Impact of shale gas policy on domestic and international natural gas markets.

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Abstract

Recent advancements in natural gas extraction have significantly increased the technically recoverable unproven natural gas reserves in the United States. The extraction of shale gas became possible as a result of the confluence of two existing gas extraction techniques; horizontal drilling and hydraulic fracturing, which when used in tandem allow access to gas trapped in shale formations. The shale gas resource in the United States is significant, estimated at 770 TCF (EIA, 2011).¹ The Marcellus shale play alone is estimated to hold 489 TCF (P50), or more than twenty years of supply at current domestic consumption (Engelder, 2009; EIA, 2011).^{2,3}

The production process for recovering shale gas is proving highly controversial in the United States with claims that the chemicals used in hydraulic fracturing contaminate underground and surface water sources. The flowback from shale gas wells (i.e. fluids that return to the surface) can include gelling agents, surfactants, chlorides, dissolved solids, metals, biocides, lubricants, organics and radionuclides (New York Department of Environmental Conservation, 2011, p6-17). As a result, government legislators and regulators across all levels of governance (e.g. city, county, state, regional, and federal) are beginning to investigate shale gas extraction; to determine if it is appropriate to subject the industry to more stringent regulations or create a ban on the extraction process.

In this paper, we analyze the impact of public policy regulating the extraction of shale gas in the Marcellus shale play on gas markets. We use several scenarios to explore the impact of public policy on shale gas extraction, and the resulting changes to resource availability on gas markets. To do this we use the World Gas Model, a model developed at the University of Maryland, which allows for analysis of combinations of parameters that may largely affect global or local gas markets, such as significant shale gas availability in the US (Gabriel et al., 2005a, b; Egging et al., 2009, Gabriel et al., 2010). Because shale gas is so abundant across such a small region, the impact of action at the municipal, county, state and regional governance level can have a larger impact on gas markets than might otherwise be anticipated.

I. Introduction

[•] The authors gratefully acknowledge the support from the Research Council of Norway (R&D Project Agreement no. 190913/S60) and from the industrial sponsors of the project. We also wish to thank Dr. Engelder at Pennsylvania State University for providing shale gas resource estimates for the Marcellus shale basin.

¹ Technically recoverable unproven reserves

² P50 represents the 50th percentile value

³ Using 2010 natural gas consumption totals

In this paper we explore the impact of government regulations on the technically recoverable but unproven shale gas reserves found in the Marcellus shale play in order to estimate the anticipated recovery potential. We conduct an analysis of areas under the jurisdiction of federal, regional, state, local (county), and municipal (e.g. city, town, and village) bodies of government; looking for policies that might limit drilling for natural gas.

The structure of the remainder of the article is as follows. First, we will discuss the geography and resource potential of the Marcellus shale play. Then we will examine the public policy environment, beginning with potential limitations to drilling on federal lands. Next we focus on regional governance bodies including River Basin authorities, which have banned the hydraulic fracturing in certain areas. Then we examine policies of state, local and municipal governments. At this time we have conducted a policy review for the states of New York and Pennsylvania, however, we plan to expand the analysis to include all states and municipalities across the entire Marcellus shale play. In the last few sections of the article, we discuss the impact of shale gas on natural gas prices in the United States and abroad.

Marcellus Shale Play

The Marcellus shale play is located in the northeastern United States and covers more than 77,074 square miles, spanning an area including portions of New York, Pennsylvania, Maryland, Ohio, and West Virginia. There is significant disagreement across sources of the Marcellus boundary. In Figure I we show the boundary as estimated by the Energy Information Administration (EIA), United States Geological Service (USGS), and Engelder (2009).⁴

Figure 1. Marcellus shale play boundary based on estimates from the USGS, EIA, and Engelder (2009)



Source: Engelder, 2009; USGS, 2002; Wrightstone, 2009

We will use the Marcellus boundary put forward in Engelder (2009) from this point onward in the article.

⁴ It should be noted that Engelder (2009) is estimating the resource potential by county instead of the geographic area of the Marcellus.

Resource estimates of the Marcellus shale play appear to vary widely (USGS, 2011; McLaughlin, 2011; Engelder, 2009). The United States Geological Survey (USGS) in August of 2011 estimated a mean resource potential for natural gas and natural gas liquids in the Devonian Marcellus Shale within the Appalachian Basin Province of 84.2 trillion cubic feet (TCF) and 3.38 billion barrels respectively (Coleman et al., 2011). However, the Energy Information Administration (EIA) had previously estimated recoverable gas in the Marcellus at 410 TCF (McLaughlin, 2011). This latest estimate from the USGS was a significant increase from 2002 estimates, which suggested a mean resource potential for natural gas and natural gas liquids of 2 TCF and 0.01 billion barrels respectively (USGS, 2011).

According to David McLaughlin of Resources for the Future, the apparent conflict between the USGS and EIA estimates is not actually a conflict at all. The Energy Information Administration estimate of 410 TCF represents recoverable gas, which is the inferred reserves in known but unproven fields, while the USGS estimate is undiscovered, technically recoverable natural gas, which only includes undiscovered resources outside known fields. Therefore, the two reports are estimating two separate events in the total set of resources and according to McLaughlin the numbers at some point in the future could be summed together (McLaughlin, 2011). This would represent a resource potential of 500 TCF, which is close to the estimate of 489 TCF (P50) put forward by Engelder (2009).

II. Public Policy Environment

Shale gas extraction is possible as a result of the confluence of two preexisting drilling techniques; horizontal drilling and hydraulic fracturing. In the process of hydraulic fracturing large amounts of water, as well as a mixture of chemicals and sand are injected under high pressure into a well. The resulting pressure fractures the rock, allowing the gas to escape.

The process has proven controversial because of the chemicals used in the process, potential for ground and surface water contamination, impacts on local infrastructure, and the large amounts of water necessary for the process. As a result there has been some community push back against hydraulic fracturing. In this section we investigate the public policy and agency response to shale gas extraction at various levels of governance.

We first explore federal regulations before delving into regional, state, and local regulations. At this time the state, county, and local government policy analysis is complete for the states of New York and Pennsylvania, with plans to extend the study to all of the surrounding states in the shale play. New York and Pennsylvania were chosen as initial case studies because together they represent a large percentage of the total natural gas resource; and, they provide starkly different regulatory viewpoints in the management of hydraulic fracturing.

Federal regulation of shale gas extraction in the Marcellus shale play

Federally administered lands in the Marcellus shale play include lands administered by the National Park Service (NPS), US Fish and Wildlife Service (USFWS), US Forest Service (USFS); the Department of Defense including Army, Navy and Army Corps of Engineers, and the Bureau of Indian Affairs (BIA). Other agencies that play a role in the management of extracting shale gas from federal lands include the Bureau of Land Management (BLM), Department of

Energy, and the Environmental Protection Agency.⁵ In this section we briefly discuss the role of each agency.

Federally administered lands in the Marcellus shale play total 4,494 square miles, which is less than one percent of the entire shale play land area. A majority of the federally administered land in the Marcellus shale play is administered by the Forest Service (see Table 1).⁶

Table 1. Federally administered lands in the Marcellus shale play by Federal Agency

		Land area
Bureau of Indian Affairs		96.6 square miles
US Forest Service		4,030.7 square miles
Department of Defense		231.4 square miles
US Fish and Wildlife Service		51.4 square miles
National Park Service		179.4 square miles
	Total	4,494 square miles

Source: USGS, 2003

Currently, shale gas extraction is treated largely the same as other oil and gas activities. However, in February of 2011 the Secretary of the Interior and the head of the BLM announced a review of commercial rules governing development of oil shale resources on public lands (Office of the Secretary of Interior, 2011).

The Bureau of Land Management (BLM) is responsible for overseeing oil and gas activities on federal lands, including Indian lands (DOE, 2009). The BLM cannot manage geophysical resources on lands administered by other agencies unless a memorandum of understanding exists that provides for BLM involvement. The agency has national-level memorandums of understanding with the US Forest Service, Department of Defense with directives for the Air Force, Army, and Navy lands; and the Bureau of Reclamation (BLM, n.d., a, p12).⁷ Each memorandum of understanding authorizes the BLM to manage subsurface operations while allowing each agency to protect its surface rights. In the following paragraphs we detail the steps taken by each agency to lease oil and gas rights.

The BLM oversees the creation of Resource Management Plans (RMPs) and Applications for Permit to Drill (APD), as well as conducting inspections of land where drilling is occurring in order to ensure compliance with all laws and regulations. In the case of wells on Indian lands the BLM is required to consult with tribes and use tribal information in determining how land will be used and managed (BLM, 2007).

On Bureau of Indian Affairs land each tribe decides whether and how to develop their mineral and energy resources (BIA, 2011a). The Indian Nations, as a result of the court case US vs. Shoshone Tribe, 304 US 111 (1938), are the beneficial owners of the natural resources both on

⁵ The BLM does not have any lands in the Marcellus shale play. The Department of Energy (DOE) in early 2011 became peripherally involved in shale gas extraction; however, the agency does not directly regulate it.

 $^{^{\}rm 6}$ For a map of all federal lands in the Marcellus see Appendix A.

⁷ The BOR does not administer any lands in the Marcellus shale play

and below their lands (Haudenosaunee, 2009, p2). The Bureau of Indian Affairs is the lead agency on lease agreements up to the point of signing, which is when the Bureau of land Management becomes involved and reviews each individual lease and addresses reclamation issues (BIA, 2011b).

The National Park Service is in the process of updating its regulations for oil and gas drilling inside parks. The planned update includes encouraging more horizontal drilling from sites outside of parks, requiring higher bonds on producers, tightening operating standards, and imposing fees for crossing federally owned land in parks (National Park Service, 2011). The regulation of oil and gas on NPS lands will largely depend on the ownership of the mineral rights. It appears that the National Park Service does not own a large proportion of the mineral rights on parklands in the Marcellus shale play (Downing, 2011).⁸ An estimate of mineral ownership rights is unavailable as not all parks are aware of their mineral right ownership and a national database of mineral ownership on NPS lands does not exist (Mellott, 2011).

The USFS identifies areas on national forest system land where leases can be sold. It then determines the lease stipulations necessary to protect the surface resource. The BLM then issues the lease and manages the subsurface operations. During the drilling process the Forest Service is in charge of all surface operations on their lands (Natural Resources Law Center, n.d.). The Department of Defense requires agreement to their terms before geophysical exploration can take place (BLM, n.d.).

In 2001, during the Clinton Presidency, the US Forest Service enacted the Roadless Area Conservation Rule (Roadless Rule), which prevents road construction, road reconstruction, and logging on approximately 58.5 million acres of US Forest Service land (Special Areas; Roadless Area Conservation, 2001). Most of the area impacted by the Roadless Rule is found in western states; however, a small percentage does overlap with the Marcellus shale play. Table 2 lists the total roadless acreage by state in the Marcellus by categorization (USFS, 2011). In 2011, a federal appeals court upheld the rule, which was challenged by states seeking to build roads in these areas (Paulson, 2011).

	Roadless Conservation Area that allows road construction and reconstruction	Roadless Conservation Area that does not allow road construction and reconstruction
New York	0 square miles	0 square miles
Pennsylvania	1.6 square miles	37.5 square miles
Maryland	0 square miles	0 square miles
West Virginia	293.8 square miles	21.9 square miles
Ohio	0 square miles	0 square miles
Total	295.3 square miles	59.4 square miles

 Table 2. Total Roadless Conservation Area in the Marcellus shale play by state

Source: United States Forest Service, n.d., a

⁸ Of the 32,000 acres in the Cuyahoga Valley Park, the National Park Service owns an estimated 18,768 acres, of which they own the mineral rights for approximately 938 acres (5 percent) (Downing, 2011).

The Environmental Protection Agency (EPA) through the Safe Drinking Water Act places some restrictions on underground injection. The Safe Water Drinking Act does not apply to most fluids injected for hydraulic fracturing as a result of the Energy Policy Act of 2005. One exception to this rule is the use of diesel fuel in hydraulic fracturing. Any wells that inject diesel fuel must obtain prior authorization from the EPA's Underground Injection Control program. These wells are classified as Class II wells and must meet certain monitoring, operating, and reporting requirements (Tiemann and Vann, 2011). In recent news, the EPA announced that it would begin developing regulations for the disposal of flowback (i.e. hydraulic fracturing fluid that returns to the surface) (Snow, 2011).

The Department of Energy recently convened the Shale Gas Subcommittee of the Secretary of Energy Advisory Board (SEAB), which has been tasked with releasing a 90-day and 180-day report on improving the safety and environmental performance of hydraulic fracturing (The White House, 2011, p. 13).⁹ The 90-day report contains recommendations concerning the implementation of drilling activities (e.g. adoption of best practices to prevent groundwater contamination, creation of a public database of shale gas operations, etc.) but does not seek to regulate the location of shale gas drilling operations (SEAB, 2011).

Regional regulation of shale gas extraction in the Marcellus shale play

The boundaries of the Marcellus shale play overlap with two river basin commissions: the Delaware River Basin Commission and the Susquehanna River Basin Commission (Figures 3a & 3b respectively).

River Basin Commissions are federal-interstate compact government agencies, which were formed by the Federal Government and the Governors from each basin state (DRBC, 2011). The Susquehanna River Basin Commission (SRBC) and Delaware River Basin Commission (DRBC) have authority over the withdrawal of water for use in natural gas extraction in the Marcellus Shale play. The SRBC and DRBC are managing the extraction of shale gas within their boundaries in different ways.

Figure 3. Maps of the Susquehanna River Basin (3a) and Delaware River Basins (3b)

3a. Susquehanna River Basin boundaries 3b. Delaware River Basin boundaries

⁹ The group's 180-day report is to be released November 18th, 2011.





Source: SRBC, 2006;

Susquehanna River Basin Commission (SRBC)

The boundaries of the Susquehanna River Basin span portions of southern New York, much of central Pennsylvania, and a small portion of northeastern Maryland (Figure 3a). The SRBC and Marcellus shale play overlap an estimated 19,786 square miles.¹⁰

The mission of the Susquehanna River Basin Commission (SRBC) is 'to manage and conserve the water resources of the basin while encouraging their sustainable use and development' (SRBC, 2011, p1).

The SRBC has the ability to regulate the injection of water using in the hydraulic fracturing process as a consumptive use and therefore is involved in the approval of all water sources used by the natural gas industry, including stream withdrawals for hydraulic fracturing (SRBC, 2011). However, the SRBC believes that the responsibility to regulate water quality lies outside their regulatory responsibilities and instead the responsibility to impose a moratorium on shale gas extraction belongs to the state (SRBC, 2011).¹¹

Delaware River Basin Commission

The Delaware River Basin Commission (DRBC) boundaries span portions of southeastern Pennsylvania and New York, western New Jersey, and Delaware (Figure 3b). The DRBC and Marcellus shale play overlap an estimated 4,782 square miles.¹⁰

¹⁰ For a map of the overlap of each river basin with the Marcellus shale play see Appendix B.

¹¹ According to the SRBC website, 'As with water quality issues, SRBC member states have the lead responsibility for regulating gas well drilling, including construction of drilling pads, access roads, water storage impoundments, well construction, and hydraulic fracturing, the method used to release gas from tight shale formations' (SRBC, 2011, p1).

The DRBC has regulatory authority concerning the management of 'water quality and water quality-related issues throughout the basin' (DRBC, 2011, p1).

Much of the overlap between the Marcellus shale play and the Delaware River Basin lies in an area of Special Protection Waters, which allows the DRBC to qualify any project as reviewable because of the potential water quality impacts (DRBC, 2011).

The DRBC, as a result of anticipated impacts on the water quality of the Special Protection Waters, enacted a moratorium on natural gas drilling until it is able to pass new regulations, which protect the watershed during the extraction process.¹² Adoption of new regulations for natural gas operations in the basin could occur as early as October 2011 (DRBC, 2011).¹³

State regulation of shale gas extraction in the Marcellus shale play

The Marcellus shale play includes portions of New York, Pennsylvania, Maryland, West Virginia, and Ohio. In Table 2 we partition the Marcellus estimated gas resource potential and land area amongst the five states. Much of the Marcellus shale play and gas resource reside within the boundaries of the State of Pennsylvania.

Each state in the Marcellus shale play has taken a different approach to manage shale gas extraction using hydraulic fracturing. At this time we focus our policy analysis on the states of New York and Pennsylvania.

	Land area (Percentage of total)	Estimated resource potential ¹⁴ (Percentage of total)
New York	15,461 square miles (20 percent)	68 TCF (14 percent)
Pennsylvania	34,201 square miles (44 percent)	298.53 TCF (61 percent)
Maryland	656 square miles (1 percent)	4.52 TCF (1 percent)
West Virginia	16,680 square miles (22 percent)	75.32 TCF (15.5 percent)
Ohio	10,075 square miles (13 percent)	40.60 TCF (8 percent)
Total	77,074 square miles	486.98 TCF

Table 2. Gas resource potential and land area of the Marcellus shale play by state

I. We use the USGS estimates of the total Marcellus technically recoverable resource in conjunction with estimates of the resource distribution within the Marcellus from Engelder, 2011.

State of Pennsylvania

In the state of Pennsylvania much of the responsibility to manage natural gas extraction at the state level rests with the Department of Environmental Protection. However, several other

¹² The moratorium took effect in May 2010 for the Delaware River Basin.

¹³ At the time of submission of this article no new regulations had yet been proposed.

¹⁴ Engelder, 2011

state agencies do play a role including the Department of Conservation and Natural Resources, Department of Labor and Industry, Emergency Management Agency, Pennsylvania Game Commission and the Department of Transportation.

The Pennsylvania Department of Environmental Protection (DEP) reviews and issues drilling permits, inspects drilling operations, issues operating permits for production or recovery facilities, and responds to complaints about water quality issues, including activities on Department of Conservation and Natural Resource lands (DEP, 2011; DCNR, 2011a). The agency is responsible for inspecting each drilling site under development between two and four times a year in order to ensure compliance with drilling and environmental standards (French, 2010).¹⁵

One tool used by the Department of Environmental Protection (DEP) to manage natural gas extraction is setbacks. The agency limits the placement of wells, which cannot be drilled within 200 feet of structures or 100 feet of streams and wetlands. Wells must be located more than 330 feet from the boundary lines (e.g. property lines) unless a voluntary unitization agreement is in place with the owner of the neighboring land. It is also possible to contest the 330-foot requirement through a hearing process with the DEP (Pennsylvania Code, 2011).

The Pennsylvania Department of Conservation and Natural Resources (DCNR) is responsible for leasing state forest and parklands. The DCNR has the power necessary to regulate the number of well pads per leased tract, water withdrawals on state forestlands, as well as ensure the restoration of lands upon the cessation of drilling activity. Further, DCNR is responsible for ensuring compliance with the conditions of the lease (DCNR, 2011a).

The Department of Conservation and Natural Resources does not own all of the mineral rights in state forests; privately held mineral rights account for over 40 percent or approximately 453 square miles of all DCNR lands (DCNR, 2011b).

Park lands are leased under a non-development lease, which precludes any surface uses, instead only the subsurface rights are leased and development must take place from lands adjacent to the parks [handbook citation]. A similar caveat exists for wild and natural areas, which are specifically designated areas within state forest, in which no development or disturbing of the surface is allowed but subsurface rights may be considered for lease similar to parklands where drilling can occur from adjacent lands [citation for handbook]. The DCNR is also responsible for drilling on lands under Lake Erie, which is allowed, as long as no drilling occurs within the lake itself [handbook citation]."

The Department of Labor and Industry monitors the storage and use of flammable and combustible liquids with flash points below 200°F in regards to fire and explosive aspects, ... [and] storage at oil refinery facilities and well site crude oil production tanks." (handbook). The Pennsylvania Department of Transportation (DOT) "regulates oil and gas operations through the regulation of vehicle weight restrictions, roadway weight limits and bonding provisions, new access onto a state route, hazardous materials highway transportation regulations, and the

¹⁵ Interested companies must specify the sources and location of fresh water and the anticipated impacts of water withdrawals on water resources, and obtain approval from the appropriate river basin commission. Further, companies must submit erosion and settlement control plans to DEP for review and approval before drilling activity can take place (DEP, 2011). When applying for a drilling permit companies must provide plans for the storage and treatment of the hydraulic fracturing flowback.

motor carrier safety regulations." The Pennsylvania Game Commission can lease its lands for oil and gas development [handbook citation].

Local regulation in Pennsylvania

The determination of legal authority for the regulation of natural gas drilling by municipal governments rests on two Pennsylvania Supreme Court rulings from 2009. The ruling in the case Range Resources – Appalachia, LLC v. Salem Township has the most consequence, in that it declares that townships lack the authority to ban drilling outright. The decision in Huntley & Huntley v. Borough Council of the Borough of Oakmont, however, provided Pennsylvania's municipal governments with a certain level of leeway in that it declared that municipalities have the right to ban gas drilling in designated zoning districts (Huntley & Huntley v. Borough Council of the Borough of Oakmont, 2009).

In Range Resources, the township of Salem's ordinance placed 'substantive restrictions' on gas drilling, and levied considerable fees for permit applications. The Court determined that Salem was attempting to enact a 'comprehensive regulatory scheme relative to oil and gas development within the municipality' which was in conflict with the state's Department of Environmental Protection, and therefore invalid (Range Resources – Appalachia, LLC v. Salem Township, 2009).

In the case of the natural gas company Huntley & Huntley v. Oakmont, Huntley sought to skirt the attempts of Oakmont to regulate its drilling activity in a residential area where it had lease agreements with two property owners, claiming that the state Oil and Gas Act superseded the Borough's authority. The Pennsylvania Oil and Gas Act limits the ability of local government to regulate natural gas exploration, which preempts such governments from regulating any matters addressed by the Act (Pennsylvania Statutes and Consolidated Statutes, n.d.). In this case, the court ruled in favor of the municipal government, determining that the state Act did not supersede municipal government authority to designate districts in which gas drilling could be banned (Pabst et al., 2009; Pennsylvania State University's Cooperative Extension, 2009).

State of New York

In the State of New York the Department of Environmental Conservation is the lead state agency in the regulation of shale gas extraction.

The New York Department of Environmental Conservation (NYDEC) is tasked with permitting and regulating gas well drilling in New York, which was authorized by the Environmental Conservation Law (ECL) Article 23 (NYDEC, 2011). The Division of Mineral Resources reviews applications for environmental compliance, conducts on-site inspections, and enforces restoration rules upon completion of drilling operations (DEC, 2011a).

In 2010, the DEC was tasked with performing additional review of environmental impacts from horizontal drilling and hydraulic fracturing by the New York Governor. This review culminated in the Supplemental Generic Environmental Impact Statement (SGEIS) issued September 7, 2011. The comment period for the SGEIS is set to end in mid-December of 2011 (DEC, 2011b). The proposed SGEIS regulations can be found in Table 3 below. During the review of the proposed regulations any entity proceeding with a permit application must conduct a site-

specific environmental review and must consider the same issues being considered in the SGEIS (DEC, 2011a).

The New York City Department of Environmental Protection is opposed to hydraulic fracturing, especially in areas around the Catskills watershed, which supplies unfiltered water to the City. As a result, the Department of Environmental Conservation has imposed strict regulations on two watersheds, Catskills and Skaneateles Lake watersheds, which provide unfiltered water supplies for the City of New York and Syracuse, respectively (Navarro, 2010).

In the state of New York certain blocks of land such as state parks and state historic sites are off limits to oil and gas extraction with the exception of two existing leases (NY Office of Parks, Recreation and Historic Preservation, 2009).¹⁶

Local regulation

Local governments in the state of New York are organized into counties and below them into municipal city, town, and village governments. Article IX of the New York State Authority gives these governments home rule authority to provide services and enact regulations within their jurisdictions. However, Article 23 contains a supersession provision stating that its regulations supersede all local laws or ordinances that pertain to the regulation of oil, gas and solution mining industries (Kenneally and Mathes, 2010, p2).

It is uncertain as to whether this supersession provision overrides local authority to pass drilling moratoria or regulate land use within their jurisdiction. On September 16, 2011 Anschutz Exploration Corporation filed suit against the City of Dryden, NY, which had amended its zoning laws to prevent natural gas drilling within its boundaries. The outcome of this case will set a precedent for how local governments can regulate natural gas drilling within their boundaries (Portero, 2011).

III. Results

To be presented at the Infraday Conference

¹⁶ In 1964, New York entered into a lease to operate a natural gas subsurface storage field under 9,500 acres of Allegany State Park. In 1979, New York sold the rights to extract natural gas under Darien Lakes State Park.