Submission to Public Bills Committee: Bill 6

March 17, 2025

My name is Barb Harris. I live in River John. I am speaking on behalf of the Nova Scotia Fracking Resource and Action Coalition, NOFRAC. Thank you for the opportunity to speak today.

I am here to ask that Bill 6 be amended by removing clause 3, which would repeal the ban on hydraulic fracturing in shale, and Clause 21, which would repeal the ban on uranium exploration. I will speak mainly to Clause 3. I will also note that this government has not consulted with First Nations about the intention to repeal these protective bans.

If the present government questions the wisdom of the fracking ban, there is no need to repeal existing legislation. A process to review the present prohibition already exists in the legislation this government wants to repeal.

The legislation the government wants to repeal reads:

(2) No person shall engage in high volume hydraulic fracturing in shale formations unless exempted by the regulations for the purpose of testing or research.

It continues:

11B (1) The minister **may review** the prohibition.

Where the Minister reviews the prohibition, **the Minister shall consider the net benefit to Nova Scotians,** taking into account

a) social issues

b) economic issues

c) health issues

d) environmental issues

e) scientific and technical issues

f) regulatory effectiveness and efficiency and

g) any other matter or thing that the Minister considers necessary or advisable.

We **have** legislation that establishes a science and evidence-based process to evaluate the net benefit of allowing hydraulic fracturing in shale to Nova Scotians. **Why does this government want to repeal the prohibition without using this process?**

HISTORY OF PRESENT LEGISLATION

The present legislation resulted from a lengthy, science-based process. In 2013 Prime Minister Stephen Harper commissioned The Council of Canadian Academies (CCA) to study the environmental impacts of hydraulic fracturing in Canada. Fracking is an essential part of the relatively new industry known as unconventional oil and gas.

The CCA's 2014 report highlighted serious gaps in scientific knowledge about the impacts of fracking for unconventional gas on water, air, land, and human health. They concluded that "There can be advantages in "go-slow" approaches" and noted, "... there may also be some negative impacts of development that cannot be eliminated, and the scientific basis for identifying areas that are particularly vulnerable has not been established."

Nova Scotia introduced a two-year moratorium on fracking in 2012. In late 2013, the Nova Scotia government established an independent review panel on Hydraulic Fracturing in Nova Scotia. The expert panel spent six months reviewing the science and the knowledge gaps. It considered Nova Scotia specifics including geology and the resource available. Eleven public hearings were held throughout the province, attended by over 1200 people. Close to 250 independent experts and community members made detailed submissions. The legislation this government now wants to repeal grew out of these independent reviews. It was NOT a lazy or cowardly public policy process.

NOT ALONE IN BANNING FRACKING

Nova Scotia is not alone in believing that a moratorium or ban on fracking is wise public policy. Newfoundland and Labrador, PEI, New Brunswick and Quebec also prohibit fracking in shale. NL, NB and Quebec all held extensive reviews and concluded the practices should be prohibited. PEI banned fracking after public consultation on its Water Act.

These reviews took place because both federal and provincial governments understood that unconventional oil and gas development including fracking differs in many ways from conventional oil and gas – in the techniques used, the deep drilling, long horizontal

wellbores, the huge amounts of water used generating massive amounts of contaminated wastewater, the industrialization of landscapes.[1] The extensive impacts of shale gas development on water resources, climate, health and environment continue to be understood as the science develops.

Bans on fracking exist around the world. France, Germany, Northern Ireland, Wales, Bulgaria, Slovenia. As of 2024, five US states have banned fracking, including Vermont (2012), Maryland (2017), Washington (2019) and New York (2020) and California (2024.) A list of jurisdictions where bans or moratoriums on fracking exist is attached as Appendix A. The list is 6 pages long and growing. The risks of fracking and shale gas remain serious enough that new jurisdictions, including some where fracking has taken place in the past, are moving to ban or restrict it.

Dr. John Cherry is a globally recognized expert in groundwater contamination He chaired the Council of Canadian Academies study in 2013-14. In 2015, Dr. Cherry told a New Brunswick commission reviewing fracking, "given where New Brunswick is at, given there is currently a moratorium policy, it makes sense to continue that moratorium into the future**. The east coast, and New Brunswick, is not suitable for experimentation."**

THE SCIENCE IS GROWING

A decade later, we have more than 2500 scientific studies, government reports, and investigations into the shale gas industry and its impacts. Nearly 80% of all peer-reviewed research on shale gas development has been published since January 2013. We are still learning the full impacts.

The evidence we have does not support the claim that shale gas development can be done safely. Looking at clean water resources, health, climate – studies show that concerns about shale gas development and fracking have been confirmed. In fact, the documented impacts of shale gas and fracking are worse than we knew in 2014.

Following is a small sample of what the science tells us now:

PUBLIC HEALTH IMPACTS

In relation to public health, a study released last month (conducted by three Nova Scotia researchers from St.FX) found that Albertans living within at least 1.5 kilometres of an oil or gas well have an **estimated nine to 21 per cent higher risk** of experiencing cardiovascular or respiratory issues due to their proximity to a well. That's between 1 and 2 of every ten people That is a lot of harm -- and a lot of stress on a health care system. **The closer a**

[1] Triangle Petroleum planned to develop shale gas in the Kennetcook area of Nova Scotia. The intense development of up to 680 wells in the Kennetcook area is documented in "*Out of Control: Nova Scotia's Experience with Fracking for Shale Gas", Appendix D*

person lived to an oil or gas well, the greater their risk, the study found. Approximately 380,000 people out of Alberta's population of 4 million, live within 1.5 km of a well. If Premier Houston wants to learn from Alberta, this is a powerful lesson.

This is just one study among a growing number from both Canada and the US finding increased rates of illness and disease, including premature births, birth defects, childhood leukemia, asthma, heart disease in populations living near fracking operations and shale gas infrastructure. I'm sure this committee will hear more from the Canadian Association of Physicians for the Environment about population health impacts as well as problems with doctor retention in areas experiencing shale gas development.

FRESH WATER USE

As for environmental impacts – let's start with water. Fracking uses, and contaminates, massive amounts of fresh water. A 2024 report on fracking in the Montney region of BC and Alberta found that horizontal wellbores deep underground nearly doubled in length since 2010 -- now averaging 2,884 metres (2.9 km.) An average well now consumes 23.1 million litres of water, 10 times more than in 2010. Technological advances can be a two-edged sword. Technological advances that benefit industry can also generate new problems for society.

The millions of gallons of water used for fracking is **permanently** removed from the available supply of clean drinking water. We need to fully understand the potential impacts -- on agriculture and food security, on other water using industries and on rural populations, not just in the short term, but in 10 or 20 years and longer.

WASTEWATER DISPOSAL CHALLENGES

Another environmental risk that should not be underestimated is fracking wastewater. Fracking in shale generates massive amounts of highly contaminated, potentially radioactive wastewater. Disposal of fracking wastewater remains an unresolved problem of the industry, with both short- and long-term potential impacts. In many areas wastewater is disposed of by injection into underground wells. A 2016 Texas study notes, "Wastewater injected into disposal wells may, in some circumstances, migrate to the surface or into freshwater aquifers. Toxins can migrate to groundwater through leaks, cracks, or nearby abandoned wells, and multiple cases of groundwater contamination associated with wastewater disposal wells have been identified." Underground injection of fracking wastewater is known to cause earthquakes and their magnitude is increasing. A 2023 study from Stanford University found wastewater injected underground by fossil fuel operators caused a magnitude 5.6 earthquake in November 2022 in the Peace River area of Alberta's oil sands region.

Nova Scotia would face an even greater challenge with fracking wastewater disposal for several reasons. First, because underground disposal of wastewater is not suitable in Nova

Scotia's geology. Second, fracking wastewater in some geographic areas contains radioactive elements. Nova Scotia has only had one experience with exploratory drilling and fracking for shale gas. In that case, analysis of wastewater from Triangle Petroleum's exploratory drilling in Kennetcook, NS showed that the wastewater contained radioactive elements.[2] This raises additional risks and challenges.

RISKS TO DRINKING WATER

Our knowledge about fracking's risk to drinking water has advanced in the last 10 years. In 2014, there was fierce debate about whether fracking could contaminate drinking water. Evidence of drinking water contamination from fracking is now firmly established, including in an EPA study released in 2016. Since 2014, multiple lawsuits based on drinking water contamination from the shale gas industry have resulted in multi-million dollar verdicts and settlements. Safe drinking water is a BIG issue in rural Nova Scotia. According to the Nova Scotia government, approximately 46% of Nova Scotians rely primarily on groundwater from dug or drilled wells for their water supply. Nova Scotia's population is spread throughout the province, there are no vast unpopulated spaces.

EARTHQUAKES

In 2014, there was debate about whether earthquakes in shale gas extraction areas were linked to disposal of fracking wastewater underground. Evidence from around the world now definitively links earthquakes to underground storage of fracking wastewater and **in some instances to fracking itself.** Earthquakes linked to fracking have even been documented in areas where no earthquakes previously occurred. The intensity of earthquakes in some oil and gas regions is increasing. In February 2025, CBC reported "In both B.C. and Alberta's gas and oil areas, the number of higher-magnitude earthquakes has gone up. 'In 2021, we saw about 60 earthquakes a year, and in 2024, we were up to 160,' said Gail Atkinson, a consulting seismologist and former professor at Western University in London, Ont."

Earthquakes impact existing infrastructure and buildings. What might the impact of earthquakes and fracking be on aging infrastructure in our province, or in rural areas of with extensive underground coal mines? (Geothermal heat from mines is an underutilized energy resource that could provide opportunities for small-medium rural industries in

[2] Wastewater from Triangle's exploratory operation also contained toxins released from the shale, residues of fracking chemicals and was highly saline, three to four times saltier than seawater. The story of Nova Scotia's one small experience with fracking for shale gas in an exploratory well is documented in *Out of Control, Nova Scotia's Experience with Fracking for Shale Gas.* *Out of Control* also documents the potential well density and industrialization of rural landscapes in Nova Scotia based on Triangle Petroleum's documentation.

former coal mining areas of the province, as they do in Springhill.) These are all factors that need to be considered and counted on the cost side of the equation.

SOCIAL IMPACTS

As for social impacts, shale gas development can negatively impact rural communities in multiple ways. Communities where extensive fracking took place experienced increased stress on health care systems, a rising cost of living and increased housing shortages. Fracking requires thousands of heavy truck trips for each frack. The heavy wear results in costly damage to roads and bridges. In most areas, the costs of repair have been left to taxpayers. Nova Scotia's Independent Review of Fracking (p. 112) found "Local roads in rural areas tend not to be designed to withstand the stresses imposed by heavy truck traffic."

ECONOMIC IMPACTS

Are the problems offset by economic benefits? Studies show that economic promises are frequently exaggerated and real costs underestimated. In 2021, Forbes magazine published an in-depth study of one of the most intensively drilled regions of the US titled, "*Will the Fracking Boom Ever Translate into Jobs and Income for Appalachia's Residents?*

In 2021, the Ohio River Valley Institute published a report titled, "*Appalachia's Natural Gas Counties: Contributing more to the U.S. economy and getting less in return.*" It quantifies the decade-long failure of the natural gas boom in the Marcellus and Utica fields to deliver growth in jobs, income, and population to the 22 Ohio, Pennsylvania, and West Virginia counties that produce more than 90% of the region's natural gas.

John Hanger, former Pennsylvania secretary of Environmental Protection and policy director to Governor Tom Wolf, called the report's findings "shocking". "This report documents that many Marcellus and Utica region fracking gas counties typically have lost both population and jobs from 2008 to 2019. This report explodes in a fireball of numbers the claims that the gas industry would bring prosperity to Pennsylvania, Ohio or West Virginia. These are stubborn facts that indicate gas drilling has done the opposite in most of the top drilling counties," said Hanger.

A 2022 report from the same organization focusing on Pennsylvania found that "the 20 rural Pennsylvania counties that have not been heavily impacted by the natural gas industry have done no worse in job or population performance and, in some cases, have done better than those counties whose economies relied heavily on natural gas."

Meanwhile, shale gas development can undermine existing industries including agriculture and tourism.

HAS TECHNOLOGY SOLVED THE PROBLEMS?

The science available today tells us that neither technology or regulations has eliminated negative environmental and health impacts of fracking. A 2024 study shows that in Alberta and BC,

"Leakage of fluids from oil and gas wells is a source of the key greenhouse gas methane, and presents environmental risks, including groundwater contamination. .... In Canada, industry reporting on well integrity is often incomplete." Study authors concluded "that wellbore emissions, groundwater contamination, and broader environmental risks are underestimated."

A 2023 study of methane emissions from abandoned oil and gas wells in Alberta and Saskatchewan found "that subsurface leaks, as evidenced by surface casing vent flows, occurred at 32% of abandoned wells in Alberta, substantially higher than previously estimated using provincial data alone (6 and 11%)." Study authors concluded, "Therefore, well integrity failures and groundwater contamination are likely to be more common than previous studies suggest."

CLIMATE IMPACTS

This brings us to the climate impacts of leaking methane. In 2025, we know that methane has greater climate impacts than was recognized in 2014. It is now recognized as 86 times more potent a greenhouse gas than CO2 over a 20-year period – and that 20-year period is critical for slowing climate change. Emissions from shale gas development have been identified as a major driver in increased global methane emissions.

Increasing numbers of studies, like the two cited above, are measuring actual methane emissions from multiple stages of shale gas development. They are consistently finding that emission levels are far higher than those reported by industry or governments. The difference in measurements were highlighted after a BC government report based on flyover monitoring claimed minimal leakage from abandoned wells, while researchers challenged the data based on actual on-the-ground assessments showing far higher levels. This is a perfect example of the importance of looking beyond industry and government reports and study the science as well as missing information.

As gaps between estimates or reported levels of methane emissions and actual measured levels of emissions increase, they provide strong evidence to question the claim that fracked gas is a bridge fuel for climate goals. I am sure the committee will hear more about the climate impacts of fracking from other presenters. I have attached Appendix B, excerpted from the *Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking and Associated Gas and Oil Infrastructure, Ninth Edition, October 2023 (The Compendium)*, which provides a detailed summary of climate impacts of shale gas development and links to relevant studies.

ORPHANDED AND ABANDONED WELLS

Orphaned, abandoned and inactive wells remain a long-term economic and environmental liability for provinces that must be included on the balance sheet. Not only are they a significant financial burden for many generations, "they have the potential to contaminate water supplies, degrade ecosystems, and emit methane and other air pollutants that are harmful to human health and to the climate," according to a study published in 2023.

The problem has grown dramatically. In 2010, there were 700 orphaned wells in Alberta. In 2020, the number was 8,600. According to the International Energy Agency, in 2024 there were 5650 abandoned and 139,000 inactive wells in Western Canada. The federal government has already contributed $1.7 billion towards well remediation. Only a fraction were remediated by 2024. Nowhere has the industry put aside enough money to cover these costs. How could we expect it to be different in Nova Scotia? Tens of thousands of abandoned oil and gas wells in Western Canada should set off warning bells for our Premier and MLAs.

CAN REGULATIONS MAKE FRACKING SAFE?

It has been argued that good regulations could prevent the problems experienced elsewhere. Earlier I quoted the 2014 CCA study noting, "there may also be some negative impacts of development that cannot be eliminated, and the scientific basis for identifying areas that are particularly vulnerable has not been established."

It has become clear over the last 10 years that many aspects of shale gas development cannot be effectively regulated. You cannot regulate what will happen when rock is repeatedly exposed to pressure designed to fracture it a kilometer underground and 2 km distant. You cannot regulate where crevices and fissures will open underground and allow toxic fracking wastewater to infiltrate aquifers. You cannot regulate where and when methane gas will flow underground and contaminate groundwater, streams or wells. You cannot regulate cement to prevent deterioration over time and under pressure of repeated fracking and prevent the release of methane into the atmosphere. You cannot predict or regulate where fracking-induced earthquakes will take place. These are not theoretical risks. They are real risks documented in scientific research. I have appended information documenting the limits of regulation excerpted from the *The Compendium* as Appendix C.

Where regulations can reduce or prevent harm, they need to be strongly deterrent so that companies do not choose to risk being fined for non-compliance as a minor cost of doing business. Deterrent regulations need to be paired with effective monitoring and enforcement. Effective monitoring and enforcement would be costly.

Unfortunately, all too often, fracking has been exempted from protective environmental regulations. As of 2012, the hydraulic fracturing process in the US was exempted from

seven major federal regulations including the Clean Water Act and the Safe Drinking Water Act. Neither the US nor Canada currently classifies fracking wastewater as hazardous waste, In Canada, fracking remains exempt from reporting required by the National Pollution Release Inventory.

This pattern of exempting shale gas development and fracking from protective environmental regulation raises additional doubts about the Premier's assurances that regulations will ensure fracking is done safely in Nova Scotia.

CONCLUSION

The 2500 studies now available illustrate that the harms associated with shale gas development are well documented. In relation to health, climate, water resources and environment, the impacts are even greater than we knew 10 years ago. They illustrate that neither regulations nor technology has eliminated actual or potential negative impacts of shale gas development including fracking.

NOFRAC believes that the state of the science strongly argues that the existing ban on hydraulic fracturing in shale remains the right policy for Nova Scotia. I hope this government will step back and reconsider this bill, based on the evidence provided to this Committee and other information they have received, including letters from the Assembly of Nova Scotia Mi'kmaw Chiefs and the Canadian Association of Physicians for the Environment.

If this government continues to question the wisdom of the ban on fracking, we ask that section 3 of this bill be withdrawn, and that the ban on fracking remain in place until an informed, science-based, participatory evaluation of the net benefit to Nova Scotians, as well as consultations with First Nations, is carried out. We ask similarly that section 21 also be withdrawn and that the ban on uranium exploration remain in place until a similar science-based participatory review takes place for uranium.

There is no need for haste on Bill 6. Neither uranium mining nor fracking is going to start up overnight. Fracking will not solve the immediate problems caused by Trump tariffs and unstable relations with the US.

It is so easy to break things. It is much harder - and more costly - to repair them, when it is even possible. We only need to look at Boat Harbour to know how long it can take – in that case 53 years- and how financially costly it can be – half a billion dollars and counting- to correct problems after they have occurred. The human costs are never eliminated.

We are a small province. We do not have room to make big mistakes.

Thank you.

Appendices: Supplement to Submission from Nova Scotia Fracking and Resource Coalition (NOFRAC) to Public Bills Committee, March 17, 2025

Appendix A: Timeline of Fracking Bans and Moratoria

Excerpted from *Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking and Associated Gas and Oil Infrastructure*
Ninth Edition, October 2023, pp 39-46

Note: There may be additional jurisdictions which are not included. Nova Scotia and Quebec both have bans on hydraulic fracturing in shale but are not listed in the compendium.

As a response to the proliferating documentation of the risks and harms of fracking—augmented by increasing evidence of its declining benefits and unrealized promises—various countries, states, and municipalities have instituted bans and moratoriums.[3]

[3] Hector Herrera, "The Legal Status of Fracking Worldwide: An Environmental Law and Human Rights Perspective," The Global Network for Human Rights and the Environment, January 6, 2020, https://gnhre.org/2020/01/06/the-legal-status-of-fracking-worldwide-an-environmental-law-and-human-rightsperspective/.

France banned fracking in July 2011. In 2017 this ban was extended to include all exploration and extraction of oil and gas within France and all its territories until 2040.

The government of North Ireland declared a moratorium on fracking in December 2011. In February 2022, Northern Ireland's Minister for the Economy Gordon Lyons announced that the preferred option resulting from his Department's policy review would be a ban on all forms of petroleum licensing.

Bulgaria banned fracking in January 2012.

In May 2012, the state of Vermont banned fracking and prohibited the storage and treatment of fracking waste.

In July 2012, a revision of environmental laws in Austria prompted the main Austrian oil and gas group to announce a stop to its shale gas plans in the country.

In April 2013, the Luxembourg parliament passed a motion against shale gas exploration.

In October 2013, after extended anti-fracking protests, U.S.-based Chevron pulled out of Lithuania, blaming regulatory and legislative restrictions that came into place after it had won permits for shale gas exploration. There is currently no fracking in Lithuania.[4]

In July 2014, the Flanders region of Belgium temporarily banned fracking. This ban is still valid. There is currently no domestic gas extraction in Belgium.

The California counties of Santa Cruz, San Benito, and Mendocino all banned fracking in 2014.

New York State banned fracking in December 2014.

In January 2015, Scotland became the first country in the United Kingdom to impose a formal moratorium on fracking. In 2016, as part of the ongoing moratorium process, the government of Scotland released a series of reports that reconfirmed the evidence for potential contamination of air and water, threats to worker health from silica dust exposure, and risks to the health of nearby residents. It further noted that the pursuit of unconventional oil and gas extraction would make it more difficult for Scotland to achieve its climate targets on greenhouse gas emissions.[56] In October 2017, Scotland's moratorium was extended "indefinitely" in a decision that led to an unsuccessful court challenge by the British petrochemical company Ineos. In 2019, the government confirmed that would no longer issue licenses for fracking nor grant permission for any onshore drilling projects.[7] In 2020,

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[4] Andreea Maierean, "What Went Wrong? Fracking in Eastern Europe," *Discover Energy* 1, no. 1 (August 16, 2021): 3, https://doi.org/10.1007/s43937-021-00003-5.

[5] Health Protection Scotland, "A Health Impact Assessment of Unconventional Oil and Gas in Scotland: Volume 1 - Full Report," (Public Health Scotland, November 8, 2016), http://www.hps.scot.nhs.uk/resourcedocument.aspx?resourceid=3102.

[6] Energy and Climate Change Directorate, "Unconventional Oil and Gas: Compatibility with Scottish Greenhouse Gas Emissions Targets," Research and Analysis, Scottish Government, November 8, 2016, http://www.gov.scot/Resource/0050/00509324.pdf.

[7] Severin Carrell, "Scottish Government Extends Ban on Fracking," October 19, 2019, sec. UK Politics, https://www.theguardian.com/uk-news/2019/oct/03/scottish-government-extends-ban-on-fracking.

Ineos purchased tens of thousands of acres of leases near Austin, Texas and applied for fracking permits.[8]

In February 2015 the government of **Wales** declared a moratorium on fracking "until it is proven safe." In July 2018, the Welsh government confirmed that shale gas was not compatible with decarbonization targets and said it would not support applications for fracking.

In March 2015, the Canadian province of **New Brunswick** declared a moratorium on fracking and in 2016 extended it indefinitely, citing unresolved problems with the disposal of fracking wastewater. In 2019, the moratorium was lifted in the Sussex area where a small gas industry had been operating prior to the moratorium and was seeking to attract investors. However, the obligation to consult with Indigenous peoples remained in effect and no proponent came forward with a proposal.[9]

In March 2023, Premiere Blaine Higgs reignited the attempt to lift the moratorium in the Sussex area in a letter to First Nations' chiefs that emphasized fracking's revenue potential.[10]

In July 2015, the **Netherlands** banned all shale gas fracking through 2020 and then extended the ban to 2023. In October 2018, the Dutch government announced that gas extraction of all kinds in the Groningen gas field would entirely cease by 2030 after public outcry over continuing earthquakes in the region. Gas production has already been cut by 60 percent since its peak in 2013. On May 22, 2019, Groningen was hit with a magnitude 3.4 earthquake that damaged multiple homes.[11]

In August 2015, **Denmark** declared a stop to new applications for shale gas drilling, extending its 2012 moratorium.

In December 2015, the plenary of the **European Parliament** affirmed the incompatibility of shale gas extraction via hydraulic fracturing with the European Union's commitment to decarbonization, and it acknowledged public concerns about the environmental and health impacts of fracking. While falling short of an outright EU-wide moratorium on fracking, the report states that "it is questionable whether hydraulic fracturing can be a viable technology in the European Union."[12]

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[8] Sergio Chapa, "Drilling down: British Petrochemical Giant Ineos Plans to Begin Fracking in Texas," *Houston Chronicle*, May 7, 2020, sec. Sector News, https://www.borderless.net/news/chemical-value-chain/drilling-downbritish-petrochemical-giant-ineos-plans-to-begin-fracking-in-texas/.

[9] Silas Brown, "New Brunswick Indigenous Chiefs Left 'blindsided' by Decision to Lift Fracking Moratorium," *Global News*, June 5, 2019, https://globalnews.ca/news/5356115/indigenous-chiefs-issue-warning-gas-fracking/.

[10] Aidan Cox, "Higgs Pitches First Nations on up to $1.6B in Revenue with Possible Shale Gas Expansion," *CBC News*, March 30, 2023, https://www.cbc.ca/news/canada/new-brunswick/new-brunswick-fracking-shale-gas-firstnations-1.6794489.

[11] "Groningen Hit by Strong Earthquake as Gas Extraction Impact Continues," *Dutch News*, May 22, 2019, https://www.dutchnews.nl/news/2019/05/groningen-hit-by-strong-earthquake-as-gas-extraction-impact-continues/.

[12] Committee on Industry, Research and Energy, "Report: On towards a European Energy Union" (European Parliament, n.d.), http://www.europarl.europa.eu/sides/getDoc.do?pubRef=-//EP//TEXT+REPORT+A8-2015-0341+0+DOC+XML+V0//EN.

In January 2016, **Broward County, Florida**, one of three counties that make up the larger Miami metropolitan region, banned both hydraulic fracking and acid fracking via a unanimous vote of the Broward County Commission.

In 2016 a government-appointed panel in the Canadian province of **Newfoundland and Labrador**, where a moratorium had been in place since 2013, recommended that fracking remain "paused," citing data gaps and unresolved questions about the underlying geology.

In June 2016, **Germany** adopted a moratorium on fracking in shale but allowed exploratory drilling research projects. This moratorium, which was due to be reviewed in 2021, remains in place. Fracking in sandstone is explicitly permitted.

Also in 2016, Butte and Alameda counties in **California** banned fracking, along with Monterey County, which also banned all new oil drilling.

In August 2016, the state of Victoria in **Australia** halted both fracking and conventional gas extraction on the grounds that the risks outweighed any potential benefits. In March 2020, the fracking ban became permanent while the ban on conventional drilling without fracking was lifted.[13]

In September 2016, a **California** judge, arguing that the agency had failed to consider the dangers of fracking, struck down a bid by the Bureau of Land Management (BLM) to open one million acres of public land in central California to oil drilling.

In November 2016, Winona County, **Minnesota** banned the mining of frack sand, a decision that was upheld in district court in November 2017 and upheld again by the Minnesota Supreme Court in March 2020.[14][15] In January 2021 the U.S. Supreme Court refused to hear the case, and the Winona County ban on frack sand mining prevailed.[16]

In December 2016, the Portland City Council in **Oregon** approved zoning code changes that banned the construction of new fossil fuel projects, including terminals for storing and transporting natural gas, and also prohibited the expansion of pre-existing facilities, including an LNG plant.

In 2017, Ponca Nation in northern **Oklahoma** banned fracking on Ponca lands by passing a Rights of Nature law declaring that natural elements possess inalienable rights.[17]

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[13] Samantha Hepburn, "Victoria Bans Fracking for Good, but Quietly Lifts Onshore Gas Exploration Ban," Phys.org, March 19, 2020, https://phys.org/news/2020-03-victoria-fracking-good-quietly-onshore.html.
[14] Chris Rogers, "Supreme Court Considers Frac Ban," *Winona Post*, April 17, 2019, http://www.winonapost.com/Article/ArticleID/63818/Supreme-Court-considers-frac-ban.

[15] Matt McKinney, "Minnesota Supreme Court Upholds Winona County Ban on Frac Sand Mining," *StarTribune*, March 11, 2020, https://www.startribune.com/minnesota-supreme-court-upholds-winona-county-ban-on-frac-sandmining/568701922/.
[16] Matt McKinney, "U.S. Supreme Court Rejects Suit against Winona County Frac Sand Ban," *Star Tribune*, January 12, 2021, https://www.startribune.com/u-s-supreme-court-rejects-suit-against-winona-county-frac-sandban/600009755/.
[17] Ray Levy Uyeda, "Indigenous Activists Look to Rights of Nature Laws to Stop Fracking," Daily Kos, October 28, 2022, https://www.dailykos.com/stories/2022/10/28/2130922/-Indigenous-activists-look-to-Rights-of-Naturelaws-to-stop-fracking.

In March 2017, the Castilla Leon region in **Spain** signed a political agreement to give up on shale gas exploration. This decision followed the implementation of several other regional bans in Spain or laws that otherwise made fracking unviable. These regions include Cantabria (April 2013), La Rioja (May 2013), Catalonia (February 2014), Basque Country (June 2015), and Castillo La Mancha (March 2017). In May 2021, Spain passed a climate bill that banned fracking nationwide and banned all new oil and gas exploration.

In April 2017, **Maryland** became the third U.S. state to ban fracking when Governor Larry Hogan signed a ban bill that was overwhelmingly approved by the state legislature. Maryland's ban followed a two-and-a-half-year statewide moratorium.

Also in April 2017, Entre Rios passed the first province-wide ban on fracking in **Argentina**. This ban follows 50 individual municipal bans and is intended to protect the Guarani Aquifer, which extends beneath parts of Argentina, Brazil, Paraguay, and Uruguay.

In June 2017, **France** expanded its fracking ban to include a ban on all new oil and gas exploration.

In July 2017, **Ireland** banned fracking when legislation was signed into law by the president.

Also in October 2017, Canada's **Prince Edward Island** included a prohibition on fracking as part of its Water Act.

In December 2017, **Uruguay** prohibited fracking for four years.

In March 2018, the **Australian state of Tasmania** extended its moratorium on fracking until 2025.

In October 2018, the National Authority for Environmental Licenses denied applications for commercial fracking in **Colombia.**

In December 2019, the Colombian Ministry of Mines approved a regulatory framework for fracking pilot studies.

In April 2022, a judge suspended the license of one such project on the grounds that Afro-Colombian communities had not been consulted.

In December 2018, the newly elected president of **Mexico** announced a suspension of all further energy auctions for three years, temporarily halting permits for new fracking operations. This announcement was widely seen as a possible step by President Obrador toward fulfilling a campaign promise to ban fracking in Mexico.[18] However, he has not done so. In January 2023, Mexico's Safety, Energy and Environment Agency began preparing a rule for both its state owned oil company (Pemex) and private companies to frack for oil and gas after the next president takes office in December 2024. Pemex has already drilled and fracking at least three wells.[19]

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[18] Rebecca Bertram, "Will Fracking Be Banned in Mexico?," Energy Transition, April 17, 2019, https://energytransition.org/2019/04/will-fracking-be-banned-in-mexico/.

[19] Arturo Solis, "Exclusive: Mexico Prepares Environmental Framework for Future Fracking," *Bloomberg Línea*, January 3, 2023, https://www.bloomberglinea.com/english/exclusive-mexico-prepares-environmental-frameworkfor-future-fracking/.

In May 2019, **Washington State** enacted a statewide ban on fracking.

In June 2019, the state of **Oregon** put in place a five-year fracking moratorium.

Also in June 2019, the state of **Connecticut**, where no fracking takes place, banned the disposal of oil and gas extraction waste.

In November 2019, **the United Kingdom** declared a moratorium on fracking after an Oil and Gas Authority analysis found that preventing earthquakes associated with fracking is not possible with existing technology but left open the possibility that the temporary ban could be reversed if induced seismicity became manageable. In April 2022, the government ordered a new report from the British Geological Survey to assess any recent changes to the science, a decision seen by the industry as a possible first step toward overturning the ban.[20]

Also in November 2019, Governor Gavin Newsom announced a moratorium on all new fracking and cyclic steam permits for the state of **California**. This moratorium lasted until April 2020 when 24 new permits were issued for fracking in Kern County.[21]

In April 2020, the state legislature, in a bill signed by Governor Ralph Northam, banned fracking east of I-95 in the state of **Virginia**.

On August 3, 2020, **New York State** banned the importation of out-of-state fracking waste for disposal in municipal waste landfills and wastewater treatment plants. Seven different landfills across New York State had accepted liquid and solid fracking waste from Pennsylvania.

In February 2021, the Delaware River Basin Commission–which consists of governors of New York, New Jersey, Pennsylvania, and Delaware together with the U.S. Army Corps of Engineers–finalized a rule to permanently ban fracking in the **Delaware River watershed** on the grounds that fracking exposes its waters to "significant, immediate, and long-term risks." This ban replaces a temporary moratorium on fracking that had been in place since 2010.[22]

In October 2021, the Commission proposed additional rules that would prohibit the discharge of fracking wastewater to water or land within the Basin but that would not explicitly disallow the importation of wastewater from fracking operations located outside the Basin.[23]

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[20] "Business Secretary Kwasi Kwarteng Orders Scientific Review of Fracking Impact," BBC.com, April 5, 2022, https://www.bbc.com/news/uk-politics-60999026.

[21] Janet Wilson, "Fracking in California Gets Green Light after 9-Month Pause; Aera Energy Receives Permits," *Desert Sun*, April 3, 2020, https://www.desertsun.com/story/news/environment/2020/04/03/calgem-approves-24-fracking-permits-aera-energy-after-9-month-pause/2944712001/.

[22] Michael Rubinkam, "Agency Permanently Bans Fracking Near Delaware River," PBS.org, February 25, 2021, https://www.pbs.org/newshour/nation/agency-permanently-bans-fracking-near-delaware-river.

[23] Delaware River Basin Commission, "Full Text of FAQ: Proposed Regulations Addressing Importation and Exportation of Water and the Discharge of Wastewater from High Volume Hydraulic Fracturing," December 7, 2021, https://www.state.nj.us/drbc/meetings/proposed/notice_import-export-rules_faq_full-text.html.

In spring 2023, the Commission clarified its policy language to remove this loophole after a citizen group filed federal lawsuit.[2425] The longest free-flowing river in the Northeast, the Delaware River provides drinking water to more than 15 million people (approximately five percent of the U.S. population). About one-third of the river's watershed is underlain by the Marcellus shale formations.

In 2021 and 2022 prohibitions under multiple jurisdictions advanced in **California.**

In April 2021, Governor Gavin Newsom announced a plan to ban fracking of new and existing wells by 2024 and to consider phasing out oil production statewide by 2045. In practice, the state has begun denying fracking permits, citing climate concerns.[26]

In September 2021, the Los Angeles County Board of Supervisors voted unanimously to end oil and gas drilling in the County's "unincorporated" areas, which includes 1,600 wells, many in the Inglewood Oil Field, one of the largest urban drilling sites in the country. Effective November 2021, Culver City, California prohibited the drilling of any new, or redrilling of any existing, gas or oil well. The City Council also required the phasing out, plugging and restoration of all existing gas and oil wells, by November 24, 2026. A portion of the Inglewood Oil Field, one of the largest U.S. urban oil fields, lies within Culver City. In January 2022, the Los Angeles City Council voted unanimously to ban new oil and gas wells and phase out existing ones. [See also Case Study: Drilling and Fracking in California, p. 98.]

In April 2022, in a unanimous vote by the National Assembly, **Slovenia** imposed a complete ban on fracking in the face of threatened lawsuits by a UK-based fracking investor seeking to extract gas in the northeastern part of the country.[27]

In April 2023, a fracking ban in **Colombia** passed the Senate and is expected to win congressional approval. The ban is part of a larger policy initiative by the Colombian state to transition to renewable energy within two years.[2829]

In May 2023, Croatia banned large-scale fracking operations although exploratory activities are still allowed.[30]

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[24] Michael Rubinkam, "Agency Clarifies Frack Waste Ban in Delaware River Watershed," *AP News*, April 28, 2023, https://apnews.com/article/delaware-river-fracking-wastewater-ban-a23a62bb7187665f2f2bfcb32845dd9f.

[25] Delaware River Basin Commission, "Full Text of FAQ (Revised): Final Regulations Addressing Importation and Exportation of Water and the Discharge of Wastewater from HVHF and HVHF-Related Activities," Delaware River Basin Commission, March 28, 2023, https://www.nj.gov/drbc/about/regulations/finalrule_import-export-hvhfdischarge_FAQtext_revised.html.

[26] Los Angeles Times Editorial Board, "Did California Issue Its Last Fracking Permit? Let's Hope So," *Los Angeles Times*, December 17, 2021, https://www.latimes.com/opinion/story/2021-12-17/fracking-permits.

[27] Sebastijan R. Maček, "Slovenia Imposes Blanket Ban on Fracking," isds.bilaterals.org, April 7, 2022, https://www.isds.bilaterals.org/?slovenia-imposes-blanket-ban-on.

[28] Luis Jaime Acosta, Griffin, and Sabrina Valle, "Exclusive: As Colombia Moves to Ban Fracking, Exxon Seeks to Recover Investment," Reuters, April 27, 2023, https://www.reuters.com/world/americas/colombia-moves-banfracking-exxon-seeks-recover-investment-sources-2023-04-27/.

[29] Patricia Rodriguez, "Is Colombia One Step Away from a Fracking Ban?," *NACLA*, February 8, 2023, https://nacla.org/colombia-one-step-away-fracking-ban.

[30] Total Croatia News, "Parliament Amends Law to Ban Large-Scale Hydraulic Fracturing," *Total Croatia*, May 11, 2023, https://total-croatia-news.com/news/politics/parliament-amends-law-to-ban-large-scale-hydraulicfracturing/.

In sum, as evidence continues to mount of its environmental and public health costs, legislative and governmental bodies are increasingly apprehensive about the risks and harms of fracking.

Nevertheless, in several notable cases, hard-won bans and other restrictions on fracking have been overturned:

A fracking ban passed by the city of **Denton, Texas** in 2014 was invalidated in 2015 by a state law, pushed by oil and gas interests, that prohibits Texas municipalities from passing local bans.

In **Colorado,** the Colorado Supreme Court struck down local fracking bans in the cities of Fort Collins and Longmont in May 2016, and a subsequent attempt to reinstate the ban in Longmont was struck down by a Boulder district judge in November 2020.

In January 2019, the Colorado Supreme Court ruled against a case brought by six youth that would have halted new drilling permits pending a comprehensive study of health and environmental impacts. The ruling allows Colorado to continue to weigh costs and technical feasibility against adverse public health impacts. A statewide ballot measure (Proposition 112) to increase well setback distances to 2,500 feet from occupied buildings, public spaces, and bodies of water narrowly failed in November 2018. According to the Colorado Oil and Gas Conservation Commission, the measure would have prevented drilling on approximately 85 percent of non-federal lands in the state.

In April 2019, the Colorado State legislature passed a bill (SB 181) intended to reorient state oversight of the oil and gas industry away from promoting fossil fuel extraction and toward protecting public health and the environment. As a result of the law, the state setback distance was set at 2,000 feet. This buffer zone applies only to new wells on new well pads and allows for the drilling and fracking of new wells on pre-existing well pads. Further, the rule allows requests for waivers.

In March 2022, the Colorado Oil and Gas Conservation Commission (COGCC) denied a waiver request from Occidental Petroleum for a large proposed fracking site that would have drilled 26 wells fewer than 2,000 feet from 62 homes in a residential area of Firestone.[31]

SB 181 also grants Colorado municipalities more regulatory authority over fracking activities.

In February 2022, the Broomfield city council banned the use of perfluoroalkyl and polyfluoroalkyl substances (PFAS chemicals) in fracking operations.[32] Nevertheless, waivers were granted for three different projects sited closer than 2,000 feet from homes in 2021 and at least one, thus far, in 2022. A 2022 analysis of the impact of SB 181 in Colorado one year after its implementation found that the reforms wrought by this legislation have, up to now, led to many changes in process but few in outcome. “The oil and gas industry still largely gets its way with the agency and residents near oil and gas facilities are still suffering from negative effects to their health, safety, and welfare. The COGCC still operates from an outlook that presumes permitting of new facilities and the continued operation of

[31] Judith Kohler, “Colorado Regulators Reject Drilling Plan near Homes in Growing Firestone Community,”*Greeley Tribune*, March 10, 2022, https://www.greeleytribune.com/2022/03/10/colorado-rejects-kerr-mcgeefirestone-drilling-plan/.

[32] Sydney McDonald, “PFAS Chemicals Banned in Broomfield Fracking Operations,” *Daily Camera*, February 9, 2022, https://www.dailycamera.com/2022/02/09/pfas-chemicals-banned-in-broomfield-fracking-operations/.

existing facilities rather than first determining whether those activities are truly protective of people, the environment, and wildlife."[33]

In December 2017, **Australia's Northern Territory** government delayed a decision to extend or lift a fracking moratorium after a draft final report identified multiple risks to water, land, tourism, and indigenous culture. In April 2018, it lifted this moratorium. In September 2021, more than 60 climate scientists issued a dire warning over the plan to frack in the **Beetaloo Basin** within the Northern Territory after the federal government used grants to incentivize gas exploration there.[3435]

In October 2021, Empire Energy won approval to begin fracking in the Beetaloo Basin. In December 2021, a territorial court voided the fracking grants but did not rule against fracking. Consultation with traditional landowners was the subject of a Senate inquiry in March 2022.[36]

In May 2023, the Northern Territory government said that it was satisfied with the inquiry, clearing the way for fracking to begin.[37] In September 2023, a report by health professional based on more than 300 peer-reviewed studies documented threats from fracking in the Beetaloo to climate, biodiversity, water, food, air, soil, and "physical, social, emotional, and spiritual health."[38]

In November 2018, the statewide moratorium in **Western Australia** was lifted over intense opposition, highlighting the limitations of aboriginal land rights. Local bans in heavily populated areas of the state were left in place.

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[33] Mike Foote and Casey Morris, "COGCC: One Year After Mission Change," Prepared for Colorado Sierra Club, January 17, 2022, https://www.larimerallianceblog.org/wp-content/uploads/2022/01/COGCC-One-Year-After-Mission-Change-1.pdf.

[34] "Over 60 Scientists & Experts Call on NT Chief Minister Gunner to Honour Commitment to Net-Zero Fracking Emissions," The Australia Institute, September 23, 2021, https://australiainstitute.org.au/post/over-60-scientistsexperts-call-on-chief-minister-gunner-to-honour-commitment-to-net-zero-fracking-emissions/.

[35] Christopher Knaus, "'Grave Mistake': Climate Scientists Issue Dire Warning over Beetaloo Basin Fracking Plans," *The Guardian*, September 22, 2021, https://www.theguardian.com/australia-news/2021/sep/23/gravemistake-climate-scientists-issue-dire-warning-over-beetaloo-basin-fracking-plans.

[36] Christopher Knaus, "Beetaloo Traditional Owners yet to Be Consulted on Production of Fracking Gas, Senate Inquiry Hears," *The Guardian*, March 21, 2022, https://www.theguardian.com/australia-news/2022/mar/22/beetalootraditional-owners-yet-to-be-consulted-on-production-of-fracking-gas-senate-inquiry-hears.

[37] Lisa Cox, "Northern Territory Clears Way for Fracking to Begin in Beetaloo Basin," *The Guardian*, May 2, 2023, https://www.theguardian.com/australia-news/2023/may/03/northern-territory-clears-way-for-fracking-tobegin-in-beetaloo-basin.

[38] Melissa Haswell, Jacob Hegedus, and David Shearman, "The Risks of Oil and Gas Development for Human Health and Wellbeing: A Synthesis of Evidence and Implications for Australia" (Office of the Deputy Vice Chancellor (Indigenous Strategy and Services), University of Sydney., 2023), https://apo.org.au/node/324169.

In August 2023, the California Supreme Court ruled against a ballot initiative (Measure Z) that, seven years earlier, had banned fracking, banned new oil and gas wells, and phased out wastewater disposal in **Monterey County, California.**[39]

[39] Sophie Austin, "California High Court Says County Can't Enforce Oil Well Ban as State Debates Future of Fossil Fuels," *Associated Press*, August 3, 2023, https://apnews.com/article/california-oil-gas-wells-vote-ballot-2024-40519fda5272d7d8d0fdaba94ea74ad7.

Appendix B: *Fracking is accelerating the climate crisis* (A Summary of the Science)

Excerpted from *Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking and Associated Gas and Oil Infrastructure*
Ninth Edition, October 2023, pp 53-56

Fracking is accelerating the climate crisis.

Natural gas is 85-95 percent methane, a potent greenhouse gas. On the grounds that natural gas emits, when combusted, only 53 percent of the carbon dioxide emitted by coal, early promoters of fracking argued that natural gas could serve as a "bridge fuel" while renewable energy sources ramp up. An abundance of scientific evidence now disproves these claims and shows that natural gas is at least as damaging to the climate as coal and may be worse due to inevitable leaks of unburned methane. A July 2023 study found that a methane leakage rate of just 0.2 percent causes the warming potential of natural gas to exceed that of coal, which, when burned, forms sulfate aerosols that mask warming.[4041]

Recent research using satellites and aircraft reveal that fracking operations and their ancillary infrastructure are emitting significantly more methane than 0.2 percent and several times higher than the levels disclosed by the industry or estimated in federal greenhouse gas inventories.[42] The liquefaction and transportation of natural gas as LNG raises its greenhouse gas emissions even further, by another 30 percent, both because of the need for evaporative cooling and venting but also because flaring is used to control pressure during regasification.

Research also demonstrates that methane, while less persistent in the atmosphere than carbon dioxide, is a far more powerful greenhouse gas than formerly understood. The United Nations Intergovernmental Panel on Climate Change (IPCC) estimates that over a 20-year time frame–longer than the decade remaining to limit global warming to 1.5o C–methane can, pound for pound, trap 86 times more heat than carbon dioxide. (See footnote 1859.) Methane concentrations in the atmosphere have nearly tripled since pre-industrial times, with levels surging past 1,900 parts per billion by the end of 2021.[43]

Altogether, the science to date shows that methane is the biggest contributor to the ongoing failure to meet agreed-upon global emissions targets and stabilize the climate. According to the IPCC's Sixth Assessment Report, the first installment of which was released in 2021, methane has contributed nearly 40 percent of all global warming to date. The report devoted an entire chapter to the problem of methane and potent heat-trapping gasses other than carbon dioxide. To avoid exceeding 1.5o C of

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[40] Deborah Gordon et al., "Evaluating Net Life-Cycle Greenhouse Gas Emissions Intensities from Gas and Coal at Varying Methane Leakage Rates," *Environmental Research Letters*, July 4, 2023, https://doi.org/10.1088/1748-9326/ace3db.
[41] Hiroko Tabuchi, "Leaks Can Make Natural Gas as Bad for the Climate as Coal, a Study Says," *The New York Times*, July 13, 2023, https://www.nytimes.com/2023/07/13/climate/natural-gas-leaks-coal-climate-change.html.
[42] Terry Slavin, "Analysis: Benchmark of Big Oil on Methane Emissions Shows 'Significant Gap' between Reality and Reporting," Reuters, August 14, 2021, https://www.reuters.com/article/emissions-methane/analysis-benchmarkof-big-oil-on-methane-emissions-shows-significant-gap-between-reality-and-reportingidUSMTZSPDEH8EU9J79K.
[43] Jeff Tollefson, "Scientists Raise Alarm over 'Dangerously Fast' Growth in Atmospheric Methane," *Nature*, February 8, 2022, d41586-022-00312–2, https://doi.org/10.1038/d41586-022-00312-2.

global warming, the IPCC urged "strong, rapid, and sustained reductions" in methane emissions. (See footnote 45.) At the 2021 climate summit in Glasgow, 105 nations signed the Global Methane Pledge to cut methane emissions globally by 30 percent by 2030 in an attempt to limit warming to 1.5o C.

The call to curtail methane in order to stabilize the climate has been echoed by the both the U.N. Environment Programme (UNEP) and the International Energy Agency (IEA), which found that oil and gas operations around the world emit a level of methane that is equivalent to all the energy-related emissions of carbon dioxide from the European Union.[44] (See footnotes 1704, 2389.) According to a 2019 study, shale gas production in North America alone contributes more than half of all of the increased emissions from fossil fuels globally and at least one-third of the total increased emissions from all sources globally over the past decade. (See footnote 1741.) A 2021 study found that reductions in human-caused methane emissions alone, of which oil and gas wells are the single largest source, could avert nearly one-third of the global warming expected in the next two decades. (See footnote 1692.)

Multiple studies, using a range of methodologies, now also show that real-world methane leakage rates from North American drilling and fracking operations greatly exceed earlier EPA estimates and are likely driving the current surge in global methane levels. IEA's Global Methane Tracker 2023 found that the United States now leads the world in methane emissions from oil and gas operations.[45] Global methane emissions from the energy sector are about 70 percent greater than the amount national governments have officially reported, with North American methane emissions reported at 14.0 million tonnes (Mt), but estimated by the IEA to be 20.9 Mt.[46] An April 2023 study shows that 15 percent of the world's gas- and oil-derived methane emissions are contributed by the United States. (See footnote 1672.)

Methane escapes into the atmosphere from all parts of the extraction, processing, and distribution system–for both oil and gas–all the way to the burner tip. In the heavily drilled Barnett Shale of northeastern Texas, methane emissions were shown to be 50 percent higher than the EPA had estimated. Fracking operations and associated infrastructure contributed 71-85 percent of the methane emissions in the region. A 2018 analysis of methane leaks from the entire U.S. oil and gas supply chain found leakage rates were 60 percent higher than reported by the EPA, and a 2019 study in southwestern Pennsylvania found shale gas emissions that were underreported by a factor of five when compared to EPA estimates. (See footnotes 1741, 1776.) A 2021 study of the intensely drilled and fracked Uinta Basin in northern Utah found that 6 to 8 percent of the total gas extracted escaped as atmospheric emissions, a shockingly high leakage rate that remained constant between 2015 and 2020, even as gas production in the region declined over the same period. (See footnote 1681.)

The Permian Basin in West Texas and eastern New Mexico–the world's largest shale deposit for oil and gas–accounts for more than 40 percent of total U.S. oil extraction and 22 percent of gas extraction each

[44] International Energy Agency, "Methane Tracker 2021" (IEA, January 2021), https://www.iea.org/reports/methane-tracker-2021.
[45] International Energy Agency, "Global Methane Tracker 2023," February 2023, https://www.iea.org/reports/global-methane-tracker-2023.
[46] International Energy Agency, "Methane Tracker 2022" (IEA, February 2022), https://www.iea.org/reports/global-methane-tracker-2022/overview.

year.[47] According to a 2020 study using satellite observations, methane leakage from drilling and fracking activities in the Permian is two times higher than previously estimated and is now thought to contribute half of the methane emissions from all U.S. oil- and gas-producing regions, with newer wells and associated flaring operations a major culprit. (See footnote 1710.) A 2022 study found that 9.4 percent of gas production in New Mexico's Permian basin escaped into the atmosphere, a leakage rate that is 6.7 times higher than the EPA estimate.[48] A July 2023 study that collected aerial measurements at 7,474 oil and gas wells across the basin confirmed the importance of previously underreported emissions sources in the Permian Basin.[49] Halting methane emissions from the Permian could do more to slow climate change than almost any other single measure.

An August 2023 study using satellite observations found that methane emissions from oil and gas extraction activities are 30 percent higher than the global totals submitted to the United Nations Framework Convention on Climate Change as part of mandated reporting by nation states. Most of this discrepancy is attributable to under-reporting by the world's four largest emitters: the United States, Russia, Venezuela, and Turkmenistan.[50]

Much of the methane emitted from drilling and fracking activities and associated infrastructure originates not from accidental leaks but from purposeful losses that are inherent in the design of the industry's machinery or to normal operating use and are, therefore, not possible to mitigate. (See footnotes 2045-2047.) Methane is vented into the atmosphere during routine maintenance on compressor stations and pipelines; to create evaporative cooling for LNG storage and transport; during the flowback period after a well is fracked; and as an emergency procedure to control pressures.

Malfunctioning and unlit flare stacks are a major culprit. Research from Texas comparing satellite measurements with data on flaring volumes collected in state databases reveal that mass venting of raw gas into the atmosphere is much higher than reported, with methane emissions exceeding 3 percent of production rather than the widely presumed 1-2 percent. (See footnotes 513, 514.) In three Texas shale basins, unlit flares and inefficient flaring are responsible for a fivefold increase in methane emissions above present assumptions and, taken together, constitute 4 to 10 percent of total U.S. oil and gas methane emissions.

Inactive, abandoned wells and liquid storage tanks are also significant emitters of methane. (See footnote 1682.) A 2022 study found significant tank-related methane releases at twelve of fifteen shale

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[47] Olga Popova and Gary Long, "Advances in Technology Led to Record New Well Productivity in the Permian Basin in 2021," Today in Energy (U.S. Energy Information Administration, September 30, 2022), https://www.eia.gov/todayinenergy/detail.php?id=54079.

[48] Zachary R. Mider, "The Methane Hunters," *Bloomberg Businessweek + Green*, August 20, 2021, https://www.bloomberg.com/features/2021-methane-hunters-climate-change/.

[49] William M. Kunkel et al., "Extension of Methane Emission Rate Distribution for Permian Basin Oil and Gas Production Infrastructure by Aerial LiDAR," *Environmental Science & Technology*, August 10, 2023, acs.est.3c00229, https://doi.org/10.1021/acs.est.3c00229

[50] Lu Shen et al., "National Quantifications of Methane Emissions from Fuel Exploitation Using High Resolution Inversions of Satellite Observations," *Nature Communications* 14, no. 1 (August 16, 2023): 4948, https://doi.org/10.1038/s41467-023-40671-6.

gas well pads monitored in in West Virginia with optical gas imaging cameras. (See footnote 1675.) Methane leakage at the levels now being documented, using multiple approaches in measurement and modeling, negates previously hypothesized benefits from burning methane instead of coal in most existing power plants. Trading coal plants for gas plants does not reduce cumulative lifetime carbon emissions when upstream methane leaks are factored in. (See footnote 2210.)

Rising methane levels in the atmosphere make increasingly difficult the urgent task of limiting global warming to below levels called for in the Paris Agreement, which was based on older presumptions that global methane levels had plateaued. Instead, methane levels began to rise in 2007 and then shot up sharply in 2014, a time period that corresponds to a massive increase in the use of fracking in North America.

Indeed, increasing evidence points to fossil fuels in general, and fracking in particular, as the main driver of this surge. Isotopic analysis identifies shale gas production as the source of at least one-third of the total increased emissions from all sources globally and the source of more than half of the increased emissions from fossil fuels globally. These results suggest that the North American fracking boom is a major culprit of the ongoing rise in atmospheric methane levels. (See footnotes 1748, 1755, 1777.)

Appendix C: *Inherent problems in the natural gas and oil extraction process: Regulations are incapable of preventing harms* (A Summary of the Science)

Excerpted from *Compendium of Scientific, Medical, and Media Findings Demonstrating Risks and Harms of Fracking and Associated Gas and Oil Infrastructure Ninth Edition, October 2023, pp 49-50*

Regulations are incapable of preventing harm.

Studies reveal inherent problems in the natural gas and oil extraction process, such as well integrity failures caused by aging or the pressures of fracking itself, in the process of extracting fracking fluids from the well, and in the waste disposal process. These issues lead to water contamination, greenhouse gas emissions, air pollution with carcinogens and other toxic chemicals, earthquakes, and a range of health, environmental and other stressors inflicted on communities.

Some of fracking's many component parts–which include the subterranean geological landscape itself–are simply not controllable.

Compounding the innate unpredictability of the fracking process: The number of wells and their attendant infrastructure continues to proliferate, creating burgeoning cumulative impacts, and the size of individual wells keeps growing. With the horizontal portions of a single well now extending as far as two miles or more underground, fluid injections, once typically three to five million gallons per fracked well, now can easily reach 10 to 20 million gallons per well.

The injection of ever-increasing volumes of fluids into an ever-increasing number of wells creates significant deformations in the shale. These are translated upwards, a mile or more, to the surface. Along the way, these "pressure bulbs" can impact, in unpredictable ways, faults and fissures in the overlying rock strata, including strata that intersect freshwater aquifers. Such pressure bulbs may mobilize contaminants left over from previous drilling and mining activities. (See footnotes 823, 824.) No set of regulations can obviate these potential impacts to groundwater.

Regulations cannot eliminate earthquake risks. (See footnote 1384.) Fracking activities have triggered earthquakes around the world. In spite of emerging knowledge about the mechanics of how fracking and the underground disposal of fracking waste trigger earthquakes via activation of faults, no model can predict where or when earthquakes will occur or how powerful they will be. Induced earthquakes can occur many miles from fracking sites. (See footnote 280.) According to the UK's Oil and Gas Authority, methods for predicting a relationship between the volume of injected fracking fluids and the location, timing, and magnitude of seismic activity "lack convincing empirical evidence or proven theoretical basis." (See footnote 1317.)

Regulations cannot prevent air pollution. The state of California determined that fracking could have "significant and unavoidable" impacts on air quality, including driving pollutants to levels that violate air quality standards. (See footnote 566.) In northeastern Colorado, ambient levels of atmospheric hydrocarbons have continued to increase even with stricter emission standards. (See footnote 581.) Tighter state regulations and tougher enforcement, including unannounced visits by state health inspectors equipped with infrared cameras, have reduced leaking methane and toxic vapors at

individual well sites, but total air emissions continue to rise as the total number of wells continues to increase. There are more than 53,000 active oil and gas wells in Colorado.

Regulations cannot stop radioactive emissions. Radioactive elements commonly found in shale formations are released during the process of drilling and fracking. They may accumulate in tubes, pipes, and equipment at fracking sites at levels known to cause health risks. Excess radioactivity has been detected in the soil near well pads, downstream of water facilities where fracking wastewater is treated, and in municipal landfills where fracking waste is dumped. (See footnotes 971, 973.) Radioactive liquids and solid drilling waste from fracking operations in the United States are essentially unregulated. Radioactive airborne particles are also released from fracking wells themselves and are detectable in residential areas downwind from drilling and fracking operations.[51]

Regulations cannot stop wells from leaking. Methane leakage of active wells is wildly variable: Four percent of wells nationwide are responsible for fully half of all methane emissions from drilling and fracking-related activities. Predicting which wells will become "superemitters" is not possible, according to a survey of 8,000 wells using helicopters and infrared cameras. However, marginal wells near the end of their lifespans—so-called stripper wells—appear to represent a disproportionately large source of methane emissions relative to their production, sometimes leaking more gas than is extracted and put into a pipeline.[52] Stripper wells are typically not profitable to operate but, because the cost of decommissioning them can be greater than the cost of keeping them running, they remain online or at the ready.

In addition to unintentional well leakage, purposeful methane releases are engineered into the routine operation of fracking extraction, processing, and transport infrastructure, as when vapors are vented through release valves in order to regulate pressure and prevent explosions. These releases are not fixable plumbing problems. (See footnotes 1808, 1809.)

[51] Carly Cassella, "Elevated Radiation Found near US Fracking Sites Has Public Health Experts Worried," Science Alert, October 23, 2020, https://www.sciencealert.com/elevated-radiation-levels-discovered-near-us-fracking-sitesstudy-finds.

[52] Jacob A. Deighton et al., "Measurements Show That Marginal Wells Are a Disproportionate Source of Methane Relative to Production," *Journal of the Air & Waste Management Association* 70, no. 10 (2020): 1030–42, https://doi.org/10.1080/10962247.2020.1808115.

Appendix D: *Out of Control: Nova Scotia's Experience with Fracking for Shale Gas*

Out of Control, including the summary, full report and appendices can be found here:
https://nofrac.wordpress.com/nofrac-reports/issue-paper-2/