What the Frack?

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On occasion, I am asked about environmental issues and topics that are peripheral to what ESA does on a day-to-day basis. One such topic is fracking. And for the most part I read the same articles as you. Many of these articles are written with an inherent bias. This makes it difficult for the average person to arrive at an objective conclusion.

Because my curiosity and interest on this subject runs high, I have read many articles and attended lectures where both sides of the issue are presented. Going a step further, I found a well-written, informative, and seemingly even-handed book that presented both sides of the fracking story: *The Boom: How Fracking Ignited the American Energy Revolution and Changed the World*, by Russell Gold.[1] I recommend this book to anyone who wishes to learn more.

By analyzing this trove of information through my own (admittedly biased) filters, I arrived at some tentative conclusions, which I will share below. I invite you to reach your own conclusions.

So, to start, let's look at what fracking is, what makes it a game-changing technology, where the greatest danger to the environment and human health lies, what fracking means to the financial well-being of our nation, and what can be done to eliminate most of the risk.

What is fracking?

Fracking is a methodology that injects, under high pressure, a solution of water and sand that is infused with a blend of chemicals. These chemical blends (proprietary to each drilling company) consist of agents such as biocides, acids, scale inhibitors, ethylene glycol, friction-reducing agents, corrosion inhibitors, and antimicrobials. Upon injection, the fracking fluid fractures the methane-bearing shale bedrock deep underground. The ratio of water:sand:chemicals is roughly 90:9:1. The creation of additional cracks and fissures enhances the extraction of either crude oil or natural gas. This article focuses on fracking as used to extract natural gas because that is the most common extraction technology used today, especially in the northeast United States.

Why is fracking attractive?

Twice during the 1970s, the United States experienced oil shortages precipitated by OPEC oil embargos. When OPEC members reduced oil output, gasoline prices increased and supplies

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[1] Gold, Russell. *The Boom: How Fracking Ignited the American Energy Revolution and Changed the World*. Simon and Schuster, 2014.

decreased, creating lines at the pump. Shortages were so dire for a brief time that the government instituted an odd/even system to buy gasoline. Nerves became frayed as people had to wait--sometimes for hours--just to buy a tank of gasoline. I distinctly recall feeling uneasy during both episodes. Seeing the United States beholden to Middle Eastern countries was frustrating and infuriating.

New Jersey's energy prices reached all-time highs in 2008. Using gasoline as a gauge, gasoline prices reached a record level of almost $4.00 per gallon in the summer of 2008. Then after a precipitous drop at the end of 2008, gasoline prices escalated again in their normal seesaw fashion reaching near-record prices several times until the middle of 2014. Since then the United States has experienced a dramatic drop in energy prices. While there are several causative factors, one important reason is the dramatic increase in domestic energy production. In fact, the United States is poised to become, for the first time in my lifetime, a net energy exporter.

The United States is blessed with a true abundance of natural resources, including fossil fuels. Petroleum engineers have long known that deeply buried geologic formations hold vast amounts of natural gas, but until recently, we didn't know how to extract it efficiently. Fracking, which has been used for more than 100 years (albeit in a rudimentary fashion at its outset), has come of age. And the United States is finally able to tap the ginormous bounty of natural gas trapped more than a mile below ground from the Marcellus Formation.[2]

Why is fracking controversial?

First, let's discuss the positives. Fracking is so efficient and successful that it has created an abundance of natural gas, driving down energy prices. Fracking allows us to tap domestic resources—very few of which have been tapped thus far. It also provides the economic benefit of being exportable in liquid form. Fracking brings great wealth to people whose land lies atop of the Marcellus formation. The drilling and fracking process brings short-term prosperity to the general area in which it occurs as large infusions of capital pour into local businesses and jobs are created. And finally, natural gas is one of the cleanest burning fossil fuels. America's carbon footprint will shrink dramatically when we increase our overall utilization of natural gas as an energy source.

Now let's discuss some of the negative issues. A series of issues, ranging from nuisances to serious environmental hazards, create the controversy. The drilling process, while temporary, is noisy and requires logistical support and supplies that must be delivered by trucks, often over rural roads. Further, many of these roads simply cannot withstand the vehicular pounding. Next,

[2] The Marcellus shale stretches from upstate New York through Pennsylvania to West Virginia and west to Ohio. It exists at depths of roughly 5,000-6,000 feet below the ground surface. Below the Marcellus Shale is the Utica shale formation. It too holds a massive bounty of natural gas. When natural gas within the Marcellus formation has been fully extracted, the plan is to re-drill each gas well, going deeper into the Utica formation, where new horizontal branches will be drilled, fracked, and the natural gas extracted. These two geologic formations combined are believed to hold a 60-100 year supply of natural gas. More information can be found here: http://geology.com/articles/marcellus-shale.shtml.

very large volumes of fresh water are required from local sources to make up the fracking fluids. This is a real but temporary impact to some local water resources. Fracking fluid contains a proprietary blend of chemical additives added to the water, making the combination a hazardous substance requiring special handling. When frack water is extracted from the wells, it must be stored temporarily and then properly disposed.

When fracking is completed, the results are both positive and negative. The positive outcome is, of course, the acquisition of abundant supplies of natural gas. The negative results, however, can indeed be very bad. One assertion is that methane (natural gas) enters potable drinking water supplies. The other issue regards contamination of potable drinking water supplies from fracking fluids.

Are the negative issues true?

In a word, yes. And as with most things, there are qualifiers and facets that must be considered. In my opinion, every negative issue mentioned above can be easily addressed; that is, each is an easy fix. But one issue looms especially large and presents a real threat to public health. In fact, when Governor Andrew Cuomo of New York outright banned fracking in New York State, I agreed with his position because of this one issue. And that issue is the risk of pollution of potable water supplies with fracking fluids.

A properly constructed well is safe, posing almost no risk to potable aquifers. Wells are constructed with three concentric casings. Grout (cement) is pumped down the well and it flows back up and fills the annular space exterior to each casing to form a seal. The grout is supposed to be a continuous monolith along the entire vertical extent of the well. In this fashion, as fracking fluids are drawn upward from the Marcellus shale, there is no way for these fluids to leak horizontally into other geologic formations that lie adjacent to the well.

However, if the grout seal is poor, liquid and gas can leak up through the annular space and find its way into the potable aquifer. When this happens, the shallow potable aquifer can be rendered non-potable due to incursion of the fracking fluids. In addition, natural gas can saturate the aquifer as well. This is one way that methane can find its way into household water taps.

This terrible outcome is prevented by exercising a high degree of care during well installation. And beyond just being careful, there is a way to determine if a well has been properly sealed. It turns out that an instrument (a radial differential temperature log, or RDT) was invented around 1979. After a well was grouted, the RDT was run down the entire well and it was able to determine if the grout was installed properly. The RDT could pinpoint where the grout had gaps enabling the grout fissure to be sealed.

So why hasn't this technology been used in today's wells? After all, it seems to me that properly addressing this problem in part renders the New York State moratorium unnecessary. After carefully re-reading the section of *The Boom* that deals with this issue, I am forced to conclude that there are two reasons. Drilling companies are driven by profits and profits are, in part, derived from efficiency. It is not efficient to probe every well and look for problems. The

second reason is that the states in which fracking occurs are not passing laws mandating that the wells be installed correctly to begin with.

A word about potable aquifers.

Potable groundwater aquifers rarely extend much beyond 1,000 feet below the ground's surface. The aquifers below 1,000 feet are typically brine (an indigenous salt water solution). This abundance of salt renders them non-potable. That is why the injection of fracking fluids 5,000-6,000 feet below the ground's surface is of no direct impact to drinking water supplies. But, as explained above, unless the well is grouted correctly, there is a possibility that the fracking fluid can find its way into the shallow aquifer.

A word about methane.

The media has reported that methane has emerged from people's water taps. But what is the source of methane found at the water tap? Some people strongly contend that this "water-tap methane" is there because of fracking. That may be true, but not in every case. Some methane is created naturally via anaerobic decomposition of organic matter situated 10-50 feet below ground. This methane can find its way into potable wells. In other cases the methane is produced deep within the earth under great pressure and heat. This would, of course, be methane found in the Marcellus shale. And some potable wells have been contaminated with Marcellus-derived methane via poorly constructed methane extraction wells. Fortunately these two forms of methane have different chemical "signatures" that can be identified in a laboratory.

A word about well integrity.

It is probably not known what percentage of fracked wells are grouted properly. Studies demonstrate the critical importance of properly sealing every single well. https://www.washingtonpost.com/news/wonk/wp/2014/09/15/study-bad-fracking-techniques-let-methane-flow-into-drinking-water/. http://www.wsj.com/articles/fracking-report-cites-bad-wells-for-tainted-water-1410820465. I believe that drilling companies are careful when they drill and that most wells are sound. But they can increase dramatically the level of care taken.

What if commercial airlines performed with the same level of care currently taken by natural gas drilling companies? Recent estimates indicate that there are roughly 29,000 domestic flights per day. What if one domestic flight fell from the sky every day? If this were the case, would the flying public deem that to be an acceptable risk? No, of course not. I think the drilling companies need to regard well integrity with the same degree of care as the airlines do airline safety. Doing so would remedy many concerns, promote a deeper sense of trust, improve public sentiment, and therefore create a more positive attitude toward the entire drilling and fracking process.

Summary

I believe it is a good thing for the United States to exploit indigenous sources of energy. But I also believe that some natural gas companies are acting irresponsibly for the sake of profits. They need to demonstrate an unequivocal commitment to protect drinking water supplies.

History shows, however, that will not happen without strong government oversight and regulation.

Each state government needs to commit to natural gas-induced prosperity. But each state should also promote and advance the extraction of natural gas only after properly regulating the gas companies, forcing them to build safer wells and re-examine wells they have already drilled. Will this cost a lot of money? Yes, indeed. But that, to me, is the cost of doing business in a way that is protective of people and our natural resources.

The extraction of natural gas is a long-term play. All parties need to treat this process with the scrutiny and rigor befitting an activity that may continue for the next 100 years.

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