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Catching environmental noncompliance in shale gas development in China and the United States

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ABSTRACT

Coal is the top fuel for power generation in both China and the United States. Its replacement is one critical method to mitigate the serious environmental impacts. Natural gas is associated with much less air pollution and is one of the most important alternative fuels. In the United State shale gas – one key type of unconventional natural gas – has become a disruptive energy resource during the past years. China has the world's largest resource of shale gas, and it is keen to develop them to alleviate unacceptable air pollution and to ensure energy security. However, one big obstacle standing between the ambition and the reality is the potentially serious environmental impacts caused by shale gas development. We construct an analytical framework, focusing on the coverage and implementability of monitoring, reporting and verification (MRV) systems, to qualitatively evaluate the probability of detecting noncompliance – for enhancing compliance – in China and the United States on three prominent environmental impacts, including water contamination, water consumption and methane leakage. China should improve significantly on the implementability dimension and pay urgent attention to currently weak MRV systems on water contamination. The United States needs to extend the MRV coverage of ground water consumption. Only when the environmental impacts in shale gas development were effectively controlled, the fuel switching to replace coal could bring significant environmental gains.

1. Introduction

Coal is the leading fuel in power generation in both China and the United States. Fuel switching is one critical method to control its infamous impacts on climate change and environmental pollution. As a key alternative fuel, natural gas emits only about half the amount of CO_2 and much less conventional pollutants to generate one kWh of electricity (U.S. Environmental Protection Agency, 2000). In the first quarter of 2012, U.S. energy-related CO_2 emissions hit a 20-year low, and one of main reasons for this is the declining use of coal and the increasing use of natural gas (U.S. Energy Information Administration, 2012a). Thanks to the breakthroughs of horizontal drilling and hydraulic fracturing (or "fracking"), the booming domestic development of shale gas has helped to make the U.S. natural gas wellhead prices more than 36% lower, from $5.77/GJ in 2007 to $3.66/GJ in 2011 (U.S. Energy Information Administration, 2013a,b), while the price of Central Appalachian coal increased from $1.76/GJ to $3.00/GJ in the same period (BP, 2012; U.S. Energy Information Administration, 2013c). Considering the higher thermal efficiency, natural gas became more economical.

In the world energy market, the U.S. natural gas price has been much cheaper than the prices both in Asia and Europe since 2008 (World Bank, 2013). The projection in the Annual Energy Outlook 2012 Reference Case shows that the U.S. natural gas production will exceed consumption in early 2020s, along with a relatively low price, allowing the United States to transition from being a net importer to a net exporter of natural gas, and this will enhance its energy security in the complicated international energy market (U.S. Energy Information Administration, 2012b). Cheaper natural gas also boosts the U.S. economy, especially in the "Great Recession" after the financial crisis. More than 600,000 people were employed in shale gas industry in 2010 with more indirect and induced jobs being created to support the industry (IHS Inc., 2011). The lower price also makes natural gas a more affordable fuel for manufacturers and this is bringing industry back to the United States (IHS Inc., 2011); as a result, even more jobs are created.

The shale gas development promises to provide a clean, affordable, abundant and more secure fuel, thereby greatly contributing to a vision of a "Golden Age of Gas" (International Energy Agency,

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2011). However, the golden picture is blurred by potentially negative and serious environmental impacts as addressed in many important publications to analyze the impacts more comprehensively (International Energy Agency, 2012; Considine et al., 2012; Wang et al., 2012; Spellman, 2012) or specifically on several widely-recognized major ones, including water contamination (Olmstead et al., 2013; Vidic et al., 2013), ecological disruption due to the huge consumption of water (Yang et al., 2013), and methane leakage (Howarth et al., 2011). The new application of hydraulic fracturing brings new challenges and adds difficulties in addressing the environmental impacts of unconventional gas extraction, compared to conventional gas production. These environmental reasons have become significant obstacles impeding the use of hydraulic fracturing in shale gas production in some countries (The Economist, 2011), like France, which insisted that it would not reconsider the shale gas exploration ban before further environmental researches have been carried out (Agence France Presse, 2012). Besides, as shown in demonstrations by many environmental and public health NGOs, "fracking" projects or shale gas development in general have caused wide public concerns in many parts of the world (World Wide Fund For Nature, 2012; Sierra Club Atlantic, 2012; Friends of the Earch Europe, 2012). Hence, the environmental impacts of shale gas exploration are among the decisive factors shaping the landscape of world shale gas development in the future.

Twenty-two "Golden Rules" have been proposed by the International Energy Agency to help governments and the industry gain a "social license to operate" (International Energy Agency, 2011, 2012). They provide guidance on measuring and disclosing environmental data, engaging local communities, choosing optimal drilling location, preventing leaks from wells, managing water use and disposal, targeting zero venting and minimal flaring of gas, and improving project planning and regulation control (International Energy Agency, 2012). The "Golden Rules" emphasize monitoring, reporting and verification (MRV) systems for preventing potential environmental impacts, including monitoring the baseline and progress of key environmental indicators, effectively reporting and verifying data on, for example, water consumption, waste water generation and methane emissions.

However, the "Golden Rules" in principle are still far away from the "Golden Rules" in practice, with there being an enforcement gap between them. The application of the "Golden Rules" in shale gas development raises costs by an estimated 7% for a typical individual shale gas well, enough to devour a significant proportion of prospective profits (International Energy Agency, 2012). If noncompliance could not be effectively caught and deterred, the additional compliance costs would serve as disincentives for companies to follow the "Golden Rules". The higher the compliance costs are, the greater the enforcement challenges will become (Becker, 1968). Hence, adequately stringent environmental regulation should be established accompanied by effective enforcement.

Successful environmental policy enforcement requires an effective system of monitoring, reporting and verification (MRV) to catch noncompliance. Monitoring is an essential basis for the realization of an effective MRV system because it is the most direct way of getting first-hand data on environmental impacts. Reporting helps to keep the information transparent and available so that an environmental protection department can issue a directive calling for improvement and solving any problems based on actual data. In order to validate the accuracy and reliability of reported information and policy compliance, verification is necessary. MRV systems should be considered as the backbone of environmental management for shale gas development.

In the United States, the use of fracking technology is still controversial. Many states have updated their regulations for shale gas production but with widely varying requirements (Rahm, 2011). For example, among the 31 shale gas producing states, only 18 have clear requirements or proposed requirements for fracking fluid disclosure (Richardson et al., 2013). Although state governments are the principal environmental enforcement authority for shale gas production, it is the federal government who sets up many requirements for MRV systems (Zoback et al., 2010). Studies show that most states do witness adequate compliance with existing regulations, although a few exceptions occurred in the production process (Considine et al., 2012; Spellman, 2012; Boyer et al., 2012).

Current environmental MRV systems in shale gas development have not been systematically examined in the literature. This paper contributes mainly to evaluating existing environmental MRV regulations to help especially China, a country with an ambitious shale gas plan but poor environmental policy enforcement records, make improvements. The rest of the paper is organized as follows. Section 2 introduces data and constructs an analytical framework to guide further analysis. Then we examine the current MRV systems on their coverage and implementability to catch environmental noncompliance in China and the United States. In order to stay focused, we concentrate on three common and critical environmental impacts, particularly water contamination (Section 3), water consumption (Section 4), and methane leakage (Section 5). A brief conclusion and discussion will be given in Section 6 in which we suggest how the two countries could improve the effectiveness of MRV systems.

2. Data and methodology

2.1. Data

We collected a relatively comprehensive dataset of regulation documents in China and the United States specifically on their MRV systems for regulating the three major environmental impacts. As listed in Table 1, these documents provide detailed legal and policy evidences in our analysis. In order to put our analysis in empirical context, we also collected first-hand data in a field trip in June 2013 to China's pioneering shale gas producing sites in Sichuan province (Fig. 1) and in May 2014 through interviewing 17 experts and shale gas-related engineers in a dedicated workshop held in Chongqing. Particularly, the interviewees include two from shale gas operators in China, two from governmental think tanks, one from the government, nine from service/equipment/material providers for shale gas well drilling and operation, two from downstream users of shale gas (mainly chemical companies), and one from an environmental impact assessment agency.

Fig. 1. A field trip to China's shale gas producing sites in June 2013 (first shale gas well in China – Wei 201).