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Economic benefits, external costs and the regulation of unconventional gas in the United States

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HIGHLIGHTS

- SWOT summary of unconventional gas developments.
- Risks and returns of unconventional gas highlighted.
- 10 principles given to reduce risks and increase rewards of gas extraction.

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ABSTRACT

We review the economic benefits and external costs of unconventional gas production (UCG) in the United States from a policy perspective. Based on an overview of state regulation in Pennsylvania, a state that has witnessed very rapid growth of gas production over the past 5 years, and global experiences we present 10 key principles that are proposed to reduce the risks and to increase the net rewards of UCG. Application of these principles has the potential to reduce the risks of UCG, especially at a local level, while maximizing the benefits of gas developments.

1. Introduction

Until recently, the majority of natural gas in the US was produced by ‘conventional’ methods, frequently associated with oil production. As recently as 2003 some key projections (National Petroleum Council, 2003) were for increased gas imports, higher gas costs and declining energy security in the US and Europe. As a result, in the period 1996–2010, large investments were made in importing gas infrastructure in Europe and also the East Coast and Gulf of Mexico in the United States, plus corresponding outlays in gas liquefaction plant in gas exporting countries, such as Qatar (IEA, 2006).

While expectations for declining gas output have largely been realized in Europe the situation in the United States has been very different. Beginning in around 2005, but rapidly accelerating after 2008, the United States was able to profitably access previously uneconomic sources of gas, so called ‘unconventional gas’ (UCG) mostly in the form of shale gas. Starting first in Texas, and then adjacent traditional hydrocarbon provinces, improved gas extraction and drilling technologies that include the combination of horizontal drilling, hydraulic fracturing, 3-D and 4-D seismic imaging, coiled tubing, measurement while drilling and slimhole drilling have been able to extract gas from geological formations with low permeability, such as shales. Of these techniques, hydraulic fracturing has attracted the greatest controversy. It involves the injection of a fluid under pressure, typically more than 95% water, with the addition of a proppant (commonly sand) to hold the tiny fractures open, plus a very small proportion of certain chemicals.

The scaling up of UCG technologies in the US has been very rapid. Between 2009 and 2015, gas output grew by almost one third, completely confounding earlier projections (IEA, 2016). This growth is shown in Fig. 1 for the Marcellus Basin that now accounts for nearly a fifth of United States gas production, with much of the drilling activity centred on western and northern Pennsylvania. As a whole, this Basin has seen UCG production rise from almost nothing in 2008, until in 2016 it has reached levels where, had the Basin been a country, it would be among the largest gas producers globally (EIA, 2016c).

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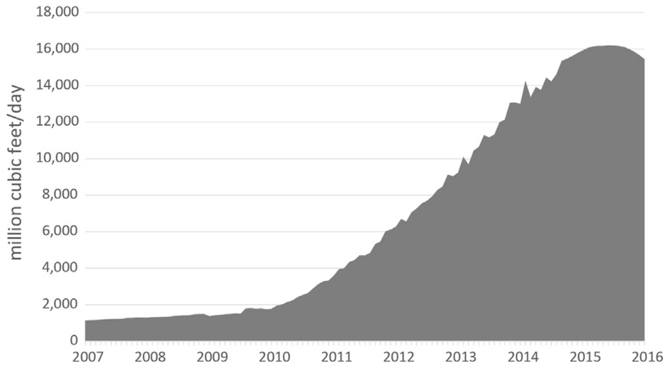

Fig. 1. Marcellus Region, Natural Gas Production.
Source: US Energy Information Administration (December 2015).

Supply from UCG in the United States has been instrumental in the market price of US gas being at or below US$4 Mbtu over the past several years. A US$4 Mbtu gas price, in energy terms, is equivalent to an oil price of around $25 per barrel, and at current prices of around US$2/Mbtu (EIA, 2016c) is much cheaper in relative terms to oil at US$40/barrel. The principal beneficiaries of these gas developments include gas companies; the landowners who receive payments for gas extracted from their property; governments who benefit from increased revenues from charges, fees or taxes; the gas development companies and their employees; the service companies and their suppliers; and those who consume gas, including households, commercial and industrial users, as well as electricity generators and users. Weighed alongside these economic benefits are external costs and threats that include methane emissions, possible ground water contamination and loss of amenity values.

To ensure the external costs in generating the benefits of UCG are minimized, best practice gas extraction requires regulation and enforcement at a local or provincial level. In this paper, we present a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis of UCG developments in the United States. We give a particular focus on how to effectively manage the risks of gas development and to maximize the opportunities. In Section 2 we highlight the benefits of UCG, in Section 3 we review the external costs and summarize past and current regulation in Pennsylvania and the role of the US Federal Environmental Protection Agency (EPA). Section 4 provides a SWOT analysis and presents ten key principles in terms of regulation and best practices intended to reduce the risks and expand the opportunities of UCG. In Section 5, we offer our conclusions and policy implications.

2. Economic benefits of UCG

There are potentially very large rewards and opportunities in the development of unconventional gas. In particular, Porter et al. (2015) assessed the annual economic benefits of unconventional gas and oil development value added in the United States as $433 billion (2012 $) and the industry, as a whole, provides direct and indirect employment of 2.7 million with average household savings from lower energy costs of $776 (2014 $).

On-going local jobs as a result of UCG developments are supported by the need to drill large numbers of wells, and then later re-enter the drill sites for multiple fracturing operations. Thus, UCG production more closely resembles a manufacturing process rather than traditional oil or gas extraction. In the regions where there are shale oil and gas developments there are, typically, positive total employment effects (Brown, 2014; Weber et al., 2014) with one estimate placing the number of jobs supported by unconventional gas at 1 million in the United States in 2010, with a projected rise to 1.5 million by 2015 (Bonakdarpour and Larson, 2012).

Other economic benefits of UCG developments include royalties flowing to landowners and local taxes. States and regions can also gain from royalties or other charges. For example, Pennsylvania introduced a well impact fee in 2012, which raised more than $200 million in each of 2012 and 2013, although this is well below what other US states generally charge by way of severance taxes and that are similar to royalties (Department of Environmental Protection, 2014). Current gas output in Pennsylvania could be expected to yield around three times more if severance taxes equal to about 4% of wellhead value were imposed, as occurs in some other states.

In terms of private royalties, Brown et al. (2015) estimate that in the six most important oil and gas shale developments in the US that these amounted to US$39 billion in 2014 alone. Despite these substantial royalties, De Silva et al. (2016) compare both the fiscal and development costs in the US, Australia and Europe of gas developments and highlight the comparative financial advantage of the US.

Beyond direct payments to property owners and to state governments, UCG-producing States and regions benefit from lower gas prices for both consumers and large industrial and electricity users, compared even to neighbouring States (EIA, 2016b). Further, in the absence of the rapid growth in indigenous shale gas supplies, the US could have been expected to import significant quantities of higher cost LNG, so that gas prices would be closer to those in the United Kingdom or Europe, where gas prices have been at least $4–5/MBtu higher than the US over the period 2011–2015. As natural gas prices, typically, influence wholesale electricity prices, households can expect to also benefit from lower power prices. For instance, lower natural gas prices as a result of UCG developments are estimated to worth, in aggregate, more than $100 billion per year to US households (Bonakdarpour and Larson, 2012).

Replacing coal by gas in the power sector also offers benefits in terms of reduced conventional pollution, and lowered greenhouse gas emissions. For instance, the US recorded a decline in its greenhouse gas emissions of nearly 5% between 2010 and 2012, primarily driven by this substitution, as CO_2 emissions from power generation fell by 9% (US EPA, 2016). While there was a small rebound in coal use, as gas prices rose in 2013, the increase in gas fired power, and consequent greenhouse gas reductions, looks certain to be sustained, as older coal fired plants are retired from 2015 onwards. Indeed, from the second half of 2015, gas fired power has supplanted coal as the most important energy input for electricity generation in the US (EIA, 2016a).

3. External costs and regulation of UCG

There are potentially multiple external costs of UCG that are not directly borne by those undertaking gas developments. These include: groundwater pollution, surface contamination from spills, reduced property values, increase methane emissions, loss of amenity values and micro seismic events. The extent of each of these costs depends on where the geological formation is located in terms of surface features and human habitation, as well as the regulations imposed on gas developers and their actual practices. Public concerns, and regulatory issues, while differing between regions and gas-producing technologies, can be loosely grouped as follows:

(i) Land access, most acute where settlement or existing land use is most intense;

(ii) Water issues around potential contamination of aquifers,