IMPLICATIONS OF WIDER AVAILABILITY OF UNCONVENTIONAL GAS ON CHINA ENERGY SYSTEM UNDER CLIMATE CONSTRAINT SCENARIOS

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Overview

This paper investigates implications of wider availability of unconventional gas on China energy system using the TIAM-UCL global energy system model. Two major scenarios are developed: one with low availability of unconventional gas and the other with high availability of unconventional gas. Both of these scenarios are modelled with and without climate policy by restricting cumulative greenhouse gas (GHG) emissions. The analysis focusses on implications on China's primary energy production and consumption, primary energy trade, generation mix and final energy consumptions.
Estimates of global recoverable gas resources have increased sharply in the recent decade, predominantly as a result of technological advances unlocking gas resources in unconventional reservoirs, such as tight sands, coal bed methane, and, most importantly, shale rock. Although at present, unconventional gas predominantly plays a significant role only in United States, it has the potential to reduce supply, price volatility, and energy security concerns for a number of regions globally, as lessons learned in the United States are applied internationally.
Since 2006, China is the biggest CO2 emitter in the world and its emissions will increase continuously due to expected high growth rate for energy service demand as a result of economic developments. Further, China's economy is carbon intensive at present. However, China agreed to improve its carbon intensity by 40% - 45% in 2020 compared to 2005 level. IEA's Energy technology Perspective Report (IEA 2012) also mentions that the commitment of China's government to a lower-carbon path is clear, both in its domestic initiatives and in its continuing engagement internationally, where it displays active technological co-operation and growing leadership in climate negotiations.
Growing concern over climate change has in recent years also worked in favour of natural gas, which contains around 25 percent less carbon than oil and half as much carbon as coal. It is still, however, a fossil fuel and unabated burning of the estimated remaining recoverable volumes of natural gas alone (610 tcm) would form well over 60% the remaining 'carbon budget' of 500 Gt carbon.
While estimates of unconventional gas resources even in countries with a longer history of shale gas production, such as the United States, remain very uncertain, even greater uncertainty surrounds unconventional gas resources in the rest of the world. Recent reports, including ARI for the EIA (Kuuskraa et al. 2011), the World Energy Council (WEC, 2010), and Medlock et al. (2011), have sought to address this uncertainty by providing estimates of shale gas on a global scale. This paper uses the 16 region TIAM-UCL (The TIMES integrated assessment model) global energy system model to investigate the impacts of the wider availability of unconventional gas on China energy system under different long-term energy scenarios.

Methods

TIAM-UCL is a 16 region technology rich bottom-up whole system global model from energy resources to conversion to infrastructure to sectoral end-use. China is an explicit region in the model. It is a linear programming partial-equilibrium model that minimises total discounted energy system cost in the standard version and maximises societal welfare (the sum of consumer and producer surplus) in the elastic demand version (Loulou and Labriet 2007). Within TIAM-UCL, all major sources of conventional and unconventional gas (existing proved and probable reserves, reserve growth, undiscovered, arctic, tight, coal bed methane, shale, and associated) are modelled separately within each of the 16 regions, with individual availabilities and costs of production. Sour and deep water gas are modelled as part of the conventional gases and available at higher costs. Geological aspects of gas production are modelled through imposing build and natural decline

constraints, resulting in asymmetric production profiles for each cost component of each resource category. Gas can be consumed in end sectors in which fuel switching with any other energy source is possible. A low gas availability scenario is modelled by severely restricting the growth of unconventional gas production and increasing the costs of production. Production therefore comes predominantly from conventional sources, and moves to the higher cost sources more quickly, resulting in a higher gas price. This scenario therefore models knowledge of the gas markets in the early 2000s before the recent surge in unconventional gas production. A high gas availability scenario removes this constraint, allowing production from any of the three unconventional gases, and through an accelerated reduction in shale gas costs. A lower long-term gas price therefore results. The model is run at global level and the analysis focusses on China. The scenarios are:

- Reference Scenario with low gas availability (LG-REF): no climate policy is applied and the availability of unconventional gases is limited;
- Reference Scenario with high gas availability (HG-REF): no climate policy. Unconventional gas availability is increased and production costs of some gas types slightly reduced;
- Low Carbon Scenario with low gas availability (LG-LCS): a cumulative GHG emission constraint is applied in order to restrict the global temperature increase to 2^{o}C. All other assumptions; and
- Low Carbon Scenario with high has availability (HG-LCS): a cumulative GHG emission constraint is applied in order to restrict the global temperature increase to 2^{o}C.

Early Results

The results show that China's gas consumption increases under high availability scenarios (HG-REF and HG-LCS) with higher increases under HG-LCS in early period (Figure 1). Unconventional gas production in China increases till 2030 under high gas availability scenarios. But, despite the fact that China demand more gas in HG-LCS than that in HG-REF, post 2030 unconventional gas production in China decreases rapidly in HG-LCS while it keeps on increasing under HG-REF. Adding climate policy has negative impact on indigenous gas production from unconventional sources in long-term. China opts to import cheaper gas, which is produced mainly from conventional sources in MEA mean less carbon emission in upstream, available in the market in the form of LNG. Actually developed countries demand less gas under climate policy as they move to low carbon energy sources. This means that developing countries have access to cheaper gas under climate policy scenarios.

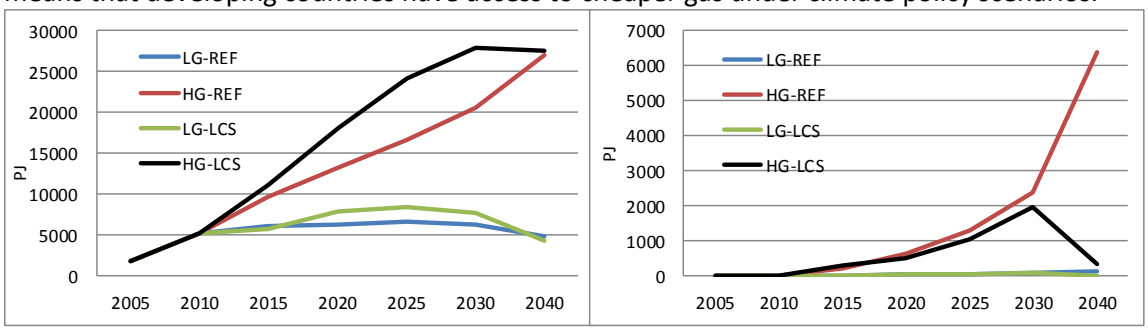

Figure 1: gas consumption in China (left) and unconventional gas production in China (right)

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