energy Strategy and Reform*, Background Reports, November 2003.
[30] Nobuyuki Higashi, *Natural Gas in China Market Evolution and Strategy*, 9.

protection, projected that natural gas would comprise 5.3 percent in 2010, and 10 percent in 2015 and the *12th Five-Year Plan for the Natural Gas Industry*, issued by the NDRC, sets the target of 176 billion cubic meters in domestic natural gas production by 2015.[31]

During the last decade natural gas consumption has experienced rapid growth, largely caused by an expansion in pipeline infrastructure, which allowed natural gas – primarily a local commodity in gas producing regions – to penetrate residential areas along Chinas east coast.[32] From 2000 to 2012 natural gas consumption in China quintupled, reaching a total of 130.5 billion cubic meters. The growth in consumption has been supported by both domestic production and natural gas imports, by way of LNG and pipeline. According to Chinese statistics, China began importing natural gas in 2006, and in 2011 it imported 31 billion cubic meters, roughly half of which was through LNG.[33]

Compared with their concern for oil security, Chinese leaders have been relatively relaxed about growing imports of natural gas for a number of reasons. First, China's newfound role as a net importer of gas as well as the ability to close long-term supply agreements reduces anxiety about access.[34] Second, the role of natural gas in China´s energy mix is limited. Natural gas continues to make up only 5 percent of China's total energy mix, a number far below the global average of 21 percent.[35] Third, natural gas can be substituted as a fuel for many of its uses, whereas oil is less replaceable. Nevertheless, growing dependency on imports has meant that natural gas has begun to emerge as a strategic issue.[36]

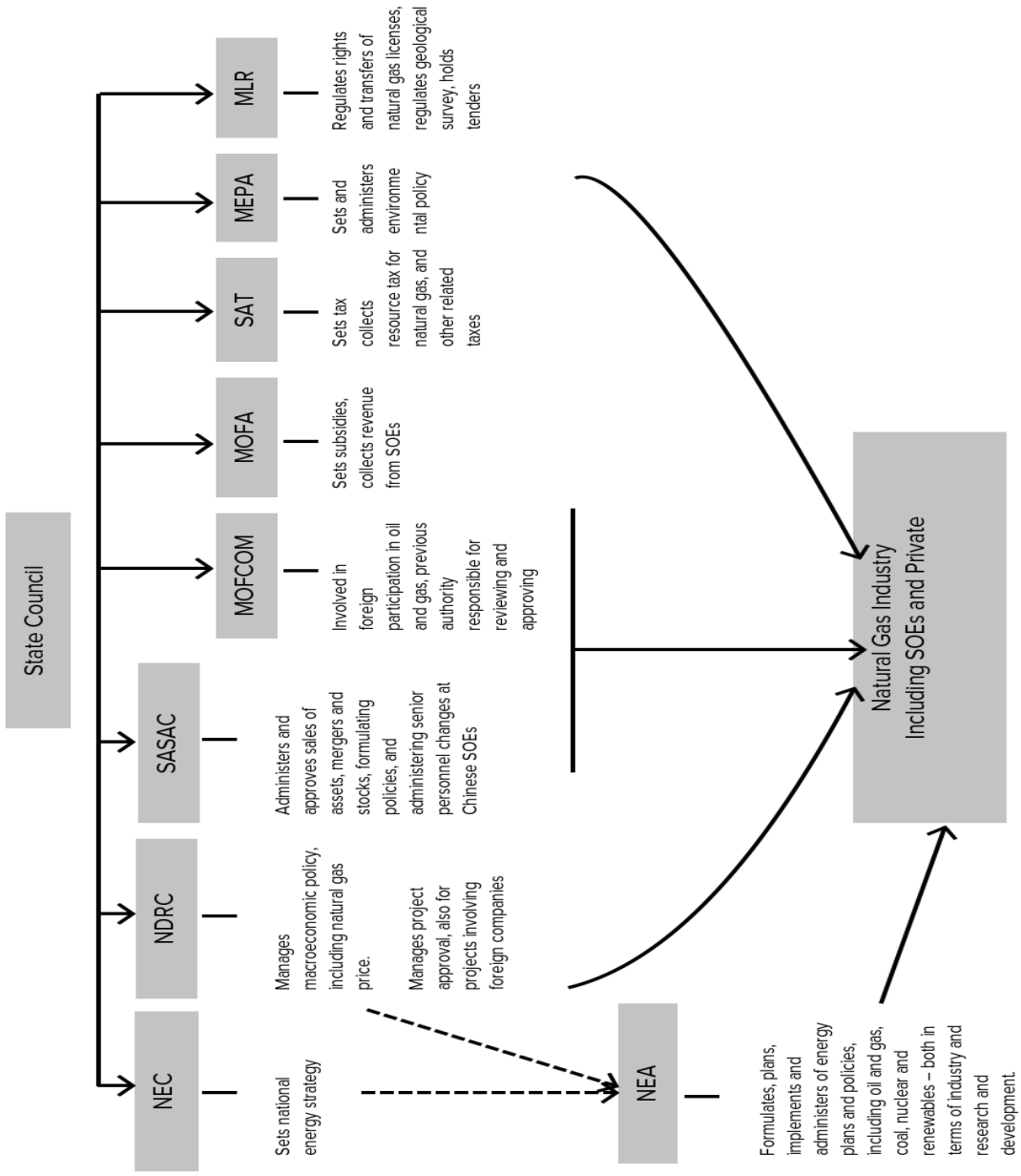
3.1 Regulation of China's natural gas sector

As explained above, the energy sector lacks centralized regulation, and the natural gas sector is so far no exception. There is a high degree of state intervention in setting price and conditions for market access. However, authority over natural gas is split between different agencies and ministries, with a variety of actors responsible for formulating strategies and policies.[37] The institutional hierarchy and function of these organizations in relation to natural gas is illustrated in Figure 3.1. The figure shows how overlapping authority occurs in several different policy areas. First, since natural gas is classified as a natural resource, the MLR

[31] NDRC, "Five year plan for natural gas," October 22, 2012; Nobuyuki Higashi, *Natural Gas in China Market Evolution and Strategy*, 10.
[32] Nobuyuki Higashi, *Natural Gas in China Market Evolution and Strategy*, 4.
[33] National Bureau of Statistics, *Statistical Yearbook*, 2013, http://data.stats.gov.cn/.
[34] Guy C.K. Leung, "China's Energy Security: Perception and Reality," *Energy Policy* 39, no. 3 (March 2011): 1330–37, doi:10.1016/j.enpol.2010.12.005.
[35] IEA, "FAQs: Natural Gas," 2014, http://www.iea.org/aboutus/faqs/gas/.
[36] Zhang Yi, "«Tianranqi duiwai yicun dugao jingshi nengyuan anquan» 天然气对外依存度高警示能源安全 [High degree of dependency on foreign sources of natural gas a warning for China's energy security]," *Guangming Ribao*, May 25, 2014, 10 edition, http://epaper.gmw.cn/gmrb/html/2014-05/27/nw.D110000gmrb_20140527_3-10.htm.
[37] Wu, "Deregulation and Growth in China's Energy Sector," 1419; Nobuyuki Higashi, *Natural Gas in China Market Evolution and Strategy*, 10; Anne-Sophie Corbeau et al., *Gas Pricing and Regulation: China's Challenges and IEA Experience* (Paris: IEA/OECD, 2012), 30.

has joint responsibility with the NDRC and the NEA in formulating industry specific strategies. Furthermore, several institutions participate in project approval processes, both formally and informally.[38] For example, the NEA, the NDRC as well as local governments all have key roles in planning and approval of natural gas infrastructure.[39]

Figure 3.1: Government institutions in the natural gas industry



Source: Compiled by the author

[38] Author interview with IOC representative, April 28, 2014.
[39] Anne-Sophie Corbeau et al., *Gas Pricing and Regulation: China's Challenges and IEA Experience*, 28.

The fragmented regulatory system for natural gas stands in contrast to the oligopolistic structure of Chinese natural gas markets.[40] The three NOCs, CNPC in particular, dominate the natural gas sector. CNPC controls 70% of the upstream natural gas sector, and 80% of the pipeline infrastructure.[41] Sinopec, the second largest of the three, has a stake in natural gas resources located in Shandong and Sichuan, and has entered both the pipeline industry and the LNG industry. CNOOC is the third largest of the NOCs, and the pioneer in the Chinese LNG industry and active in offshore natural gas development.[42] Due to their oligopoly within the upstream and midstream natural gas industries, as well as their strong government ties, NOCs play an important part in setting the conditions for other participants in the domestic natural gas sector.[43] Hence, there is not much space for small and medium-sized enterprises. Most acreage is owned by the NOCs, with few licenses and less competitive economics available for smaller companies. The exploration threshold for keeping licenses is low, and NOCs are therefore able to keep their licenses, an obstacle for other market players.[44] Additionally, with the majority of pipelines owned by CNPC and Sinopec, smaller players face problems transporting natural gas to downstream markets and are forced to sell to the their gas to pipeline owners, often without much leeway for negotiation. Foreign enterprises wishing to explore and develop conventional natural gas resources in China have so far only been able to do so through partnering with the government or NOCs through production sharing contracts (PSCs) or cooperative joint ventures (CJV).[45]

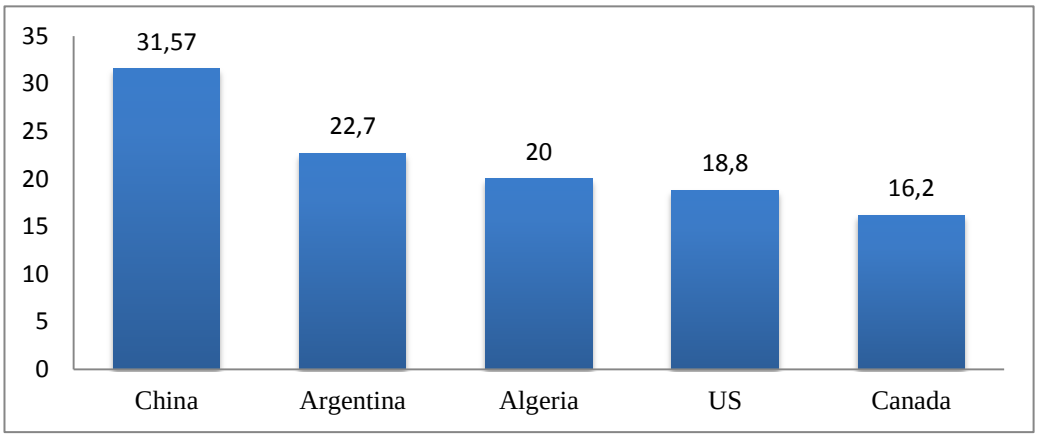
In sum, the natural gas sector is characterized by a high degree of government intervention, an uncentralized regulatory system and an oligopolistic market structure. In this environment, and in the absence of market liberalization, non-NOC actors and foreign enterprise have not been able to find a foothold. However, government strategy towards the shale gas industry indicates a departure from the established way of managing natural gas. It is to this case the paper now turns.

[40] Ibid., 18.
[41] Nobuyuki Higashi, *Natural Gas in China Market Evolution and Strategy*, 11.
[42] Ibid., 17.
[43] Erica S. Downs, *The Energy Security Series: China*, 23.
[44] Anne-Sophie Corbeau et al., *Gas Pricing and Regulation: China's Challenges and IEA Experience*, 24.
[45] Wang Weidong, *Foreign Investment in Upstream Oil and Gas in China* (Grandall Law Firm, November 1, 2013), http://www.lexology.com/library/detail.aspx?g=d5d49dd5-bc8b-46d1-8917-922a0f934225.

4 Shale gas in China

In the context of securing a stable supply of natural gas, policymakers and industry players in China have paid close attention to the shale gas revolution on the other side of the Pacific Ocean. The newly exploitable resources have opened opportunities for upstream investments in North America, and a potential future of access to LNG to Asian markets. On the other hand, the discovery of shale gas reserves in China has also nurtured hope that the US shale gas revolution can be replicated domestically. By some measures, China has the largest shale gas reserves in the world. The US Energy Information Agency (EIA) estimates that China's technically recoverable reserves exceed 31 tcm (see table 4.1).[46] Chinese numbers are slightly less sanguine – according to MLR appraisals, China has 25.1 tcm in technically recoverable reserves – but nevertheless support the notion of shale gas as a potential game changer in China's domestic energy industry.

Table 4.1: Top 5 countries with technically recoverable shale gas resources (tcm)



Source: EIA, Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States (Washington, DC: U.S. Department of Energy, June 2013).

Shale gas has emerged as a key component of government strategy for increasing the amount of natural gas in the energy mix and to reduce reliance on foreign sources of natural gas. As a result, shale gas has been labeled as a strategic emerging industry[47] and as one of the most

[46] Zhang Dawei, "'Jiaqiang Zhongguo Yeyanqi Ziyuan Guanli de Silu Kuangjia' 加强中国页岩气资源管理的思路框架 [A Theoretical Framework for Strengthening the Management of the Shale Gas Resources]," *XInnengyuan* 31, no. 12 (December 2012): 115–34.

[47] State Council, *"Guowuyuan guanyu yinfa 'shierwu' guojia zhanlüe xingxinxing chanye fazhan guihua de tongzhi"国务院关于印发"十二五"国家战略性 新兴产业发展规划的通知 [Notice on the 12th five year plan for the development of national strategic industries]*, 2012, http://www.gov.cn/zhengce/content/2012-07/20/content_3623.htm.

important factors for the development of China's natural gas industry, thus by extension an integral part of China's energy security.[48] Consequentially government has set high targets for shale gas output. The short-term target for shale gas is 6.5 bcm by 2015 and the medium-term target was set at 60-100 bcm by 2020, necessitating a 65 percent compound annual growth rate. However, ambitious targets have been challenged by amalgamation of technical and institutional challenges. Recently, Wu Xinxiong, leader of China's national energy administration reduced his expectations for shale gas output in 2020 to 30 bcm - a 50 percent reduction in comparison to the original target.[49] This adjustment shows that regulators within the NEA have begun to come to grips with the fact that substantial challenges remain for the development of the shale gas sector.

4.1 Challenges towards shale gas development

There is still much uncertainty surrounding geological characteristics of shale gas plays in China. Industry insiders continue to stress the uncertainty in the estimates that have been conducted until now.[50] Current surveys and industry experiences indicate that geological characteristics of shale gas resources could be one of the most important hurdles facing commercialization. One concern is that difference between Chinese and North American resource plays reduce the transferability of technology developed in North America to Chinese conditions. Chinese shale deposits are often significantly deeper than in the US.[51] Wells in the US rarely go deeper than 3000 meters, while Chinese shale gas deposits are found at depths around 3000-5000 meters.[52] Also, some areas have complex geological characteristics, increasing the difficulty of finding areas suitable for drilling operations. Moreover, while hydraulic fracturing is more effective in brittle conditions, several Chinese basins have high clay content, which can significantly reduce well output.[53] Additionally, the topographical features of some shale gas regions will be challenging in terms of project logistics – although this is an issue already faced by developers of conventional resources.

Another important challenge for shale gas development is water scarcity. Water is the key ingredient in hydraulic fracturing. During the drilling process, water, mixed with a concoction of chemicals is blasted at high

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[48] NDRC, "Five year plan for natural gas."

[49] *Caixin, "Yeyanqi rechao jiantui: shei zai luoyong? Di san lun zhaobiao haiyou shei canjia?" 页岩气热潮褪退：谁在裸泳？第三轮招标还有谁参加[The shale gas hype is receding: who wants to swim naked? Who still wants to participate in the third round of bidding?], 2014, September 18, http://energy.caixin.com/?p=10151*

[50] Author interview with NOC representative, April 24, 2014

[51] Zhang Dingning, "'Zhongguo yeyanqi chanye fazhan yu zhengce jianyi' 中国页岩气产业发展与政策建议 [Policy and development recommendations for China's shale gas industry]," *Kechixu fazhan*, November 2011, 64–68.

[52] EIA, *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States* (Washington, DC: U.S. Department of Energy, June 2013).

[53] Neil Gunningham, "A Shale Gas Revolution for China?," *Climate Policy* 14, no. 2 (2014): 306, doi:10.1080/14693062.2014.842857.

pressures into the drill-hole to fracture sediments, so that trapped gas is leaked through the drill-hole to the surface. Hydraulic fracturing, which is necessary to extract shale gas requires large amounts of water. Typically a horizontal well in the US will use around 11 to 19 thousand cubic meters.[54] The amount of water needed for hydraulic fracturing also varies from basin to basin, depending on factors such as depth, organic content and porosity. At the moment, hydraulic fracturing operations in China require significantly more water than in the US. According to one source in CNPC, a single well in the Sichuan region requires around 30 thousand cubic meters of water, around twice the amount as the average well in the US.[55]

Aquastat, the global information system on water and agriculture, lists China among the countries with the most severe water shortage in the world, with one fifth of the world's population, and only 6% of its fresh water resources. China's total renewable water resources (TRWR) per capita is 2,051 cubic meters per year, less than one third of the global average, and almost one tenth of the US.[56] Hence, water stress, compounded by overuse by industry, agriculture and private consumption, is already a critical issue in many Chinese regions. Water shortage is therefore an obstacle for shale gas, especially with the large-scale development envisioned by policy makers, due to the comparatively high water-demand for hydraulic fracturing. According to MLR experts, for China to realize the production target of 60-100 bcm by 2020, it needs 20 thousand producing wells. If each well uses 19 thousand cubic meters of water, the expectation is that China will need 380 million cubic meters of water, equal to the annual consumption of a city with over 12 million people.[57]

Water consumption of shale gas extraction still needs to be compared with the water intensity of extraction and combustion of other fuels. A study by the Belfer Center on water consumption levels of various energy sources, found that in comparison to both coal mining and washing (3.8 to 30.3 liters/Mmbtu) and onshore oil production (3.8 to 234.7 liters/Mmbtu), shale gas is relatively less water intensive (2.3 to 6.8 liters/Mmbtu).[58] However, due to the upfront use of water in the shale gas extraction process at the well-site, and in the absence of logistical support

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[54] USGS, *Water Resources and Shale Gas/Oil Production in the Appalachian Basin—Critical Issues and Evolving Developments*, n.d., http://pubs.usgs.gov/of/2013/1137/pdf/ofr2013-1137.pdf.

[55] Author interview with NOC representative, April 24, 2014

[56] FAO, *Aquastat: China Fact Sheet* (New York: UNFAO, n.d.), http://www.fao.org/nr/water/aquastat/data/cf/readPdf.html?f=CF_CHN_en.pdf.

[57] Luo Jing, "'Zhongguo Yeyanqi Kaifa Mianlin de Shuiziyuan Tiaozhan' 中国页岩气开发面临的水资源挑战 [The Water Resource Challenge for China's Shale Gas Extraction]," *Zhongguo Kuangyebao*, February 11, 2014, http://www.mlr.gov.cn/xwdt/xwpl/201402/t20140211_1303410.htm.

[58] Erik Mielke, Laura Diaz Anadon, and Venkatesh Narayanamurti, *Water Consumption of Energy Resource Extraction, Processing, and Conversion: A Review of the Literature for Estimates of Water Intensity of Energy Resource Extraction, Processing to Fuels, and Conversion to Electricity*, Discussion Paper, Energy Technology Innovation Policy Discussion Paper Series (Harvard Kennedy School, n.d.), 6, http://belfercenter.ksg.harvard.edu/files/ETIP-DP-2010-15-final-4.pdf.

bringing in water from outside regions, water is likely to become an allocation issue on a local level in areas where water demand exceeds renewable water supply. Water issues will vary from region to region. Arid conditions are prevalent in northern China, less so in the southern regions. In general terms, the Tarim and Junggar basins in northwest China are severely affected by water shortages, the Ordos Basin and Songliao Basins in north and northeast China are affected to a lesser extent while the Southwestern corridor has relatively abundant water resources.[59] Thus water scarcity is more likely to affect development of shale gas in the Junggar and Tarim basins, while the Sichuan basin, which has been the center of shale gas development is more likely to be less impacted.

4.2 Industry developments and output targets

Despite lofty targets, industry is still in a nascent stage of development, with a low level of drilling activity and a minimal production output. The MLR and the Chinese University of Geology well drilled the first shale gas in 2009. Subsequently, production has grown slowly, reaching 50 million cubic 2012 meters and 200 million cubic meters in 2013. At the end of 2013, a total of 285 wells were drilled (including appraisal and exploration wells), of which 23 achieved gas flow exceeding a daily production rate of 100,000 cubic meters.[60] In contrast, the same year a total of 400,000 wells were drilled in the US.

Table 4.2: Comparison between production of tight gas, CBM and shale gas

Type	2009	2010	2011	2012	2013
Tight gas	15	20,4	25,6	32,0	40,0
CBM	2,5	9,1	11,44	12,45	3,0
Shale gas	.028	.032	.038	.050	.2
Nat gas total	852,6	948,4	1026,9	1072,2	1210

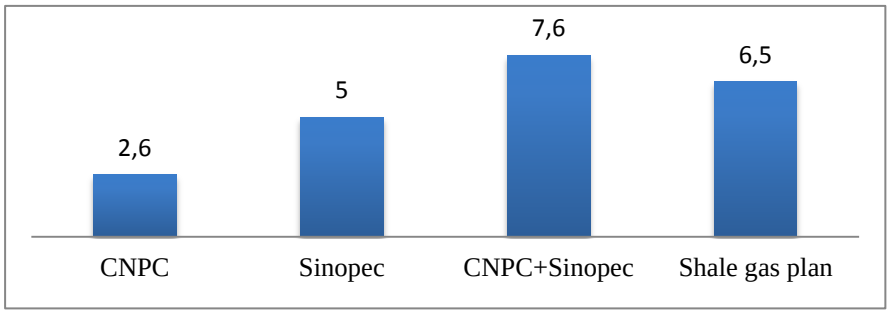
Compiled by author from interviews and presentations from industry officials

Compared with production of conventional gas, as well as other forms of unconventionals, shale gas has performed below expectations and continues to play a miniscule role in the energy mix. Several companies are involved; including the big state owned national oil companies, non-NOC SOEs and to a lesser extent privately owned domestic and international energy companies. Of these, only Sinopec has made a technological breakthrough in Fuling, Chongqing, enabling an average daily

[59] Fan Gao, *Will There Be a Shale Gas Revolution in China by 2020?* (Oxford: Oxford Institute for Energy Studies, April 2011), 32.
[60] Author interview with NOC representative, April 23, 2014.

production rate of 3.2 mcm, and cumulative output from the field exceeded 1 bcm in October this year.[61] This project marks China's first real shale gas breakthrough, although industry players suggest that the Fuling success is likely due to a combination of shale gas and tight gas, and that technological developments cannot necessarily be transferred to other areas.[62] Nevertheless, on the basis of this breakthrough, Sinopec has raised its target from 1 bcm by 2015 to 5 bcm by 2015 and 10 bcm of shale gas within 2017.[63] At the same time, CNPC has also raised its targets to 2.6 bcm by 2015.[64] The combined forecasts of Sinopec and CNPC exceed the government target for 2015 (see table 4.2), indicating that if the 2015 government target is to be met, it is likely that they are met on the backs of the two biggest NOCs.

Table 4.3: Various shale gas production targets for 2015



Compiled by author from company press releases

[61] "Sinopec's Fuling Shale Gas Field Average Output at 3.2 mcm by June End" *Natural Gas Asia*, October 31, 2014, http://www.naturalgasasia.com/output-from-sinopecs-fuling-shale-gas-project-tops-1-bcm-13925

[62] Author interviews with IOC representatives, April/May 2014

[63] Lucy Hornby and Julie Zhu, "Sinopec Speeds up Shale Gas Development," *Financial Times*, March 24, 2014, http://www.ft.com/cms/s/0/7ac3a92e-b33d-11e3-b09d-00144feabdc0.html.

[64] Wang Lu, "'Jizhan yeyanqi zhongshihuo mubiao gao chu zhongshiyou yi bei' 激战页岩气 中石化目标高出中石油一倍 [The battle for shale gas: Sinopec's target twice as high as CNPC]," *Renminribao*, March 25, 2014, http://energy.people.com.cn/n/2014/0325/c71661-24724018.html.

5 Policy Framework

In order to boost growth and overcome the material constraints outlined above, government regulators from various ministries have issued a range of policies both directly and indirectly affecting the future of shale gas in China. The major pillar of the government framework for intervention in the shale gas industry is the "Five-year plan for shale gas" (hereafter: "shale gas plan"), issued March 2012, which sets both targets and strategy for industry development. Since the release of the shale gas plan, a range of government ministries have issued centralized subsidies for shale gas producers, creating government programs and subsidies for technological development, and issuing policies aimed at de-regulating the industry, through providing access to non-NOC players and foreign actors by way of license tendering, liberalizing wellhead prices and providing third party access to transportation infrastructure (see table 4.5). This policy framework, although by no means complete, must be seen in contrast to an otherwise heavily regulated energy sector, where, as described above, state-owned companies dominate the upstream, midstream and downstream sectors.

The policies can be separated in four different categories, and are summarized in Table 4.5. First, policy makers have attempted to provide economic incentives for upstream development through direct subsidies and price liberalization. To incentivize investments, MOFA implemented a 0.4 RMB/cubic meter subsidy for shale gas in November 2012, around 45 percent of Henry Hub price in 2013.[65] On top of central subsidies, NEA also urges additional subsidies to be implemented at the local government level.[66] Moreover, the NDRC has begun to liberalize natural gas prices, both by stating the intention liberalize the wellhead price for shale gas, and by implementing a gradual nationwide reform of natural gas prices, the main thrust of which is to move gas prices towards a more market oriented price structure.[67] The aim of these reforms has been to encourage conservation, align price between domestic and foreign sources and to encourage more domestic production. The origins of current price reforms can be traced back to a pilot reform program in Guangxi and Guangzhou, implemented February 2011, which pegged natural gas prices to a basket of alternative fuels at a discount rate, thus

[65] KPMG Global Energy Institute, *Shale Development: Global Update Focus on US, China, Argentina, Australia, Indonesia and UK* (KPMG, February 2014), http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/shale-gas/Documents/shale-development-global-update-v2.pdf; MOFA, *"Guanyu chutai yeyanqi kaifa liyong butie zhengce de tongzhi"关于出台页岩气开发利用补贴政策的通知 [Notice on shale gas subsidy policy]*, 2012, http://jjs.mof.gov.cn/zhengwuxinxi/tongzhigonggao/201211/t20121105_692290.html.

[66] NEA, *"Guojia Nengyuanju Guanyu Yinfa 2014 Nian Nengyuan Gongzuo Zhidao Yijian de Tongzhi" 国家能源局关于印发2014年能源工作指导意见的通知 [Notice from National Energy Administration on Guidance for Energy Work in 2014]*, 2014, http://zfxxgk.nea.gov.cn/auto82/201401/t20140124_1756.htm.

[67] NDRC, *"Guojia fazhan gaige wei guanyu tiaozheng tianranqi jiage de tongzhi"国家发展改革委关于调整天然气价格的通知 [NDRC notice on adjusting natural gas price]*, 2013, http://www.ndrc.gov.cn/zcfb/zcfbtz/201306/t20130628_547850.html.

approaching a price more in tune with market principles.[68] The Guangzhou/Guangxi pricing scheme was transferred to the national scale in July 2013, linking the price of incremental natural gas to the same basket system as in Guangdong and Guangxi.[69]

Second, regulators aim to incentivize progress in shale gas technology through government support for domestic technology, as well as policies to promote international cooperation and technology transfer. A shale gas related research program has been added under the "973 – National Basic Research Program of China" under MOST.[70] The NEA has also designated CNPC to establish the "Energy Shale Research Centre" under CNPC's research institution in Langfang in Hebei province. Moreover the NEA recommends the establishment of demonstration areas to facilitate transfer of successful solutions.

Third, a milestone in the industry was the declaration of shale gas as an "independent mineral," thereby making it exempt from regulation in the conventional natural gas industry restricting non-NOC access.[71] In the aftermath of this declaration the MLR has released shale gas acreage through open bidding for the first time in the oil and gas industry in China.[72] As a result, non-NOC players, including both private and state-owned companies, have entered the shale gas industry. Following this initial step, regulators have attempted to create more favorable conditions for non-NOC actors, through encouraging private investment in natural gas infrastructure, calling for third-party access to NOC pipelines as well as through gradual liberalization of pipeline tariffs that subsidize integrated companies at the expense of non-integrated companies.

Fourth, policy makers have diverted from the usual path of self-reliance, eschewing international participation in its upstream hydrocarbon sector.[73] Instead, regulators have attempted to incentivize international participation, allowing for non-NOCs to cooperate with foreign companies, which is restricted in the conventional natural gas industry. This also indicates a change of course from the method previously

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[68] NDRC, "NDRC notice on pilot natural gas price reform in Guangzhou and Guangxi," December 16, 2011, http://www.ndrc.gov.cn/zcfb/zcfbtz/201112/t20111227_452929.html.

[69] NDRC, *"Guojia fazhan gaige wei guanyu tiaozheng tianranqi jiage de tongzhi" 国家发展改革委关于调整天然气价格的通知 [NDRC notice on adjusting natural gas price]*.

[70] The 973 program was launched in 1997, has supported more than 800 projects since its inception. The project in question is China Government Portal, "«Chaolinjie Eryanghuatan Qianghua Yeyanqi Gaoxiao Kaifa Jichu Xiangmu Judong» 超临界二氧化碳强化页岩气高效开发基础项目启动 [The 'Supercritical CO2 for Strengthening Efficiency of Shale Gas Extraction' Fundamental Program Begins]."

[71] China Government Portal, "'Woguo jiang an duli kuangzhong zhiding touzi zhengce guanli yeyanqi ziyuan' 我国将按独立矿种制定投资政策管理页岩气资源 [China will manage investment policies on shale gas as an independent mineral]," December 31, 2012, http://www.gov.cn/jrzg/2011-12/31/content_2034391.htm.

[72] Fan Gao, *Will There Be a Shale Gas Revolution in China by 2020?*, 21.

[73] Phillip Andrews-Speed, "State Control Is the Cause Of China's Energy Crisis," *Wall Street Journal*, April 30, 2004, http://courses.wcupa.edu/rbove/eco343/040Compecon/China/040430energy.txt.

employed towards unconventionals, particularly in the case of CBM, where building on the experience of CNOOC as the conduit for foreign cooperation in China's offshore industry, China United Coal Bed Methane Corporation (CUCBM) was established under state ownership with exclusive rights to enlist cooperation with foreign companies.[74]

[74] CUCBM later lost this exclusive right, amongst criticism of being an inefficient operator of foreign investment.

Table 5.1: Chinese government policies promoting shale gas industry development

Development plan	FYP for shale gas (NDRC et al. 2012). FYP for natural gas (NEA 2012).
Price liberalization	0.4 RMB per cubic meter subsidy for shale gas (MOFA 2012). Deregulating wellhead prices for shale gas (NEA 2013) Guangzhou and Guangxi price reforms implemented on a national scale, incremental introduction of market determined gas price. (NDRC 2013).
Taxation	Pay tax according to VAT guidelines for oil and gas industry (SAT 2013).
R&D programs and incentives for technology	Improving shale gas exploration and extraction technology included in China 12th Five Year Energy Plan (NEA 2011). Shale gas project enters Program 973 - National Basic Research Program of China (MOST 2014) Encouraging setting up demonstration zones (NEA 2014).
Resource management	Shale gas classified as an independent resource, no longer under the same restrictions for investment as oil and gas. (China Government Portal 2012).
Foreign participation	Allowing (as an "encouraged" activity) foreign oil and gas companies to participate in shale gas exploration and exploitation activities via either equity joint venture operations or cooperative joint venture operations. (State Council and MOFCOM 2011). Private Chinese oil companies may also explore and exploit shale gas, including by way of joint ventures with foreign companies (NEA 2014). Encouraging local companies to cooperate with foreign companies to bring in technology and industry. (NEA 2014).
Infrastructure	Encourages private investments in the construction of new gas pipelines and infrastructure. (NEA 2014). Shale gas producers and distributors should have access to the existing pipeline network and infrastructure on a "non-discriminatory" basis. (NEA 2014). Further encouraging private investment to enter natural gas infrastructure (Xu Shaoshi 2014).

The policies reviewed for this report indicate that Chinese energy regulators are attempting, at least in rhetoric, to emulate the experience in the US. The rapid growth in shale gas production in the US was enabled by a mix of prudent government policies, individual tenacity and innovation, favorable gas prices and a competitive market with the participation of thousands of small- and medium sized enterprises.[75] As a response to the energy challenges of the 1970s, the administrations of President Ford, and President Carter issued several policies aimed at unlocking unconventional energy resources, including tax credits, pricing incentives and R&D programs into technology for unconventional gas production as well as measures promoting the industry restructuring (including de-regulation of wellhead natural gas prices and third party access to interstate natural gas pipelines).[76] This created a preferential environment for smaller, private companies, such as Mitchell Energy, the company that finally made the technological breakthrough necessary for the commercialization of shale gas extraction. Although initial development was slow – as late as the year 2000 shale gas accounted for just 1 percent of American natural gas supplies – shale gas has grown rapidly since, the industry expanding by an average of 45 percent annually between 2005 and 2010.[77] In 2012, shale gas stood for 40 percent of domestic dry natural gas production in the US.[78] This massive growth was enabled by the participation of thousands of SMEs, participating in a competitive market with equal access to resources and open sharing of geological data.[79]

The overall policy framework towards shale gas in China has important implications for the management of the shale gas industry, the future of China's natural gas industry and potentially also for the wider debate on policy processes in China's energy sector. Not only do government announcements indicate a radical restructuring of the Chinese natural gas market, they also indicate collaboration between several regulatory institutions, as opposed to the picture of regulatory fragmentation advocated by Lieberthal and Oksenberg and subsequent analysts. Statements by government officials indicate that the shale gas industry is being used as a window for wider reform of the energy sector,[80] a priority following the Third Plenary Session of the 18th CPC Central Committee decision that the market shall play a decisive role in resource allocation.[81]

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[75] Wang Zhongmin and Krupnick Alan, *A Retrospective Review of Shale Gas Development in the United States: What Led to the Boom?* (Washington, DC: Resources for the Future, April 2013), http://www.rff.org/RFF/documents/RFF-DP-13-12.pdf.
[76] Ibid., 23.
[77] Economist, "Shale of the century," *The Economist*, June 2 2012.
[78] EIA, *Technically Recoverable Shale Oil and Shale Gas Resources: An Assessment of 137 Shale Formations in 41 Countries Outside the United States*.
[79] Desheng Hu and Shengqing Xu, "Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas," *Energy Policy* 60 (September 2013): 22, doi:10.1016/j.enpol.2013.04.068.
[80] Wang Song, "'Woguo tanlu yeyanqi jianguan' 我国探路页岩气监管 [China finds the path for shale gas regulation]," *Zhongguo kuangyebao*, January 21, 2013, http://www.mlr.gov.cn/xwdt/jrxw/201301/t20130121_1176816.htm.
[81] Phillip Andrews-Speed, "Third Plenum's Plans for China's Energy Sector," *Phiip Andrews-Speed*, December 10, 2013, http://www.andrewsspeed.com/index.php/permalink/3267.html.

However, it remains to be seen whether these reforms can be implemented in practice, and whether they will be effective in overcoming the range of natural and institutional constraints that impede the sustainable development of China's shale gas industry.

6 Institutional constraints in the Chinese shale gas industry

In 2012, Dong Xiucheng, Professor at China Petroleum University argued that lack of regulation is the main obstacle for shale gas development, and that "policies and regulation in the Chinese energy sector are in a muddled and confused state. There is no independent energy management bureau, and there is definitely no independent institution for managing shale gas."[82] However, as argued above, regulators have begun to pursue a more coherent policy regime towards shale gas, based on the experience of the US shale gas industry. This section will deal with the institutional constraints in the shale gas sector, teasing out some of the contradictions between government strategies and industry structure.

The institutional constraints can be arranged as follows. First, centrally determined and artificially low prices for natural gas have been a disincentive for upstream developers. Second, with favorable regulatory conditions, the state owned companies have established a powerful oligopoly in the natural gas sector, and control the majority of acreage and pipeline infrastructure, restricting market access for other companies. Third, regulators have so far been unable to specify environmental standards for the shale gas industry. Finally, due to a combination of the above, the incentives for international cooperation are low, and without a clear legal framework for foreign participation, IOCs are likely to be hesitant to commit resources in China's shale gas sector.

6.1 Economic incentives for shale gas development

So far, the industry still faces the challenge of excessively high costs in the drilling and production stage. Above 80 percent of total costs are associated with the drilling process,[83] and according to CNPC estimates, an average well in China will cost around 80 million, much higher than the average US well. Moreover, drilling is less efficient; the completion of a well, from prospecting to gas flow, takes much longer in China than in the US. While a typical well in Marcellus takes around 18-25 days, the estimated drilling time for CNPC is two months.[84] With high up-front investments, high maintenance costs,[85] and a low success rate, incentives are low for companies to develop shale gas, especially when they have access to cheaper, conventional sources of natural gas.[86]

As such, the right combination of high natural gas prices and government subsidies is key in order to tip the scales of the cost benefit analysis of potential investors, to incentivize development and develop economies of

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[82] Wang Song, "'Woguo tanlu yeyanqi jianguan' 我国探路页岩气监管 [China finds the path for shale gas regulation]."
[83] Author interview with NOC representative, 25 April, 2014
[84] Akash Gupta, Wang Ying, and Duke Suttikulpanich, *China Shale Gas: Potential Unearthed*, SCOUT (Standard Chartered, September 30, 2013), 38.
[85] Shale gas, unlike conventional natural gas, has high initial flow and a rapid decrease, requiring continuous drilling in order to maintain commercial flow.
[86] Author interview with IOC representative, May 5, 2014.

scale that can help reduce the drilling costs. However, the right incentives are not yet in place. First, the future of the MOFA subsidy after 2015 is unclear and some industry participants are hesitant to make commitments before they know whether or not government support will continue.[87] Second, the liberalization of shale gas wellhead prices has been undermined in practice by the mixing of shale gas and conventional gas in pipelines, and has forced producers to find local markets for their product. Therefore, in terms of commercial viability of shale gas, the real issue is the Chinese overall natural gas pricing structure.

Gas prices in China are predominantly set by government regulators in the Price Bureau of the NDRC, and consist of three separate components: ex-plant (wellhead) price, pipeline transportation tariff and end-user price.[88] The ex-plant price is set for individual projects, through negotiations between project developer and the central government, so that the price reflects costs associated with project development. The government also sets a pipeline tariff, on a pipeline-by-pipeline case. The tariff incorporates pipeline cost (construction and operation), the appropriate margin (an internal return rate of 12%) and finally the distance between wellhead to city gate.

The issues with this pricing scheme have been manifold. First, the centrally controlled prices have not reflected the high regional LNG price in Asia, nor the high premium paid on pipeline imports, leading to substantial losses by state owned natural gas importers. Second, local governments subsidize residential consumers by setting higher prices for industrial and agricultural companies. Residential gas prices are lower than those for public services, industry and transport. Third, the current system disproportionally benefits pipeline owners. Pipeline tariffs on pipeline users are artificially high compared to investment and maintenance costs for pipeline providers. This form of cross-subsidization has benefited the integrated NOCs at the expense of smaller market players.[89] As a result, while current natural gas prices in China are higher than in the US, the prices do not reflect the true structure of demand and supply for natural gas in China. Thus the regulated prices fail to send the appropriate market signals for upstream development.[90]

As mentioned above, the natural gas pricing regime is currently in a transitional phase. Recognizing the shortcomings of the cost-plus model in the face of the increasingly complex Chinese natural gas market, policy makers have begun to de-regulate the price of natural gas. These reforms are anticipated to raise natural gas prices, thus incentivizing investment in exploration and production of unconventional natural gas resources. However, reform has so far been incremental. China still has a two-tiered pricing system with the price of about 91% of supplies set by

[87] Author interview with IOC representative, April 28, 2014
[88] This paragraph is based on Anne-Sophie Corbeau et al., *Gas Pricing and Regulation: China's Challenges and IEA Experience*.
[89] Ibid., 21.
[90] Ibid., 10.

the government, with residential prices under the control of local governments and only incremental gas pegged to alternative fuels.[91]

More importantly, while the reforms bring natural gas prices closer to market levels, they might not be able to tackle the fundamental problem of encouraging natural gas as a replacement to coal. In the new system prices are not linked to coal, which is the real competitor to natural gas, especially in the power sector. Without a pricing system that internalizes the environmental costs of coal consumption, natural gas may continue to be outcompeted by coal in the power sector.[92]

In light of vested interests in the current system and concerns about the economic and social implications of releasing both industrial, agricultural and residential natural gas prices to market forces, it still remains to be seen whether or not the reforms will be carried out in their entirety, and at what pace they will be implemented. In the aftermath of the reform the price of gas in China has yet to catch up to international levels, and gaps between import prices and domestic prices have resulted in another year of losses in PetroChina's gas import operations.[93]

6.2 Restricted market access for non-NOC players

While the natural gas sector is usually reserved for the NOCs, regulators have attempted to make shale gas an exemption. The introduction of both domestic and international non-NOC players has been a recurring theme of government rhetoric towards the shale gas sector, both in policy documents and official statements. The implicit flip side of this theme is that officials need to break up NOC market dominance.

The MLR has attempted to do this by releasing acreage through license tenders. So far, two tenders have been held, with a third round long anticipated. The first of these, in June 2011, was open to state owned enterprises and had only two successful bidders. However, the decision to exempt shale gas from the legal regime towards exploration and development of conventional hydrocarbons by naming it an independent mineral, increased the interest surrounding the second round of bidding, as it was expected that private firms, and even foreign firms would be allowed to participate.[94] The second tender, opened in November 2012,[95] resulted in 16 companies winning 19 blocks, of which 6 were central level state-

[91] Song Yen Ling, "China's Gas Prices: Deregulating the Market," *Insight*, October 2013; NDRC, *"Guojia fazhan gaige wei guanyu tiaozheng tianranqi jiage de tongzhi"* *国家发展改革委关于调整天然气价格的通知 [NDRC notice on adjusting natural gas price]*.

[92] Anne-Sophie Corbeau et al., *Gas Pricing and Regulation: China's Challenges and IEA Experience*, 21.

[93] http://www.china.org.cn/business/2013-11/05/content_30499886.htm

[94] uPenn, "China's Underground Race for Shale Gas," *Knowledge@Wharton*, August 21, 2012, http://knowledge.wharton.upenn.edu/article/chinas-underground-race-for-shale-gas/.

[95] Ministry of Land and Resources, *"guotuziyuanbu yeyanqi tankuang quan zhaobiao gonggao"* *国土资源部页岩气探矿权招标公告 [Announcement on prospecting tender for shale gas]*, 2012, http://www.mlr.gov.cn/zwgk/zytz/201209/t20120910_1139187.htm.

owned companies, 8 were provincial level state-owned companies and two were private companies.[96]

Nevertheless, non-NOCs face a range of barriers in entering the shale gas industry, most of which are related to the skewed playing field in favor of the big NOCs. The NOCs already own most of the prime shale gas acreage. Shale gas acreage often overlaps with conventional natural gas acreage, which essentially means that because of their dominance in the natural gas industry, the state owned oil and gas companies constitute an oligopoly in the shale gas sector. There official requirements for minimum exploration activity to maintain permits are low,[97] which means that NOCs have been able to focus their resources on conventional plays while retaining shale gas licenses with a minimal level of activity. According to one industry player, CNPC has 85 percent of the attractive acreage and is currently uninterested in large-scale development of these resources.[98] The result of this is that there is less quality acreage available to release through bidding.[99]

While the second tender introduced non-NOC companies and in many ways demonstrated the determination of the government to go through with breaking up NOC dominance in the shale gas sector, none of the companies in question have so far made any substantial progress in exploration, much less production.[100] The tender therefore revealed that there are important hurdles for private participation in the shale gas sector that cannot be solved by simply issuing acreage. First, these companies lack experience in natural gas extraction, do not have the strong financial background that the NOCs have and are reliant on either technology developed by NOCs or IOCs.[101] Second, the acreage released by the MLR was reportedly of low quality, and ill-suited for development.[102] Third, NOCs have allegedly been unwilling to share their experiences or data from geological surveys with the new participants.[103] Due to these difficulties, as of December 2013, most companies that participated in the second bidding round had not begun drilling work and several companies have attempted to solicit financing by transferring part of their interests, or through joint ventures or production sharing agreements.[104]

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[96] MLR, "'Guotuziyuanbu dizhi kanchasi sizhang Peng Qiming jieshao zhaobiao churang de jieguo he houxu gongzuo' 国土资源部地质勘查司司长彭齐鸣介绍招标出让的结果和后续工作 [Head of MLR department of geological survey, Peng Qiming introduces tender results and ensuing responsibilities]," January 21, 2013, http://www.mlr.gov.cn/wszb/2013/2yyqzb/zhibozhaiyao/201301/t20130121_1176943.htm.

[97] Anne-Sophie Corbeau et al., *Gas Pricing and Regulation: China's Challenges and IEA Experience*, 24.

[98] Author interview with IOC representative, May 5, 2014.

[99] Author interviews with IOC representatives and government officials, April/May, 2014

[100] Tian Lei, et. al, "Stimulating Shale Gas Development in China – A Comparison with the US Experience," July 2014, http://www.rff.org/RFF/Documents/RFF-DP-14-18.pdf

[101] Edwin Lee, "China Moves to Ramp up Shale Gas Production," December 10, 2013, 2, http://www.lexology.com/library/detail.aspx?g=dfaf8073-fd40-47b2-af9b-f1702bbdb97d.

[102] Author interview with IOC representative, May 5, 2014.

[103] Author interview with representative from Chinese non-NOC energy company, April 23, 2014.

[104] Ibid.

In case these companies are able to successfully extract commercial flows of natural gas, they still face the hurdle of bringing the natural gas to the market. A well-developed and well-regulated natural gas pipeline grid was a cornerstone of the US shale gas revolution. In comparison, the Chinese industry is impeded by a lack of natural gas infrastructure. Transport infrastructure for natural gas in China includes liquefaction facilities, compressed natural gas and most importantly, pipelines. At the end of 2011, China had a total of more than 50,000 km of long-distance gas transmission pipelines, compared to more than 500,000 km in the US.[105] To meet the support the envisioned growth in natural gas consumption, an expansion of the gas pipeline network is necessary.[106]

In addition to the pipeline deficit, ownership and management is a key issue. A monopolized pipeline system prevents competition in the up-stream sector.[107] Third-party pipeline access was implemented in the US as a result of a series of FERC orders in the early 1980s and 1990s, and was integral in giving smaller market players access to downstream markets.[108] In China, however, pipeline infrastructure can be seen as a byproduct of NOC exploration, import and sales activities. Around 80% of Chinese pipelines are owned and controlled by CNPC.[109] First, this is an impediment to the establishment of an integrated gas transmission grid on a national scale, an important precondition for liberalizing natural gas prices. Second, it leaves non-integrated companies, with two choices: either selling their product to integrated companies or attempting to sell locally, through small-scale liquefaction and short distance pipelines. As outlined above, the NEA, NDRC and MLR have released policies urging private investment in construction of natural gas infrastructure, as well as third party pipeline access in case of excess capacity.[110] However, none

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[105] Anne-Sophie Corbeau et al., *Gas Pricing and Regulation: China's Challenges and IEA Experience*, 28.
[106] Nobuyuki Higashi, *Natural Gas in China Market Evolution and Strategy*.
[107] Anne-Sophie Corbeau et al., *Gas Pricing and Regulation: China's Challenges and IEA Experience*, 30.
[108] Wang Zhongmin and Krupnick Alan, *A Retrospective Review of Shale Gas Development in the United States: What Led to the Boom?*, 31.
[109] Anne-Sophie Corbeau et al., *Gas Pricing and Regulation: China's Challenges and IEA Experience*.
[110] In 2013 the NDRC released the policy document, "Management Measures for Natural Gas Infrastructure", calling for third party investment in natural gas infrastructure. Following this policy, the NEA released the "Management Measures for equal and Open Access to Pipeline Networks", requiring pipeline companies to release spare capacity for third-party access. In 2013, the NEA released the "Shale Gas Industrial Policy", which encourages private investment in the shale gas industry as well as in pipeline infrastructure. The policy also explicitly states that shale gas producers and distributors should be given "non-discriminatory access" to pipeline network and infrastructure. For the policies in question, see: NDRC, "Five year plan for natural gas"; Xu Shaoshi, *"Tianranqi jichu sheshi jianshe yu yunying guanlibanfa"天然气基础设施建设与运营管理办法 [Management policy for natural gas infrastructure construction and transport]*, 2014, http://www.ndrc.gov.cn/zcfb/zcfbl/201403/t20140320_603521.html; NEA, *"Guojia nengyuanju guanyu yinfa "youqi guanwang sheshi gongping kaifang jianguan banfa (shixing)" de tongzhi"国家能源局关于印发《油气管网设施公平开放监管办法（试行）》的通知 [NEA on efforts to open up access in oil and gas pipeline infrastructure policy (trial)]*, 2014, http://zfxxgk.nea.gov.cn/auto92/201402/t20140224_1768.htm.NEA,

of these policies are specific enough, or indicate any measures to designed to compel pipeline companies to release capacity or provide non-discriminate access to infrastructure.

The skewed market increases the risk for smaller non-NOC enterprises, and growing awareness the skewed playing field, as well as the observed failure amongst license holders from the second tender is most likely the reason why interest in a rumored third tender has been lukewarm at best; in a poll of 66 enterprises at a shale gas conference in Chongqing, 42 stated that they would refuse to participate in an eventual third bidding round.[111] This is also likely to be the main reason for the delay of the third tender, initially expected for 2013.[112]

Thus far, the lack of progress by participants in the second tender, and the apparent disinterest in a new bidding round reflects a clash between government strategy and actual market conditions. On one hand, most non-NOC companies have do not have much prior experience in extracting natural gas, and have been dependent on external expertise.[113] On the other hand, government officials have not issued the substantive policies needed to release the NOC grip on the market, by means of increasing the penalties for inactivity on licensed acreage, requiring sharing of information from geological surveys and more specific measures for allowing third-party pipeline access. Moreover, the author's discussions with government and industry players indicate that NOCs have actively resisted both government data sharing initiatives, and government calls for relinquishment of more attractive resource plays for public tender.[114] The contradiction between industry and government, and the apparent incremental pace of government policy is a testament to the influence of the NOCs in the natural gas industry, and the growing disconnect between the interests of government and its former appendages.

However, there have been signs that the NOCs have been yielding to government pressure. In February this year, Sinopec stated that it would open 30 percent of its most valuable asset, its downstream distribution networks to social and private capital.[115] Furthermore, CNPC chairman, Zhou Jiping, stated that CNPC would seek cooperation in pipeline infrastructure, refining and in developing unconventional gas resources, allowing private capital to enter as a minority stakeholder in some of its

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"Yeyanqi chanye zhengce" 页岩气产业政策 [shale gas industrial policy], 2014, http://zfxxgk.nea.gov.cn/auto86/201310/t20131030_1715.htm.

[111] Caijing, "'Minqi touzi yeyanqi: 'xianbing' haishi 'xianjing'?' 民企投资页岩气：'馅饼'还是'陷阱'？[Social and private investment in shale gas: jackpot or trap?]," *Finance Ifeng*, November 14, 2013, http://finance.ifeng.com/a/20131114/11081047_0.shtml.

[112] http://www.out-law.com/articles/options-delayed-until-spring-according-to-local-press/

[113] Author interview with government official, April 23, 2014

[114] Author interview with IOC representative, April 25, 2014

[115] Lucy Hornby, "Sinopec Plans to Open Its China Oil Distribution Networks," *Financial Times*, February 19, 2014, http://www.ft.com/cms/s/0/99eca2b6-9988-11e3-91cd-00144feab7de.html.

projects.[116] It is still too early to see whether and in what way CNPC and Sinopec will follow through on these statements. It is even more difficult to say whether they will have a real effect on how the two biggest NOCs are managed. Although diversifying investments in the energy sector might be a step in the direction of liberalizing upstream and midstream markets, allowing external investors a minority stake is not a guarantee that NOCs will release acreage or allow third party pipeline access. The policies outlined above have been ambitious and broad in scope, but fail to specify the steps taken for implementation. Based on interviews conducted by the author, the general industry expectation is that NOCs will continue to enjoy an unchallenged position in the upstream sector, and that if China will reach its shale gas targets, it will be based on CNPC and Sinopec's achievements.

6.3 Environmental regulation and population density pressures

If the experience in other countries is any indication, both government and industry in China need to take environmental concerns about shale gas seriously. Along with large scale shale gas development comes the risk of fresh water contamination adjacent to drilling sites[117] and the increased carbon footprint of shale gas extractions caused by methane leaks and flaring in the drilling process.[118] The potentially negative impact of hydraulic fracturing on water quality is particularly likely to be an urgent issue in China, where already 90 percent of groundwater is contaminated – 38 percent so polluted that it is considered undrinkable even after filtration.[119]

Also important are stakeholder perceptions of industry behavior, especially by the people that live in surrounding areas. In many countries, concerns for the environmental impacts of shale gas development have sparked protest movements, and in France and parts of the US such movements have successfully pushed for legislation to ban shale gas development. As a result, industry professionals need to pay considerable attention their environmental record and how locals perceive their operations. A KPMG survey of oil and gas industry executives showed that executives consider environmental and sustainability issues the main challenge to shale gas development.[120]

Environmental concerns have been one of the main sources for social unrest in China, and there is little reason to think that shale gas related activity would not concern local populations when drilling becomes more

[116] Chen Yang, "CNPC Eyes Mixed-Ownership Structure," *Global Times*, March 17, 2014, http://www.globaltimes.cn/content/849138.shtml.
[117] *World Energy Outlook 2012 - Golden Rules for a Golden Age of Gas*.
[118] Jeff Tollefson, "Gas Drilling Taints Groundwater," *Nature* 498, no. 7455 (June 25, 2013): 415–16, doi:10.1038/498415a.
[119] Jane Qiu, "China to Spend Billions Cleaning up Groundwater," *Science* 334, no. 11 (November 2011): 745.
[120] KPMG Global Energy Institute, *Shale Gas – A Global Perspective* (KPMG, 2011), http://www.kpmg.com/Global/en/IssuesAndInsights/ArticlesPublications/Documents/shale-gas-global-perspective.pdf.

prevalent. In Sichuan Basin, the most favorable basin for shale gas development in China, population density is a major issue. With 70 million inhabitants, Sichuan's population density is around 538 persons/km2, making it one of the most densely populated areas in China and in the world.[121] Shale gas has ostensibly already caused concerns amongst locals living around China's first successful shale-gas location. A 2014 investigative news report, following rumors of a gas explosion at Sinopec's Fuling operations, found local populations complaining about contaminated water supplies and a loud explosion, which purportedly killed 8 workers.[122] More recently, Shell announced that it is considering reducing its shale gas activities in Sichuan, due to "the challenges of operating in the very highly populated agricultural region".[123]

The environmental implications of shale gas development justify specific environmental regulation towards the shale gas industry, to ensure that companies adhere to strict technological and environmental standards. There are solutions available to address the environmental issues outlined above, and with appropriate regulation, the environmental benefits of shale gas are likely to outweigh the disadvantages.[124]

Thus far, although the urgent need for environmental regulation has been mentioned in several of the policies reviewed for this report, there is no specific environmental policy for shale gas. The absence of environmental regulation highlights a complex clashing of priorities for Chinese policy makers. While shale gas development has been framed as an important element of both energy security and as an answer to air pollution issues, the potential environmental implications of the industry have still not been adequately addressed. The importance of such regulation becomes more urgent with the introduction of more actors into the industry. Industry insiders argue that CSR practices of Chinese NOCs have improved after their internationalization, and environmental regulation in China's upstream sector have become stricter.[125] However, as the shale gas sector expands, both in term of actors and volume, the industry's environmental practices might become more difficult to supervise.

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[121] Fan Gao, *Will There Be a Shale Gas Revolution in China by 2020?*, 27.
[122] Keith Bradsher, "China Takes On Big Risks in Its Push for Shale Gas," *New York Times*, April 11, 2014, http://www.nytimes.com/2014/04/12/business/international/china-takes-on-big-risks-in-its-push-for-shale-gas.html?_r=0&pagewanted=all
[123] " Shell to Scale Back Sichuan Shale Gas Project," *Natural Gas Asia*, September 5, 2014, http://www.naturalgasasia.com/shell-to-scale-back-sichuan-shale-gas-project-13457

[124] Steffen Jenner and Alberto J. Lamadrid, "Shale Gas vs. Coal: Policy Implications from Environmental Impact Comparisons of Shale Gas, Conventional Gas, and Coal on Air, Water, and Land in the United States," *Energy Policy* 53 (February 2013): 442–53, doi:10.1016/j.enpol.2012.11.010.
[125] Author interview with IOC representative, May 5, 2014

6.4 Technology and international participation in China's shale industry

As posited earlier in this paper, the shale gas revolution in the US was driven by technological innovation. Industry professionals have been aware of the existence of shale gas for many years, but unable to extract it in a commercially viable manner. The key technologies in shale gas extraction include hydraulic fracturing, directional drilling and technologies related to seismic surveying and data collection, which are necessary to locate the right spot to drill, cut down cost and time required for the drilling process and to improve the efficiency of hydraulic fracturing, thereby also reducing the consumption of water.

Chinese shale gas is located in geologically challenging plays and in areas where water scarcity is severe, which makes technological advances and commercialization of these technologies necessary. Chinese NOCs have made improvements in domestic technologies, which have driven down the costs and time required for each well.[126] Sinopec's success also indicates that they have developed the solutions necessary to achieve commercial flows of shale gas, at least in that specific play. Nevertheless, the author's interviews with both domestic and international oil and gas companies have confirmed that China still lacks the core technologies associated with both drilling and hydraulic fracturing.[127] Besides these core technologies, Chinese NOCs also face shortages of workers with the necessary skills to operate the drills. Therefore, Chinese NOCs have relied on foreign acquisitions and domestic cooperation with IOCs and international oil and gas service companies (hereafter "service companies"), to access core technologies and a diversified supply of manpower with valuable experience from years of working in other shale gas plays.[128]

6.4.1 NOC acquisitions abroad

Domestic attempts to obtain necessary technology initially manifested in a wave of NOC acquisitions of companies with shale gas experience abroad, outlined in Table 6. As a result of these acquisitions the three biggest Chinese NOCs managed to acquire both acreage and experience in shale gas development abroad. However, the acquisition of foreign companies does not necessarily mean that there is technology transfer between the two sides. In most cases, Chinese energy companies end up holding minority stakes when they invest abroad, which means that their partners have the right to withhold proprietary technology.[129] Hence, the strategy can also be seen as a way for Chinese companies to create value for their shareholders.

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[126] Author interview with NOC representative, April 25 2014
[127] Author interviews with IOC and NOC representatives, April/May 2014
[128] *Ibid.*
[129] Catherine T. Yang, "China Drills Into Shale Gas, Targeting Huge Reserves Amid Challenges," *National Geographic News*, August 8, 2012, http://news.nationalgeographic.com/news/energy/2012/08/120808-china-shale-gas/.

Table 6.1: Foreign acquisitions/attempts at acquisitions related to shale gas by Chinese NOCs

Date	Company	Activity
November 2010	CNOOC Ltd	33.3% interest in Chesapeake's net oil and natural gas leasehold acres in the Eagle Ford Shale.
January 2011	CNOOC Ltd	USD 1.3 billion stake in Chesapeake Energy's leasehold acres in Colorado (second deal in two months.)
December 2011	Sinopec	Acquired Canadian oil and gas explorer Daylight Energy Ltd
February 2011	PetroChina	Attempt to acquire stake in Encana Corp's shale gas assets – Collapsed 4 months later as they failed to agree
January 2012	Sinopec	Joint venture with Devon energy
February 2012	PetroChina	Acquired Shell shale assets in Canada.
December 2012	PetroChina	Acquired shale gas assets from Encanada
February 2013	Sinopec	Acquired of 50% of Chesapeake Energy Corp's Mississippi Lime oil and gas properties in Oklahoma
February 2013	CNOOC	Takeover of Nexen, which holds shale gas assets in Canada
May 2013	Sinochem	Reach 1.7 bn deal for assets in Texas with Pioneer Natural Resources

Source: Compiled by the author based on news reports.

6.4.2 International companies entering Chinese markets

International cooperation has occurred either in shape of IOC agreements with NOCs, or international service companies who have established equity joint ventures in China. In the first category, the government permits two different models of international participation: Sino-foreign equity joint venture and Sino-foreign contractual (cooperative) joint venture.[130]. Several major IOCs have entered the Chinese shale gas industry through joint study (JSA) and joint assessment (JAA) agreements (reviewed in Table 6.4). The first agreement was between CNPC and Newfield in 2007, to jointly study shale gas resources in Weiyuan region.[131] Several joint agreements have followed, but the only production-sharing contract (PSC) to materialize is an agreement between CNPC and its long time partner, Shell. This contract was signed in 2012 and received government approval in March 2013, upon which Shell's chairman, Peter Voser, promised to invest 1 bn. US dollars in developing Chinese shale gas resources.[132] As mentioned above, Shell has since begun reconsidering its commitment to shale gas development in China, wishing instead to focus capital on other more profitable ventures.

Investment agreements between Chinese NOCs and IOCs in China have often coincided with agreements between the same companies abroad. This is perceived as a strategy where NOCs offer domestic acreage for international cooperation opportunities outside of China.[133] Shell's production agreement with CNPC coincided with an agreement between Shell and PetroChina in the Groundbirch shale play in British Colombia; ConocoPhilips has deals with PetroChina in both Australia and the Sichuan basin; and ENI and CNPC cooperate on natural gas in East Africa and the Rongchang block in Sichuan basin.[134] The experience of international companies is that agreements abroad can be a necessary precondition for market entry in China, and that upon such agreements NOCs open previously restricted acreage to their partners.[135]

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[130] Hu and Xu, "Opportunity, Challenges and Policy Choices for China on the Development of Shale Gas," 24.
[131] Guo Jianchun and Zhao Zhihong, "China Vigorously Promoting Shale Gas Exploration, Development," accessed May 7, 2014, http://www.ogj.com/articles/print/vol-110/issue-3/exploration-development/china-vigorously-promoting.html.
[132] "Shell Signs 1 Billion Dollar Deal for Shale Gas in China," *Gbtimes.com*, March 28, 2012, http://gbtimes.com/business/shell-signs-1-billion-dollar-deal-shale-gas-china.
[133] Author interview with IOC representative, April 28, 2014.
[134] Chen Yi, *Development Strategies of the Chinese Natural Gas Market* (The Hague: Clingendael International Energy Programme, July 2013), 28, www.clingendaelenergy.com.
[135] Author interview with IOC representative, April 28, 2014.

Table 6.2: Cooperation with IOCs on shale gas in China

Date	International Company	Local Company	Activity	Location/ Basin	Status
Oct 2007	Newfield	CNPC	Joint shale gas study	Weiyuan block, Sichuan	Completed in 2008
Nov 2009	Shell	CNPC	Joint shale gas assessment.	Fushun-Yongchuan block, Sichuan	Started joint production in Mar 2012
Jan 2010	BP	Sinopec	Joint shale gas assessment	Kaili block, Guizhou; Huangqiao block, Jiangsu	Ongoing
Mar 2011	Total S.A.	CNPC	Joint shale gas production	Sulige South, Inner Mongolia	Began production in May 2012
Apr 2011	Chevron	Sinopec	Shale gas exploration	Longli County, Guizhou	Ongoing
Jul 2011	ExxonMobil	Sinopec	Joint shale gas study	Wuzhishan-Meigu block, Sichuan	Ongoing
March 2012	Total A.S:	Sinopec	Joint shale gas study	Unknown	Announced by Total
Dec 2012	ConocoPhillips	Sinopec	Research on shale gas exploration, development and production	Qijiang block, Sichuan	Ongoing
Feb 2013	ConocoPhillips	CNPC	Joint Study Agreement	Neijiang-Dazu Block, Sichuan	Ongoing
Mar 2013	ENI	CNPC	Joint Study Agreement	Changrong block, Sichuan	Ongoing
Mar 2013	Total A.S.	Sinopec	Joint shale gas study	West of Shanghai	Negotiation
Mar 2014	Total A.S.	Sinopec	Plans to drill and produce	Anhui Province	Unsure

As mentioned earlier, energy policy makers have attempted to attract foreign companies by making shale gas exempt from the usual stringent requirements guiding international participation in the natural gas sector by declaring it an independent mineral. In theory, foreign investors are welcome to participate in China's shale gas sector as partners of both private and non-NOC state-owned companies. However, although the MLR tender was initially open to international participants IOCs decided not to participate and have so far eschewed cooperation with the Chinese companies that did. According to one company, the prospect of the acreage on offer was deemed unworthy of investment.[136] Furthermore, without precedence and sufficient guidance from regulators, IOCs are unsure about what shape cooperation with non-NOCs would take, and whether such attempts would receive final approval at all.[137] One industry player also told of confusion and insecurity amongst government regulators themselves about whether or not IOCs would be able to cooperate with private companies.[138]

According to IOC representatives interviewed for this report, NOCs and not the government, are the true gatekeepers of China's shale gas industry. Moreover, the autonomy of NOCs in guiding international investment is increasing, due to recent abolishment of MLR and MOFCOM foreign project approval authority. Once in China, IOCs basically operate at the behest of their local partner. [139] IOCs must deal with the same unequal conditions and the same market access issues that Chinese domestic companies face, most importantly, that there is no connection to the end user. Pipeline access and pricing reforms are therefore also meaningful for international participants, and these have expressed guarded optimism about the future of government reforms.[140] Like domestic non-NOC companies, international companies are also unable to access sufficient information about the geological conditions in the acreage that has been up for tender, or other potential plays. This means that IOCs entering the Chinese market have to accept high risks, especially because contract requirements normally require foreign investors to cover all exploration and production costs.[141]

The combination of large shale gas reserves and the emergence of China as the center for future demand in natural gas mean that many international companies are interested in securing a position in the industry.[142] On the other hand, a difficult operating environment makes China's upstream sector less attractive. With only a few exceptions, the upstream oil and gas industry in China has not been profitable for IOC entrants and profit, is, and will continue to be the main motivator of IOC investment decisions. With the complicated geological conditions, unfavorable market structure and an unclear mandate for international participation, IOC incentives to enter the Chinese shale gas market remain low. Driven

[136] Author interview with IOC representative, April 28, 2014
[137] *Ibid.*
[138] *Ibid.*
[139] Author interview with IOC representative, April 25, 2014.
[140] Ibid.; Author interview with IOC representative, May 5, 2014.
[141] Author interview with IOC representative, April 28, 2014
[142] Author interview with IOC representative, April 25, 2014.

by commercial interests, IOC boards are unlikely to support projects with weak prospects for breaking a profit, no matter where this project is located.[143] In addition, IOCs also have limited human capacity and financial resources, and decisions need to be made about where to focus scarce resources in order to achieve maximum return on investment. In any scenario, expansion in Chinese natural gas consumption will continue to require growth in both domestic production and imports. This means that there are opportunities for supplying growing Chinese gas markets even without access to Chinese reserves. As long as IOCs are able to supply Chinese markets from abroad, and continue to have access to resources elsewhere, they will feel less compelled to take part in the development of domestic shale gas resources.

On the other hand, the future for international oil and gas service companies in the Chinese shale gas industry might be brighter. Schlumberger, Halliburton and Baker Hughes all increased their presence in China in 2012 through agreements with Anton Oilfield Services and the Honghua Group, respectively – and Sinopec's service arm, Sinopec Oilfield Service, set up a partnership in June this year with Weatherford.[144] Service companies do not face the same risks as IOCs, who are responsible for up front fees in exploration projects. However, while these companies can offer both experience and technology, their services come at a high price, charging up to six times more per employee than their local counterparts, and carefully avoid sharing their proprietary technological solutions. For their local customers, this undermines both the commercial prospects and their ability of the to stand on its own feet.

In sum, although regulators have attempted to incite foreign participation, they have not made clear the legalities of foreign investment in the shale gas industry, nor do non-NOC companies, and to some extent the NOCs, necessarily provide an attractive investment opportunity for foreign companies. While industry insiders expect foreign participation in shale gas development to continue following the NOC-IOC PSC model, there is still only one such agreement in place.[145] As such, the future of foreign investment in China's shale gas industry remains unclear, despite the government initiatives reviewed above.

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[143] Author interview with IOC representative, May 5, 2014.

[144] Sinopec, Weatherford Team Up to Tap China's Shale Reserves, *China Business Review*, June 6, 2014, http://www.chinabusinessreview.com/sinopec-weatherford-team-up-to-tap-chinas-shale-reserves/

[145] Akash Gupta, Wang Ying, and Duke Suttikulpanich, *China Shale Gas: Potential Unearthed*, SCOUT (Standard Chartered, September 30, 2013).

7 Discussion

The above sections have discussed the emergence of shale gas as an area of priority for Chinese policy makers. In short, concerns about coal-induced environmental deterioration are driving policy makers to reconsider China's reliance on coal, and to push for cleaner alternatives, including natural gas. At the same time, China's growing energy deficit has generated a strategy of source-diversification, of which increasing domestic production is an integral component. In light of this, policy makers in China's energy sector have treated the expansion of shale gas production as a matter of urgency.

Consequentially, energy policy makers from the various institutions comprising China's energy sector have formulated a range of plans and policies aimed at boosting growth in shale gas production. Reviewed above, these include direct support through government R&D programs and subsidies for shale gas producers, a reduction of government intervention through price liberalization and efforts to increase the players involved in the development of the shale gas industry by reducing NOC control of the upstream and midstream natural gas sectors. Government policy is by far not the only thing that will affect the future of the shale gas industry; also important are the natural constraints on development, making extraction more risky, technologically challenging, time-consuming and expensive. Nonetheless, due to the important role of the state in the Chinese economy, regulators will have a key role in the sustainable development of this emerging sector.

The author's review of Chinese policy documents found that despite overlapping authorities among the multiple institutions involved, their policies have become increasingly coordinated. This finding is in contrast with the general assumption of the fragmented authoritarianism framework, which is that the fragmented structure of the Chinese energy bureaucracy creates a "disjointed, protracted, and incremental" policy process.[146] Government policy towards shale gas development have included both anodyne policies such as subsidies and R&D programs, and controversial policies such calls for market liberalization. The direction of shale gas specific policies bear similarities to the US shale gas experience, which was predicated upon a combination of preferential government policies and the participation of a diverse set of upstream and midstream oil and gas companies, in contrast to the traditional Chinese model where licenses are restricted to only a few state owned oil and gas companies.

Although the indicated direction of these policies is clear, government regulators admit that coordination problems associated with dispersed regulatory authority in the energy sector persist.[147] Some of these coordination problems have been explained above. First, the language of many of these documents is vague, especially those that touch upon the introduction of private investment, foreign investment and third-party

[146] Lieberthal and Oksenberg, *Policy Making in China*, 3.
[147] Author interview with Chinese government official, April 23, 2014

pipeline access. For example, while repeatedly calling for foreign participation, government still has not clarified to international companies whether projects between international companies and private companies will be approved, and much less the form that such cooperation will take.[148] Moreover, the future of both pricing reforms, with reports of lackluster implementation, and environmental regulation are still unclear, nurturing insecurity among industry players about the future direction of government regulation.

At the same time, a careful observation of recent developments shows that government policies have so far been difficult to implement. On one hand this bears witness of an unresolved struggle between policy makers and NOCs with entrenched interests in maintaining the status quo. NOC reluctance to release acreage, open up pipelines, share geological data and release core technologies are arguably sound practices from the perspective of a business wishing to protect its competitive advantage. However, these practices have so far thwarted government attempts at introducing market forces throughout the value chain of shale gas development. So far, more decisive policies to break up the NOC oligopoly in the hydrocarbon industry, such as separating CNPCs upstream and midstream operations and privatizing NOC owned oil and gas service companies have been discussed, but have not yet received official sanction.[149]

On the other hand, market access is only one side of this problem. The other is that there is yet to emerge a viable alternative to the NOC-led model of development. The second bidding round demonstrated the lack of capacity among non-NOC players in the upstream gas sector. With no previous experience, these companies are reliant on either foreign or NOC technology and guidance, which are both offered at a steep price. In the absence of success stories, other actors have expressed their reluctance to participate in an eventual third tender. These two issues are two sides of the same story. As long as non-NOCs are not given access to promising plays, geological information and equal treatment, they are not likely to develop the capacity needed to develop complex unconventional gas resources.

The above discussion displays the difficulties faced by Chinese policy makers. Despite sharing the same priorities, and with minimal conflict, they have been unable to make decisive progress on reducing NOC control over shale gas resources. Therefore, notwithstanding government efforts to the contrary, the NOCs, CNPC and Sinopec in particular, have consolidated their control of the shale gas industry. The findings of this study on the Chinese shale gas industry therefore strengthen the argument developed in the literature review, that diffuse government regulation in the Chinese energy industry has increased the operational autonomy of Chinese NOCs, strengthening the regulated versus its regulator. Although this suggests bleak prospects for the rapid implementation of policies toward market reform in the shale gas sector, it does not necessarily mean

[148] Author interview with IOC representative, April 28, 2014
[149] Phillip Andrews-Speed, “Third Plenum’s Plans for China’s Energy Sector.”

that the industry will be unable to develop successfully. The alternative model of state-owned enterprises driving growth has so far been able to reap modest results, but in light of a poorly developed private sector, and the transitional state of regulation, the state-led model might in the short term deliver the best growth prospects for the Chinese shale gas sector.

8 Conclusion

This study has examined priorities, strategies and policies towards the emerging Chinese shale gas industry, drawing on the body of literature on policy-making and implementation of China's energy sector. It has argued that government efforts to increase natural gas in the energy mix, combined with increasing reliance on foreign sources of natural gas, have made the development of Chinese shale gas resources a priority for policy makers. As a result, a consensus has emerged between government institutions about a direction for industry development resembling the US experience, with direct government subsidies and R&D support, and market access for private and foreign companies. However, due to material and institutional impediments, efforts to increase production of shale gas have not yielded the rapid growth targets envisioned by policy makers, and the introduction of private and foreign investment has been held back by the oligopolistic structure of the industry, entrenched interests and the tentativeness of regulators in formulating the specific policies necessary to break up NOC oligopoly.

The specific findings of this report at the industry level are threefold. First, commercial extraction of shale gas has been held back by material constraints, primarily due to the difficult geological characteristics of shale plays. This has made for a time consuming, technologically demanding and expensive drilling process, with low success rates. Despite progress in developing local solutions, companies still lack core technologies required for commercial horizontal drilling and hydraulic fracturing. Second, the report has shown the oligopolistic characteristics of the shale gas industry, with the main bulk of known acreage, geological data and pipeline infrastructure in the hands of the NOCs, of which CNPC is the main player. Third, the current industry structure impedes market access by private and international companies. According to the interviews conducted for this report, a pluralization of the industry will not occur without decisive intervention to reduce the power of the NOCs in the natural gas industry. These findings indicate incongruence between industry structure and the shale gas development path chosen by government regulators, and only time will show whether or not this incongruence can be overcome. However, there is no guarantee that a pluralization of the Chinese shale gas industry will be most efficient model for increasing production. This report points to the inexperienced and underdeveloped non-NOC oil and gas industry, making the case that a development model based on the current NOC-led industry structure is much more likely to yield results in the short-term than a large-scale introduction of non-NOC actors.

In general terms, the above analysis supports the reviewed theoretical perspectives on energy policy making in China. The shale gas sector lacks centralized coordination; regulatory responsibility is shared between many different government institutions. This is especially evident in the lack of environmental standards, which might illustrate a complex balancing of interests between a national strategy targeting rapid growth in natural gas consumption to reduce the pollution intensity of China's energy sector, and protecting local populations from potential

harmful effects of unregulated extraction of shale gas. Going into details about this apparent contradiction was outside of the scope of this report, but the topic is deserving of further study in the continued absence of a rigorous environmental regulatory scheme towards shale gas.

Despite institutional fragmentation, the study has also shown that in the case of the shale gas industry these government institutions have been able to form a consensus around which development path to pursue, where the introduction of private and international companies has an important role. This consensus originates in the political momentum behind natural gas, and in a backdrop where government has voiced support for market forces to play an increasing role in resource allocation. However, while a degree of unison exists between government regulators, there is considerable divergence of interests between the industry and its regulators; fragmentation is evident between the government and NOCs, rather than between the institutions governing energy. Thus, the shale gas industry shows that despite an emerging consensus behind a certain political project, regulators in the natural gas sector rely on industry support for implementation, in particular the powerful NOCs. At the time of this study China's shale gas industry is still in its infancy and its future remains murky. However, based on this research, the author suggests that the future of the shale gas sector is an indication of the direction and impetus behind continued reform in the Chinese energy sector, and therefore deserves further scrutiny.

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