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QUANTIFYING THE RISKS OF UNDERGROUND NATURAL GAS STORAGE

By Michaela Jellicoe and Michael S. Delgado (Purdue University)

SUMMARY

Do underground natural gas storage activities harm nearby residents? We study the negative impacts of underground natural gas storage on nearby areas, and find that nearby residents are impacted adversely by natural gas storage activities. As natural gas extraction increases, it is likely that demand for natural gas storage will increase as well. Hence, these negative impacts of underground storage should be carefully considered with expansion of natural gas storage activities.

INTRODUCTION

Recent advances in hydraulic fracturing and horizontal drilling have facilitated the extraction of natural gas from previously unrecoverable sources, spurring debate about the safety of natural gas extraction. Less frequently discussed is the impact of underground natural gas storage on nearby residents, as natural gas is often stored underground for ease of withdrawal and future consumption. As with natural gas extraction, natural gas storage activities bear environmental and health risks that may impact nearby residents of these facilities. Are these risks substantial enough to impact nearby residents? If so, how large are these impacts? What might policymakers need to be aware of in order to minimize the impacts of underground natural gas storage? We provide a general overview of underground natural gas storage, and straightforward answers to these three questions.

UNDERGROUND NATURAL GAS STORAGE

Traditionally, underground storage of natural gas served to balance differences between supply and demand (US EIA, 2004), as demand for natural gas is typically seasonal with peaks occurring during the winter heating season, while extraction occurs throughout the year. Hence, underground natural gas storage is used in order to smooth production and

consumption of natural gas, while allowing pipelines to run at maximum efficiency (Storage of Natural Gas, 2014). Additionally, underground natural gas storage acts as insurance against any unexpected supply disruptions (Storage of Natural Gas, 2014).

Recent changes in the landscape of the natural gas industry may impact demand for natural gas storage as well. Advances in the extraction process have greatly increased the supply coming from each extraction well, creating obvious demand for additional storage. Natural gas is also becoming a more popular energy source for electricity generation, which often peaks during summer months. Underground natural gas storage operators lease portions of storage capacity to third parties (US EIA, 2004) that typically purchase supplies of natural gas when prices are low and sell when prices are high, such as during summer and winter months (Storage of Natural Gas, 2014).

Any formation used for underground storage of natural gas requires certain geologic characteristics, such as a layer of porous and permeable rock to hold the natural gas, with a layer of impermeable rock above to trap the gas within the porous formation and prevent movement of the gas out of the storage area (Storage of Natural Gas, 2014). There are three types of underground formations that are commonly used for

underground storage of natural gas: depleted natural gas or oil reservoirs, aquifers, and salt caverns. Depleted natural gas or oil reservoirs are the most common type of formation used for storage (US EIA 2004), as the geologic integrity of these formations is typically known. Figure 1 contains the locations of the different types of formations across the United States.

It is possible that underground storage has positive benefits for residents, in addition to negative impacts. These positive benefits may include compensation of landowners, and local job creation. In this brief, we focus exclusively on the negative impacts.

ENVIRONMENTAL AND HEALTH RISKS

Like natural gas extraction, underground natural gas storage poses inherent risk. These risks include:

- migration of the natural gas out of the storage formation, posing risks for contamination of groundwater (Miyazaki, 2009);

- vertical migration of natural gas through existing wells, which may be particularly hazardous in close proximity to the well (Miyazaki, 2009);

- wellhead and casing degradation or failure that may expose other strata above the storage formation to the risk of contamination (Miyazaki, 2009);

- methane emissions, through off-gassing at the wellhead (US EIA, 2013);

- methane contamination of groundwater, which may be hazardous when exposed to air (IN DNR, n.d.).

In addition to the environmental and health risks associated with underground natural gas storage, there is also the potential for aesthetic impacts associated with these facilities (FERC, 2013). These aesthetic impacts include:

- visual impacts from surface facilities that may include wellhead valve assemblies, gathering lines, and compression facilities;

- noise impacts from compression facilities.

FINDINGS

The goal of our research is to ascertain whether these risks from underground natural gas storage are substantial enough to impact nearby residents, and if so, to quantify those impacts (Jellicoe and Delgado, 2014). We focus on housing sales transaction data from 2004-2013 in Indiana for homes that are located on or within 3.2 kilometers of underground

natural gas storage activity, controlling for property characteristics (e.g., square footage, bedrooms, bathrooms), effects of school districts, and differences across counties and year of sale in order to accurately estimate of the impact of underground natural gas storage on property values. Considering both the distance of each property to the underground storage activity, as well as the intensity of storage activities around each property, our statistical results show that properties located near underground storage activities do indeed transact for lower prices. We find that both storage and observation wells have a negative impact on the value of nearby homes, and that these negative impacts diminish as the distance to the underground storage activity increases or with reductions in the concentration of storage activities around each home.

In particular, when a property is closer to a well associated with natural gas storage by one kilometer, the property transacts for about $9,092 less, on average. Properties typically transact for about $407 less for each additional storage well located within a 3.2 kilometer radius, relative to homes that do not have storage well activity within 3.2 kilometers. We find that as the distance from a property to the nearest underground natural gas storage well increases, the percentage impact of storage activity on property values decreases, indicating that properties farther away from underground natural gas storage activity suffer lesser impacts than properties that are closer. Additional results indicate that properties with access to public water suffer impacts of lesser degree compared to those that depend on private sources of water, which indicates that risk of water contamination is an important concern for homeowners that is capitalized into these property values.
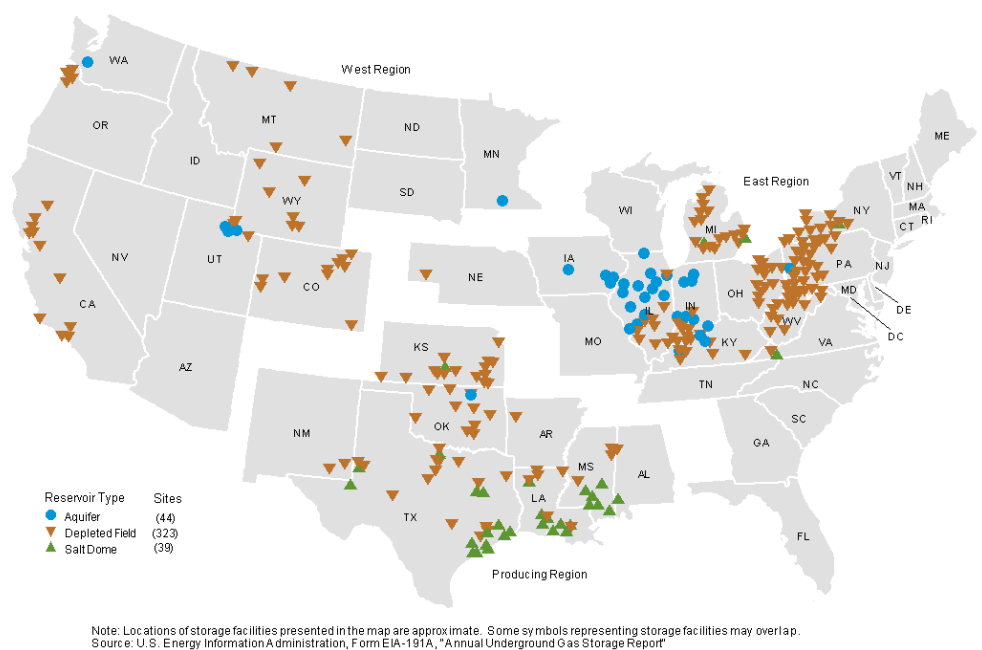

Note: Locations of storage facilities presented in the map are approximate. Some symbols representing storage facilities may overlap.
Source: U.S. Energy Information Administration, Form EIA-191A, "Annual Underground Gas Storage Report"

Figure 1. U.S. Lower-48 States Active Underground Natural Gas Storage Facilities by Type (December 31, 2012; US EIA 2012).

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POLICY IMPLICATIONS AND CONCLUSIONS

Our results indicate that underground natural gas storage activities bear risks that are substantial enough to affect nearby residents, and that these impacts are more severe in proximity, concentration, and for properties without access to public water. As demand for underground natural gas storage increases in parallel to increases in natural gas extraction, it is important for policymakers to be aware of the potential impacts of natural gas storage on nearby properties and residents.

Are these risks substantial enough to impact nearby residents? Yes. We identify significant negative impacts of underground natural gas storage on the value of nearby properties, which indicates that underground storage activities harm nearby residents. How large are these impacts? Underground storage activities adversely impact residents by around $407 for each additional storage well located nearby, and $9,092 for each kilometer closer to storage activities that each property is located.

What might policymakers need to be aware of in order to minimize the impacts of underground natural gas storage? Our results indicate that locating underground natural gas storage activities farther away from local residents will decrease the negative impact of these activities. To the extent that policymakers can control the proximity of these activities to nearby residents, care should be taken to isolate storage activities. Additionally, groundwater contamination appears to be one major source of concern for homeowners. Industry participants and policymakers can take additional actions to ensure the quality of underground water supplies through increased water testing and monitoring activities. Additionally the results of these supplementary activities can be published or otherwise shared with local homeowners via educational outreach efforts in order to allay any fears that homeowners may experience as relate to the quality of drinking water sources —therefore increasing awareness of the results and safety of monitoring activities may help to alleviate these increased impacts. Additional actions taken to ensure quality of underground water supplies, particularly for residents that depend on private water supplies, may decrease the impact of storage activity on nearby residents. ⚘

REFERENCES

Arthur, J. D., B. Bohm and M. Layne (2008). "Hydraulic fracturing considerations for natural gas wells of the Marcellus Shale." The Ground Water Protection Council 2008 Annual Forum.

Cornell University Cooperative Extension (2011). "Fracing in practice in unconventional shale gas wells." Cornell University Cooperative Extension. http://cce.cornell.edu/EnergyClimateChange/NaturalGasDev.

Federal Energy Regulatory Commission. An Interstate Natural Gas Facility on My Land? What do I Need to Know. Brochure, Federal Energy Regulatory Commission, 2013.

Indiana Department of Natural Resources. Methane Gas & Your Water Well A Fact Sheet for Indiana Water Well Owners. Brochure, Indiana Department of Natural Resources.

Jellicoe, M. and M. S. Delgado (2014). "Quantifying the effects of underground natural gas storage on nearby residents," working paper.

Miyazaki, Brent (2009). "Well integrity: an overlooked source of risk and liability for underground natural gas storage. Lessons learned from incidents in the USA." London Geological Society Special Publications Vol. 313, pp 163-172.

"Storage of Natural Gas." NaturalGas.org (2014).

U.S. Energy Information Administration (Sep, 2013). Natural Gas Explained Delivery and Storage of Natural Gas. http://www.eia.gov/energyexplained/index.cfm?page=natural_gas_delivery .

U.S. Energy Information Administration (Aug, 2004). "The basics of underground natural gas storage." U.S. Energy Information Administration. www.eia.gov/pub/oil_gas/natural_gas/analysis_publications/storagebasics/storagebasics.html.

U.S. Energy Information Administration (Dec, 2012). "U.S. Lower-48 active underground natural gas storage facilities, by type (December 31, 2012)." U.S. Energy Information Administration.

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