Fracking in the United States: Energy With Consequences?

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Hydraulic fracking, “the process of drilling beneath the earth’s surface to extract crude oil and natural gas from shale rock”, is predicted to be a $68 billion global market by 2024 (Bizley 2019). Many people across the world may seldom think about the extent to which they rely on these natural resources in their daily lives, but their use is of vital importance. The industrial, commercial, residential, and transportation sectors depend on natural gas for “heat and power systems and raw material to produce chemicals and fertilizers”. For a residence, this means heating systems for the home and simple activities such as cooking and drying clothes (“Natural” 2021). For industrial, commercial, and transportation sectors, this provides the means for a business to be operable. If these natural resources are so essential to our daily lives, and therefore, the process of extracting them from the earth, why is this topic so controversial? A poll by Gallup conducted in 2015 shows that 40% of Americans favor fracking, while 40% oppose it. 19% were reported to have no opinion (Swift 2021). This divide largely surrounds the potential negative environmental impact of fracking. This paper will seek to dissect the arguments for and against fracking, analyze the data available on fracking, and conclude the degree of rationality of these arguments.

Those opposed to fracking are typically concerned with the short and long term negative environmental effects that drilling into the earth and extracting natural gas can potentially induce. Some of the common arguments against fracking are that the reduced carbon emissions considered as a benefit of fracking are far outweighed by methane leaks from fracking wells, that new natural gas facilities does not always mean the termination of coal plants, that fracking can contaminate drinking water, that its high dependence on water usage can deplete local water sources at fracking sites, and that fracking can cause an increase in earthquakes (Whibey 2020). These arguments display a substantial concern for the effects of fracking on nature, climate, and

human health. They do not dismiss the idea that fracking has benefits, but consider the benefits to be outweighed by the drawbacks it creates, making the practice of fracking unjustifiable as a safe energy source.

If the 40% of Americans in favor of fracking from the Gallup poll could speak their argument right now, what would they say? In terms of potential environmental impact, most arguments in favor of fracking concern an over-exaggeration and misrepresentation of scientific claims. Some of the common arguments in favor of fracking suggests that the impact of short term methane emissions are not nearly as bad for the environment as carbon emissions in the long term, that well-drilling operations are highly unlikely to produce cracks that chemicals leak through to contaminate drinking water, that other fossil fuels and nuclear energy require more use of water than fracking, and that earthquakes caused by fracking are both unlikely to occur and of minimal damage (Whibey 2020). These arguments do not necessarily display ignorance of the scientific claims made by the other side, but rather deem them as misinterpretations. For instance, the pro-fracking side is not simply suggesting that earthquakes are not caused by fracking, but rather stating that they are very uncommon and that in the instances where they do occur, they are unsubstantial enough for this to be relevant to the argument.

Methane Leaks

The first major point discussed is in regard to methane leaks. All fossil fuels involve some form of hazardous emissions. To generate energy through coal burning, carbon dioxide emissions trap heat in the atmosphere and give rise to global warming. For fracking, the major concern is methane emissions. Since the world can’t just flip a switch and move to zero emissions energy sources– cutting fossil fuels “cold turkey”, it becomes more of a battle of

finding which source will be the least harmful. In this case, it becomes a matter of comparing carbon emissions and methane emissions: which will provide us with the energy we need without fast-tracking global warming even more rapidly?

The Environmental Protection Agency (EPA) reports that methane remains in the atmosphere for just 12% of the time that carbon dioxide does ("Overview n.d.). While this certainly gives methane a much better outlook, it becomes more problematic when the potency of methane is taken into consideration. Here the term "potency" refers to the degree to which a greenhouse gas can trap heat in the atmosphere, or the ability to have a larger impact on global warming than other greenhouse gasses. An article by National Geographic reveals that over the course of 20 years, methane is "approximately 80 times more potent (heat-trapping ability) than carbon dioxide. Over the course of 100 years, methane is approximately 28 times more potent than carbon dioxide" (Borunda 2019). Its enhanced impact can also be attributed to the fact that after reaching the end of its lifetime in the atmosphere, methane is broken down to carbon dioxide through hydroxyl oxidation and continues to trap heat in the atmosphere ("Why" 2020). It is evident that methane both remains in the atmosphere for a shorter period of time and decreases significantly over time in potency, but it appears that the initial potency of methane is so strong that even after the period of a century, it still outpaces carbon dioxide in the degree of harm it has on the environment- then, at the end of its lifetime, is left to be converted to carbon dioxide and continues to trap heat in the atmosphere.

Now that it is understood that methane emissions pose more of a threat to climate change than carbon dioxide for at least the period of a century, another question must be answered: where do methane emissions originate from and is fracking truly to blame for it? In 2019, the EPA recognized the following sources of methane emissions, and their relative percentage

contributions: “Natural Gas and Petroleum Systems, 30%, Enteric Fermentation, 27%, Landfills, 17%, Manure management, 9%, Coal Mining 7%, Other, 9%” (“Overview” n.d.). While emissions related to fracking make the largest contribution to total emissions overall, nearly 70% of methane emissions come from other sources. Considering that these emissions derive from many sources, there are a multitude of sectors to turn to in attempting to reduce methane emissions. Perhaps the goal could be to make reductions in each of these categories. For example, to reduce methane emissions due to enteric fermentation, implemented strategies could include “optimizing feed digestibility and availability, balancing and fine tuning feed rations; promoting better animal health, and; improving performance through breeding, reducing the ratio of animals dedicated to reproduction to animals dedicated to production, improving grazing and grassland management in grazing systems to increase feed quality and productivity, and improving the quality and usage of crop residues as fodder” (“Enteric” n.d.). This is just an example of one category that offers an abundance of actions that can be taken to reduce methane emissions. Based on this data, for fracking supporters, the argument could be made that we could focus on making reductions in the other 70% of methane emissions; making the impact of fracking feel unsubstantial. For anti-fracking groups, fracking could be framed to be a substantial threat because it is still the single largest source of methane emissions overall.

Research by the National Oceanic and Atmospheric Administration (NOAA) indicates that methane levels in the atmosphere have been increasing since the 1980’s, but have seen a more steady increase since 2007 (“Trends” n.d.). One suggested way of distinguishing emissions caused by fracking from those caused by enteric fermentation and wetlands is to identify the isotopes of carbon associated with the methane. Methane gas is a mixture of the isotopes carbon-12 and carbon-13. Shale gas is believed to contain higher levels of carbon-12 as opposed to

carbon-13, making it chemically distinct (or at least believed to be distinct) from the methane originating from enteric fermentation. The lighter carbon atom, carbon-12, has been the primary carbon source of methane increases since 2008. Robert Howarth, the Cornell University ecologist who spear-headed this study, uses this information to link methane emission increases to shale gas production, yet acknowledges that the chemical identification of shale gas can vary due to location and method of chemical analysis (Leahy 2019). This variance can be problematic in trying to confidently link a specific carbon-isotope source to methane emission increases. Haworth also supports this link by stating that the spike in methane emissions occurred when the U.S. fracking boom took off. The combination of carbon-12 concentrations being linked to fracking and the U.S. fracking boom occurring during this time period of methane emission spikes due to carbon-12, nevertheless, is an interesting correlation that should be scrutinized. Given all of this information regarding methane leaks, it is evident that methane may pose more of a threat in the short term to our climate than carbon dioxide emissions, however, establishing a direct link between fracking and increased methane emissions since 2008 is still challenging to confidently do.

A common argument made in support of fracking claims it be an improvement toward clean energy as opposed to coal plants. Deemed “the transitional fuel”, carbon emissions from fracking are stated to be 45% less than that from burning coal (Lomborg 2012) (Ellingson et. al 2016). Fracking is also said to be a cheaper energy source than coal (Schneising et al., 2014) (Ellingson et. al 2016). Given its reduced carbon dioxide emissions and cost savings, many coal plants have been repurposed into natural gas facilities over the past decade. Between 2011 and 2019, 121 coal plants in the United States were converted to burn other types of fuel. Of these 121 coal plants, 103 of them were converted into natural gas facilities (“More” 2020). While

these conversions are certainly taking place, natural gas facilities aren't putting a complete end to coal use, but rather operating alongside it. It seems to be a fallacious argument that air quality is improving through the use of this "transitional fuel" when coal is still polluting the air with large carbon dioxide emissions. Coupling this to the potential rise in methane emissions due to fracking, a more impactful greenhouse gas than carbon dioxide, it calls into question the ability of fracking to be a true source of improvement toward clean energy. Energy production and use only continues to increase in the United States, hitting record highs in 2018. In a breakdown of U.S. energy sources in 2020, petroleum, coal, and natural gas accounted for 79% of energy production ("U.S. n.d.). Looking at the bigger picture, if we continue to generate ever-increasing amounts of energy largely from fossil fuel sources, is the switch from coal to fracking as much of a beneficial move toward clean energy as it is portrayed to be?

According to the EPA, methane emissions dropped by 17% in the United States between 1990 and 2020. Emissions increased during this time due to the agricultural sector (reason not stated), but the decreases that led to an overall decline in emissions were attributed to landfills, coal mining, and natural gas and petroleum systems ("Overview" n.d.). Could the decline in emissions be due to less fracking activity? Given the rise of fracking over the last couple decades, decreased fracking activity would not be relevant here. In fact, shale gas exhibited a growth rate of over 50% per year in the United States between the years 2007 and 2012, increasing by nearly tenfold over these 5 years. The fraction of total natural gas produced by fracking has also increased dramatically (Fukui et. al 2017). Given this information, and the general uptick in fracking over the last couple decades, shale gas production increased during the time methane emissions decreased. The potential problem with the decreased methane emissions report from the EPA is that the categories exhibiting decreased emissions are all lumped

together. The magnitude of impact from natural gas systems alone is unknown, so it can't be used to argue against the assertion that fracking has any significant impact on methane emissions. Therefore, it is difficult to either prove or disprove that the push toward increased fracking and decreased coal production is helping the United States attain cleaner energy. It could potentially be a good short-term solution, but given the upward trend of energy production and consumption in the U.S. and its reliance on fossil fuels, massive amounts of greenhouse gasses such as carbon dioxide and methane are still being emitted.

Concerns About Water

The third common argument in the fracking debate concerns water sources- specifically, their potential for contamination and depletion. The process of fracking depends heavily on the use of water. A study by Duke University found that between the years 2005 and 2014, energy companies in the United States used approximately 250 billion gallons of water to extract fuel from fracking wells. Additionally, they found that approximately 210 billion gallons of wastewater were generated for this same time period ("How" 2015). It is evident that water is an essential component of the process-but what is the basis of the fears of drinking water contamination? Researchers at Yale completed a study of 1,021 chemicals involved in the process of fracking. While they were not able to obtain sufficient information pertaining to toxicity on all of them, an analysis of 240 of these chemicals determined that 157 of them were negatively associated with developmental and reproductive health (Greenwood 2016). Given the quantity of wastewater being generated, the amount of chemicals involved in the process, and prevalence of chemicals toxic to human health, it seems it would only be human nature to worry about the contamination of drinking water. Fear alone does not give basis to arguments against

fracking on the grounds of drinking water contamination- but if there is concrete evidence that it is contaminating drinking water, it could form a valid argument.

A study by Duke University was conducted in 2016 to learn more about water and soil contamination due to fracking. The study took place in North Dakota, a very active site for fracking activity and state where a considerably large water contamination connected to fracking activity took place in 2014. That year, approximately 1 million gallons of wastewater leaked into Bear Den Bay due to an underground pipe leak. In this 2016 study of the Bakken region of North Dakota, researchers detected high levels of "ammonium, selenium, lead and other toxic contaminants" in streams ("Contamination" 2016). This is one of many case studies across the United States that establish fracking as the causation of water contamination. Despite these links being made, the EPA released a study that reported there is "no evidence of widespread, systemic impacts on drinking water" due to fracking. Another study conducted by Yale University attained a similar conclusion, stating there was "no evidence [of] contamination of organic compounds in drinking water" ("Yale" n.d.).

The important thing to note about the case studies that establish a link between fracking and water contamination is that they contain two major flaws: they either cannot prove causation, or the reported contamination is due to equipment malfunctions, mishandling, etc. that are human-induced issues, not directly caused by the mere act of fracking. For instance, the waterways sampled in these case studies are based in fracking areas and zones, and appear to establish the connection to fracking based on that fact. This assumption fails to take into consideration other causes of pollutants that may occur, and that may not be evident because they are originating in other areas but managed to flow down the waterway. In the cases of wastewater spills in connection to fracking, such as the case of Bear Den Bay in North Dakota,

the cause of the spill isn't directly caused by the action of fracking but rather in equipment malfunctions and or mishandling by humans. These things are often fixable and can be improved through training and the development of better equipment- options that would sensibly be explored to improve the effectiveness and environmental-friendliness of fracking.

Now that wastewater has been considered, it is important to discuss the other water related concern- depleting water sources. Before even taking the water needs of hydraulic fracking into consideration, water resources in the United States already are in danger of depletion in the years to come. According to an article by National Geographic, nearly half of the United States freshwater basins could be unable to meet consumer demand in as little as fifty years" (Heggie 2020). Factors such as a rising population, agricultural demand, and climate changes certainly greatly influence this, but what about the impact of fracking on top of all of these other factors? As mentioned earlier, it was estimated that 250 billion gallons of water were used to extract fuel by fracking from 2005 through 2014. Increased fracking activity could cause this number to skyrocket. This certainly seems to be a valid concern of fracking, which, according to the American Petroleum Institute, uses approximately 4 million gallons of water to frack a single well ("How" n.d.). This water dependency could certainly be a valid concern. The important question that has to be answered from this, however, is are the consequences of depleting water sources outweighed by the benefits of fracking? Could other alternatives to reduce water consumption in the U.S. be explored?

Seismic Activity

The last point of discussion concerns the possible influence of fracking on seismic activity. Due to the drilling that occurs deep beneath earth's core during fracking, concerns have

risen that fracking is increasing earthquake activity in the United States. According to an article by the United States Geological Survey (USGS), Oklahoma, the state that has the highest number of induced earthquakes in the country, has seen an uptick in earthquakes since 2009. 2% of earthquakes can be attributed to hydraulic fracking ("Does" n.d.). The number of earthquakes fluctuates greatly year to year. For example, in 2015 Oklahoma recorded nearly 900 earthquakes of a magnitude of 3.0 or greater on the Richter scale. In 2019, just 57 earthquakes were recorded for the same range of magnitude (Grogan 2021). The 2% of earthquakes being caused by fracking may seem like a small amount, but given the great variance in yearly earthquakes in the state, that number could really increase in significance. The fracking-induced earthquakes in Oklahoma are thought to be caused by wastewater disposal methods (Rogers 2020). While wastewater disposal is a large part of fuel extraction, it is not a part of the fracking act itself- it is more of a byproduct of it. Although a byproduct, fracking still creates the need for this wastewater disposal. If wastewater disposal poses the greatest threat to causing earthquakes, alternative disposal methods should be explored.

It is generally recognized that a very small number of earthquakes are caused by fracking activity, and those that do occur are of smaller, seemingly insignificant magnitudes. In China, however, higher magnitude, more damaging earthquakes have been observed in recent years and are attributed to fracking, on the basis of seismic sensors and satellite data. The link to fracking was made by the observance of foreshocks occurring around the same depth as fracking activity (Rogers 2020). The problem with this link is that it is again, a mere correlation. While it seems compelling to think that the connection between these variables could establish such a link, it does not actually prove fracking to be the causation.

Understanding Both Sides

Both sides of the fracking debate offer compelling viewpoints. Those opposed to fracking certainly possess reasonable questions and concerns about the potential harms to the environment and human health that fracking could induce. On the other side of things, those in favor of fracking have reason to doubt the validity of the claims being made by those opposed to fracking, because at times, they lack concrete evidence. For example, methane emissions, water contamination, and seismic activity are all concerns for those opposed to fracking. If fracking is a proven cause of these occurrences, these arguments might gain more traction. These variables, however, were mere correlations of activity, not causations. Methane emission increases during a period of increased fracking activity does not prove fracking to be the culprit. Water contamination in the vicinity of fracking sites does not mean that the contamination was caused by, or even derived from a fracking operation. Foreshocks occurring underground at the same depth of the earth's surface that fracking occurs does not mean fracking caused the seismic activity to occur. It is reasonable to question these correlations because they very well could be causations- but there is a lack of evidence to reasonably deem fracking as the cause of them.

When it comes to environmental concerns relative to methane emissions, the opposing sides can too easily portray the methane source breakdown in ways they find suitable. Does it matter more that fracking is the single biggest cause of methane emissions, or that taken as a whole, 70% of total emissions are derived from other sources? Even if we chose to blame the other 70% and look to make emission reductions in those categories, fracking could not simply be hailed as good, as it is still releasing ever-increasing amounts of methane and carbon dioxide into the atmosphere as energy demand increases. Even if we made progress in reducing overall

methane emissions, the issue of carbon dioxide emissions from burning natural gas would remain. Therefore, fracking could potentially be a good short term energy solution, but it is not helping the fight against climate change in the long run. Ideally, to alleviate environmental impact, fossil fuel dependence must decrease.

It is incredibly important to keep performing research on the possible environmental impacts of hydraulic fracking, because we cannot rule out all of these concerns regarding the environment, climate, and human health. Correlations between variables can serve as a suspicion and a good reason to conduct research, but falsely establishing a link of causation when there is a lack of evidence to prove it is problematic. Establishing fracking as "good" or "bad" is very dependent on the time frame being considered. What might be identified as a good short term solution could still be detrimental in the long term, and this seems to be the case with fracking. There could be enough evidence here to justify its use temporarily, but perhaps even more evidence exists to suggest that fracking, among all other fossil fuels, cannot be relied upon in the long term without a detrimental cost to the environment and human health.

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