January 31, 2022

The Honorable Michael Regan
Administrator
U.S. Environmental Protection Agency
1200 Pennsylvania Ave. NW
Washington, DC 20460

Re: Comment of the Institute of Governance & Sustainable Development (IGSD) and the Center for Human Rights and the Environment (CHRE) on Proposed Rule, *Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review* (Docket: EPA-HQ-OAR-2021-0317)

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1. Introduction

Thank you for the opportunity to submit this comment on EPA's proposed rule, Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 86 Fed. Reg. 63,110 (proposed

Nov. 15, 2021) (to be codified at 40 C.F.R. pt. 60) [hereinafter "Proposed Rule"]. We submit this comment on behalf of the Institute for Governance & Sustainable Development (IGSD) and the Center for Human Rights and the Environment (CHRE).

Through the regulation of methane emissions from the oil and gas sector the EPA can help guide industry and states to achieve quick reductions of this extremely harmful climate pollutant at a time when our climate crisis is intensifying and quickly moving towards dangerous and irreversible tipping points. Significant greenhouse gas (GHG) emissions reductions, particularly of methane, are not only feasible but also cost-effective, and necessary. In the US, the oil and natural gas sector is responsible for approximately 30% of U.S. methane emissions.[1] Globally, the oil and natural gas sector contributes around a quarter of anthropogenic methane emissions[2] and has the highest mitigation potential of all sectors.[3] Over half of available targeted technologies to reduce methane fall within the fossil fuel sector,[4] and many of these technologies have low, zero, or even negative costs for oil and gas companies.[5]

We applaud the EPA for taking this first step, express general support for the proposed standards and guidelines, and offer here a set of recommendations to make this regulation even more effective and better aligned with existing best practice and ambition for achieving critically necessary methane emissions reductions. We also recognize the current administration for leading global efforts to achieve methane reductions in numerous sectors, as witnessed by the US-promoted Global Methane Pledge announced in Glasgow at COP26, to work to reduce global methane emissions by at least 30% below 2020 levels by 2030. In this spirit and because methane emissions reductions are the single most effective pathway to slow the rate of warming over the next two decades, we urge the EPA to issue a strengthened final rule that will lead to even greater methane reductions. Finalizing more stringent regulations will meet the EPA's Clean Air Act (CAA) mandates[6] and related obligations to protect public health, safeguard the environment, and tackle climate change with the urgency warranted, including as expressed in Executive Order 13,990.[7]

IGSD and CHRE have extensive scientific and policy expertise related to cutting short-lived climate pollutants (SLCPs), including methane. CHRE works closely with the UN's Climate and Clean Air Coalition to promote SLCP emissions reductions, and with many state and non-state partners and countries to address and promote more aggressive and more socially equitable climate policies to reduce GHG emissions. On the issue of methane emissions in the oil and gas sector in particular, CHRE has engaged with diverse government agencies in a number of countries, including Mexico, Colombia and Argentina, as well as with oil companies and impacted local communities to call attention to and address methane and associated gas emissions identified with optical imaging (FLIR technology). Additionally, members of the IGSD staff have contributed to numerous publications on SLCPs, including the UN Environment Programme's 2021 Global Methane Assessment,[8] for which IGSD staff were technical reviewers. Both IGSD and CHRE engage extensively with partners around the world to promote fast climate mitigation to limit planetary warming to 1.5°C, as called for by the Intergovernmental Panel on Climate Change (IPCC).

Our comments focus on provisions for which we urge the EPA to act on the best available science and adopt the best available and tested practices, technology, and policies, to ensure that the final rule—provides the most reduction of methane emissions practicable; achieves the United States' international methane goals; and protects communities and ecosystems from the severe impacts of methane and associated pollutants. Specifically, we make three priority recommendations for the supplemental proposal and final rule: (1) to require effective monitoring of all sources; (2) to ban routine flaring; and (3) to use EPA's broad authority in CAA §111 to promulgate strong standards for abandoned and unplugged wells.

As detailed below, urgently implementing fast mitigation strategies is critical to staying within the 1.5ºC global warming guardrail which the international scientific community has identified as essential to slow climate feedback loops and avoid irreversible tipping points. And cutting methane emissions is the easiest, most rapid and most cost-effective pathway to achieve this.

2. Limiting near-term risks requires deep cuts to methane emissions

Internationally accepted science confirms that reducing methane emissions is critical to limiting near-term warming and keeping 1.5ºC within reach.[9] Methane alone has already caused 0.51°C of the 1.06°C of total observed warming for 2010–2019.[10] Without deep cuts to methane emissions, the world risks warming above the 1.5ºC threshold within the next ten years.[11] While it is fundamentally important to ensure the long-term decarbonization of the economy, the short-term implications of decarbonization imply significant collateral climate risks and impacts that must be addressed. Transitioning away from fossil fuels will reduce cooling aerosols that are co-emitted with CO_2 when fossil fuels combust. These cooling aerosols currently counteract—and essentially hide—some the warming caused by CO_2. Cutting these cooling aerosols in tandem with CO_2 reductions could lead to a short-term increase in warming if other pollutants like methane are not simultaneously reduced.[12]

As the EPA notes in the Proposed Rule, cutting methane emissions similarly represents the best opportunity to reduce near-term risks by limiting warming over the next few decades as the US decarbonizes.[13] The Global Methane Assessment states that the short-lived nature of methane makes any mitigative action worthwhile due to the "immediate pay off[s]."[14] By implementing all available methane mitigation measures globally, the world can avoid around 0.25ºC of warming by midcentury and slow the rate of warming by 30%.[15] As the Intergovernmental Panel on Climate Change (IPCC)'s 2021 Sixth Assessment Report states, "[s]ustained methane mitigation, wherever it occurs, stands out as an option that combines near- and long-term gains on surface temperature (*high confidence*) and leads to air quality benefits by reducing surface ozone levels globally (*high confidence*)...."[16]

Additionally, limiting near-term warming can slow self-amplifying feedbacks, such as the loss of Arctic sea ice, and reduce the risk of crossing climate tipping points.[17] Scientists project that many tipping points occur between 1°C and 1.5°C of warming, with even more possible between the 1.5°C target and 2°C.[18] Some tipping points could be irreversible after 2060,[19] and once triggered, they could cause a domino effect.[20] In the absence of fast, deep cuts to methane emissions, this cascade of tipping points could result in runaway warming.

The critical need to slow warming in the near term underscores the importance of using metrics that better reflect the impact of mitigation strategies on rate of warming in the next twenty years. We support the EPA's reference to short tons of methane and encourage the EPA to—when it must convert to global warming potential (GWP) —use a 20-year GWP for methane. A 100-year GWP for methane fails to account for the contribution of methane to the rate of warming in the critical decades ahead. . As an alternative to utilizing GWP, we recommend using the CCAC Temperature Pathway Tool, which converts emissions trajectories to temperature impacts, providing a more accurate representation of methane's impact on the atmosphere and on climate. Reliance on the GWP_{100} metric could risk near-term warming exceeding the 1.5ºC limit.

As the EPA acknowledges, reducing methane emissions also has significant public health benefits. Methane is a precursor to harmful ground-level ozone, which is responsible for crop losses, ecosystem damage, and premature deaths.[21] The Global Methane Assessment concludes that ozone from methane causes approximately 500,000 premature deaths around the globe annually.[22] The Assessment further estimates that every million-tonne reduction in methane emissions will save 1,430 lives; avoid 4,000 asthma-related emergency visits; preserve 145,000 tonnes of wheat, soybeans, maize and rice; and prevent 400 million hours—approximately 180,000 years—of lost work.[23]

The Proposed Rule's regulatory impact assessment (RIA) confirms that the atmospheric lifetime of methane and its relative contribution to ozone concentration reinforce the need to reduce emissions to ensure cleaner air for future generations.[24] The potential to improve public health in the near term and decrease the threat of surpassing irreversible climate tipping points underscores the need for the EPA to quickly issue comprehensive and ambitious regulations on methane emissions from the oil and gas sector.

3. Strong methane rules will help uphold the US's international commitments

Stringent methane emissions rules are needed to maintain the United States' international commitments on methane and other greenhouse gas reductions. This includes commitments under the Paris Agreement and the Global Methane Pledge, as well as bilateral and regional agreements to which the US has committed. Rejoining and strengthening commitments under the Paris Agreement, launching the Global Methane Pledge with the EU and over 100 countries, and engaging on methane emissions reductions with international partners all demonstrate the Biden Administration's dedication to working aggressively to reduce methane emissions globally. Given the significance of methane emissions from the oil and gas sector in the US, oil and gas methane regulations are particularly important to meeting US commitments.

A strong and even more ambitious methane rule will help the US meet its global methane emissions reductions commitments. The RIA projects total methane emissions reductions from the Proposed Rule to be 920 million metric tons of CO_2 equivalent ($MMTCO_2e$) from 2023 to 2035.[25] The EPA projects that the largest emission reductions—reductions equaling 100 $MMTCO_2e$ annually—will occur in 2026 and 2027.[26] This represents about a 50% reduction from 2019 oil and gas emissions levels, and a 15% reduction from total 2019 US methane levels.[27] We urge the EPA align its national methane rule with the country's ambitious leadership and its international commitments to reduce methane emissions aggressively by finalizing a more stringent rule for the oil and gas sector.

A. The Paris Agreement Target

President Biden reinstated the US as a party to the Paris Agreement on his first day in office, emphasizing the Paris Agreement's purpose "to help us all avoid catastrophic planetary warming and to build resilience around the world to the impacts from climate change we already see."[28] As a party to the Paris Agreement, the United States agrees to limit global warming to well below 2ºC with the target of limiting warming to 1.5°C.[29] The US NDC outlines the goal to cut greenhouse gas emissions in half by 2030 and acknowledges the critical need for reductions in SLCPs, and especially methane.[30] This includes a commitment to plug leaky wells.[31]

The world has already warmed by around 1.1°C, and current pledges under the Paris Agreement, including that of the US, would cause warming to reach at least 2.6°C.[32] Global and individual country actions are simply inadequate. More effort is needed if we are to slow global warming and avoid catastrophic tipping points before mid-century. And more leadership of the biggest emitters is necessary to embark on a viable pathway. The Biden Administration must institute more aggressive policies to reach and improve on the US's individual, near-term commitments under the Paris Agreement if its collective, long-term commitment is to be achieved.

B. Global Methane Pledge

The US, EU, and over 100 signatories launched the Global Methane Pledge at the 26th Conference of the Parties in Glasgow. Global Methane Pledge members commit to reduce global methane emissions by at least 30% by 2030, compared to 2020 levels. Implementation of the pledge would reduce warming by 0.2°C by 2050 and keep the 1.5ºC target within reach.[33]

According to the Proposed Rule's RIA, average annual reductions between 2023–2030 would be 2.75 million short tons of methane.[34] While this is a good start, it is likely too low to meet the US's commitment under the Global Methane Pledge. Because the largest extent of methane abatement can occur within the oil and gas sector, sectoral emissions must be reduced by over 50% to ensure overall methane emissions are reduced by 30%.

As a co-lead with the EU and signatory to the Global Methane Pledge, and because climate actions by the US can influence other large emitter countries, the US's domestic actions must align with reducing global emissions by 30%. The US should reduce oil and gas methane emissions to the greatest extent possible, particularly when low- or no cost technology and best practices are available. Methane emissions reduction potential in the sector are estimated to be around 65% below 2012 levels,[35] and even greater when additional sources like abandoned wells are included. Promulgating stringent oil and gas methane emissions reductions requirements—as part of the Biden Administration's larger agenda on methane[36]—will set the world on the path to achieving the Global Methane Pledge's goals.

C. Regional Commitments

On many occasions, the United States has taken a bold stance to reduce methane emissions. In the *North America Climate, Clean Energy, and Environment Partnership*, the United States committed to a 40–45% reduction in methane emissions from oil and gas by 2025.[37] At the 2021 North American Leaders' Summit, the United States, Canada, and Mexico pledged to create a North American Strategy on Methane and Black Carbon, targeting all sectors and especially oil and gas.[38]

The EPA's Proposed Rule does not appear to put the US on track to meet the original 40–45% goal. By 2025, the RIA projects that the Proposed Rule would reduce methane emissions by only 13.5 MMTCO_2e cumulatively.[39] Stricter measures by the EPA, complemented by other actions outside of the scope of this rulemaking, are needed to decrease emissions from this sector to meet the 40–45% reduction target by 2025.

4. Capture of associated gas is the best system of emissions reduction (BSER) for oil wells with associated gas

IGSD and CHRE urge the EPA to finalize capture as the BSER for oil wells with associated gas. While the Proposed Rule indicates that the EPA's preferred system is to "route associated gas to a sales line,"[40] the Proposed Rule does not go far enough in ensuring that oil and gas operators will not flare associated gas. The Proposed Rule would allow for flaring when "access to a sales line is not available."[41]As the Proposed Rule explains:

> In the event that access to a sales line is not available, we are proposing that the gas can be used as an onsite fuel source, used for another useful purpose that a purchased fuel or raw material would serve, or routed to a flare or other control device that achieves at least 95 percent reduction in methane and VOC emissions.[42]

Because of its impact on climate, the environment, and public health, flaring is not the BSER for associated gas. The EPA should only permit flaring for safety reasons and in emergency situations. Flaring methane and associated gases is dangerous to surrounding communities and should be avoided in all cases where alternatives are available. Health studies show that flaring can impact pregnancy term,[43] exacerbate asthma,[44] release carcinogens,[45] and cause mental health and heart-related conditions.[46] Flaring may release climate-warming gases such as carbon dioxide, methane, and black carbon to the atmosphere, and increase local terrestrial acidification.[47] When flares are incompletely combusted or left unlit (a common occurrence), methane gas is vented to the atmosphere.[48] Unconventional oil and gas (UOG) drilling exacerbates the problem, as flaring emissions reported by state regulators are often underestimated,[49] impacting regulator's perceived risk of vulnerable communities.

Furthermore, flaring exacerbates environmental injustice. Within major oil and gas regions, the burden of flares falls largely on Native communities and low-income rural areas.[50] There is evidence that flares also disproportionately impact Hispanic and Black communities.[51] One study found that 210,000 people living within 5km of oil and gas production are exposed to 100 or more flares nightly.[52] Firsthand accounts of these flares demonstrate the need to address this oil and gas activity: Nightly flares happen so frequently that affected communities call flaring "second sunrise."[53]

We encourage the EPA to look to US states like Colorado and New Mexico for model regulations that prohibit routine flaring. In 2020, Colorado strengthened its oil and gas regulations by banning routine venting and flaring.[54] In 2021, New Mexico similarly banned all routine flaring and venting.[55] As state regulators recognize, banning routine flaring is viable and is critical to protecting the environment and public health. The EPA should finalize regulations that do not allow for flaring as an option for associated gas from new and existing wells except in emergencies and for safety reasons.

Additionally, given the health risks associated with oil and gas development, states are increasing required setback distances. The location of wells (whether active or abandoned) in residential communities, near vulnerable populations or in the proximity of schools, hospitals and other buildings where people congregate, poses serious health risks to communities, especially disadvantaged communities which already suffer from systemic historical discrimination. As of October 2021, California's governor Newson proposed to require a "setback" distance of 3,200 feet for new wells from sensitive community locations, and more pollution control regulations for wells already existing within this distance.[56] This is the greatest set-back distance proposed thus far, demonstrating a fix to a historical public health issue experienced nationwide. Stringent federal standards should complement these efforts and protect communities from the harms of oil and gas production.

5. Enhanced monitoring requirements are needed to capture unnoticed emissions

IGSD and CHRE encourage the EPA to issue the strongest regulations possible in oil and gas monitoring, regardless of source-size, to ensure that leaks and plumes are included. It is commonly understood that oil and gas sites currently emit more methane (often many times more) than is generally estimated, due to the existence of unaccounted-for methane plumes and leaks. One study found that inclusion of leaks in estimates of methane emissions would result in emissions estimates that are 48–76% greater than the EPA's current estimates.[57] In places where oil and gas production has decreased, methane leaks may still significantly contribute to greenhouse gas emissions.[58] Random and persistent methane plumes that would classify a site as super-emitting may escape accountability under current estimates. The Environmental Defense Fund detected 900 methane plumes from over 500 sites in the Permian Basin over an 11-day period, demonstrating that super-emitting sites are still prevalent in the basin.[59]

Specifically, we recommend that the EPA eliminate the monitoring exception for smaller leak-prone wells. The Proposed Rule would exempt sources with emissions below three tons per year from monitoring requirements.[60] This ignores the risks these wells represent and the threat that these sources could become large emitters, or that collectively, they might nonetheless represent significant emissions. Requiring monthly or quarterly monitoring of these wells will protect nearby communities from leaks that would otherwise go unnoticed and unmonitored.

The EPA should follow Colorado's lead and require monitoring of all wells. In December 2021, Colorado's Air Quality Control Commission voted to adopt Regulation Number 7, which would require frequent inspection, leak detection and repair (LDAR), and storage tank maintenance for small wells, in addition to larger ones.[61] Grouping small, potentially leak-prone wells into LDAR requirements sets Colorado closer to achieving the state's environmental justice law (HB21 – 1266), which calls for a 60% reduction in greenhouse gas emissions by 2030.[62]

Additionally, IGSD and CHRE are encouraged by the EPA's consideration of new monitoring and measurement technologies and techniques, including to register actual rather than theoretical emissions. Reliance on emissions factors for calculating methane emissions results in significant miscounting and undervaluing actual emissions. The EPA should utilize advanced technology to continuously improve its measurement of actual methane emissions and to detect leaks and plumes. We encourage the EPA to determine how best to use satellite data in particular, given that the data will become increasingly robust as more satellites are deployed. At minimum, the EPA's monitoring system should be able to effectively and quickly incorporate growing data sets in order to best protect the public from hazardous leaks and plumes.

IGSD and CHRE also support the EPA's proposal to use satellite and other data to empower communities to participate in identifying and reporting large emissions events.[63] Such a policy advances environmental justice and would better protect public health and the environment by achieving quicker recognition and abatement of leaks. The EPA should work with satellite operators to ensure that data is openly and publicly shared, at no cost to the user, and in a format that is practical and useful for diverse stakeholders. This may include engaging with state agencies and institutions, as well as foreign countries, that collect satellite data and promoting the sharing and harmonization of emissions data.

6. The EPA should develop stringent requirements for abandoned and unplugged wells in the supplemental proposal

IGSD and CHRE support the EPA's intention to include abandoned and unplugged wells in the final rule. Because of their persistent emissions and interconnectivity with other oil and gas sources, abandoned and unplugged wells are properly regulated as a source within the Crude Oil and Natural Gas source category under CAA §111. To fulfil its CAA mandates, the EPA should propose and finalize regulations that protect communities from the harms caused by abandoned and unplugged wells and hold well owners accountable to the greatest extent possible.

We support the EPA's broad definition of abandoned wells and encourage the EPA to finalize a similarly broad definition to ensure all types of abandoned and unplugged wells—including idled wells (which often eventually become abandoned or unplugged wells)—are covered by the regulations. We support federal requirements for owners and operators to submit closure plans with adequate long-term (even perpetual-term) financial assurance and bonding, as well as reporting on transfers of ownership, similar to that described by the EPA in the Proposed Rule.[64] Such requirements should be complemented by a program for, at the very least, identifying and monitoring representative populations of abandoned wells to better understand their impacts on public health, the local environment and climate change.[65] IGSD and CHRE also encourage the

EPA to use its broad authority under CAA §111 to expand liability for original or other past owners and operators,[66] particularly where the transfer of unproductive wells to new ownership may have contributed to the ultimate improper abandonment of wells without regard to environmental risks, leading eventually to their orphaning. This rulemaking could also serve as an opportunity for the EPA to discourage and reduce the unnecessary protracted maintenance of idled wells to avoid closure responsibility and costs.

The EPA should promulgate stringent requirements for new and idled wells that can be quickly implemented to prevent tens of thousands (or more) wells from being abandoned and sitting unplugged for years. According to one study, "In the U.S. from 2000 to 2013, an average of 18,600 wells were abandoned per year…."[67] The US Greenhouse Gas Inventory (GHGI) found that abandoned gas wells (including orphaned and other non-producing wells) in the US had increased by 84% from the 1990s, leading to a 38% increase in methane and CO_2 emissions from abandoned gas wells.[68] In a recent release, the Department of Interior counted more than 130,000 abandoned or orphaned wells—more than double the figure it had announced in 2019.[69] As the EPA notes in the Proposed Rule, the GHGI estimates that around 3.4 million abandoned oil and gas wells were responsible for 264 kt of methane in 2019.[70] Substantial as those numbers are, they are likely grossly underestimated.[71] Using geospatial and statistical analysis, a 2021 report concluded that the actual magnitude of methane emissions from abandoned oil and gas wells is likely 20% more than the EPA estimates.[72] Experts also worry that the spate of oil and gas exploration and production companies that filed for bankruptcy or receivership in early 2020 may lead to an increase in abandoned wells.[73]

As the EPA acknowledges, national standards are warranted for these abandoned and unplugged wells. The ubiquity of the unplugged-well problem among states underscores the need for federal regulations to guide national and state plans.[74] Millions of abandoned and unplugged wells exist across the country, and emissions data indicate the patchwork of state well-closure requirements is currently insufficient to protect human health and the environment.[75] Federal closure requirements and emissions guidelines are critical to achieving comprehensive and effective regulations for the Crude Oil and Natural Gas source category. The EPA can provide key guidance and the minimum standards necessary to address the cleanup of the existing inventory of abandoned and unplugged wells and prevent this inventory from growing.

The EPA should consider establishing new source performance standards and presumptive standards for abandoned wells that include expanded liability for past owners or operators. The absence of identifiable, liable parties for millions of orphaned wells is an underlying reality that demonstrates the need for the EPA to help the sector ensure accountability of operators. The EPA could use its broad authority under CAA §111 to develop standards that would hold previous owners and operators accountable for cleanup and ensure orphaned wells are adequately addressed and properly plugged. For example, under California law, if the current operator goes bankrupt or does not have the funds to plug a well, the state can require a prior operator to plug the well.[76] The EPA also can look to the successful Superfund program promulgated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as a potential model for accountability mechanisms.

Additionally, IGSD and CHRE encourage the EPA to explore methods for prioritizing, inventorying, and plugging existing abandoned wells based on: the magnitude of emissions; harms to public health, the environment, and the climate; and proximity to environmental justice communities. Research demonstrates that a small number of high-emitting wells are responsible for a disproportionate share of methane emissions from abandoned wells.[77] Prioritizing these super-emitters, along with any lower-emitting wells near environmental justice communities first, will best address the climate and justice consequences of unplugged wells.

Such a hierarchy would be similar to the prioritization regime in the REGROW Act that Congress enacted as part of the Infrastructure and Investment Act[78] and existing state-level prioritization regimes.[79] The EPA should ensure that when addressing abandoned and unplugged wells, methane emissions and climate damage are specifically considered, as well as environmental justice concerns. Many existing hierarchies do not reach these critical issues.

We also encourage the EPA to establish a program for identifying undocumented abandoned wells and monitoring emissions at abandoned wells. The existence of known super-emitters (as well as the likelihood that more super-emitters are identified through increased LDAR actions) underscores the importance of monitoring to stop large leaks of methane and other pollutants.[80] Experts emphasize the need to enhance monitoring of abandoned wells (including once plugged) and to document wells not currently identified by states.[81]

7. Conclusion

We applaud the EPA's publication of the proposed rule and urge the EPA to finalize more stringent regulations that adequately address all sources, complying with the US's international commitments to reduce methane emissions aggressively and quickly. Cutting methane is our largest opportunity to protect communities and ecosystems from the near-term impacts of climate change. It is critical that the EPA lead the way with regulations that meet the climate emergency we are confronting and work to bend the curve of global warming as quickly as possible. Urgently implementing fast mitigation strategies, including methane emissions reductions, is crucial to staying within the 1.5ºC of warming, which the IPCC warns is essential to slow climate feedback loops and avoid irreversible tipping points.

Cutting methane emissions is the easiest, quickest, and most cost-effective pathway to achieve this, and the EPA can lead the way through the publication of a stronger final rule.

We appreciate the opportunity to comment and would be happy to continue engaging with EPA on this critical rulemaking.

Sincerely,

Jorge Daniel Taillant Executive Director, CHRE	Durwood Zaelke President, IGSD	Gabrielle Dreyfus Chief Scientist, IGSD
Laura Bloomer Staff Attorney, IGSD	Caitlan Frederick Research Associate, IGSD	Jon Turner Legal Fellow, IGSD

[1] EPA (2021) *U.S. Inventory of Greenhouse Gas Emissions and Sinks 1990-2019,* ES-16, fig. ES-9 (2019 Sources of Emissions)

[2] United Nations Environment Programme [UNEP] & Climate & Clean Air Coalition [CCAC] (2021) GLOBAL METHANE ASSESSMENT: BENEFITS AND COSTS OF MITIGATING METHANE EMISSIONS, 28 ("Fossil fuels: release during oil and gas extraction, pumping and transport of fossil fuels accounts for roughly 23 per cent of all anthropogenic emissions, with emissions from coal mining contributing 12 per cent.").

[3] UNEP & CCAC (2021) GLOBAL METHANE ASSESSMENT: BENEFITS AND COSTS OF MITIGATING METHANE EMISSIONS, 87 ("Analysis of the technical potential to mitigate methane from four separate studies shows that for 2030, reductions of 29–57 Mt/yr could be made in the oil and gas subsector, 12–25 Mt/yr from coal mining, 29–36 Mt/yr in the waste sector and 6–9 Mt/yr from rice cultivation. Values for the livestock subsector are less consistent, ranging from 4–42 Mt/yr.").

[4] UNEP & CCAC (2021) GLOBAL METHANE ASSESSMENT: BENEFITS AND COSTS OF MITIGATING METHANE EMISSIONS, 9 ("There are readily available targeted measures that can reduce 2030 methane emissions by 30 per cent, around 120 Mt/yr. Nearly half of these technologies are available to the fossil fuel sector in which it is relatively easy to reduce methane at the point of emission and along production/transmission lines.")

[5] UNEP & CCAC (2021) GLOBAL METHANE ASSESSMENT: BENEFITS AND COSTS OF MITIGATING METHANE EMISSIONS, 102 ("Individual abatement technologies were examined at a very detailed level in the IEA analysis. The IEA classifies all emissions from production, gathering and processing of fuels as upstream and all emissions from refining, transmission and distribution as downstream. Their analysis shows that the category with the largest mitigation potential, upstream leak detection and repair (LDAR), is also the cheapest. The bulk of the negative cost benefits are obtained from five abatement technologies, each of which contributes substantial health and climate benefits while simultaneously leading to economic gains even when the value of the environmental impacts is not included (Figure 4.12). The majority of the negative cost options occur in four source categories, onshore conventional oil and gas and offshore oil and gas, whereas abatement within the unconventional oil and gas and downstream categories typically have positive costs."). *See also* International Energy Agency (2021) *Methane Tracker 2021* ("We estimate that it is technically possible to avoid around three quarters of today's methane emissions from global oil and gas operations. Moreover, a significant share of these could be avoided at no net cost, as the cost of the abatement measure is less than the market value of the additional gas that is captured. Natural gas prices around the world affect the share of global emissions that can be abated at no net cost; this share is typically around 40-50%, although the plunge in natural gas prices in 2020 temporarily brought this down to around 10%.").

[6] *E.g.*, Clean Air Act § 101(b)(1), 42 U.S.C. § 7401(b)(1) ("to protect and enhance the quality of the Nation's air resources so as to promote the public health and welfare."); Clean Air Act § 111(a)(1); 42 U.S.C. § 7411(a)(1) ("The term 'standard of performance' means a standard for emissions of air pollutants which reflects the degree of emission limitation achievable through the application of the *best system of emission reduction* which (taking into account the cost of achieving such reduction and any nonair quality health and environmental impact and energy requirements) the Administrator determines has been adequately demonstrated.")(emphasis added).

[7] Exec. Order. No. 13,990, 86 Fed. Reg. 7037 (Jan. 20, 2021) ("Our Nation has an abiding commitment to empower our workers and communities; promote and protect our public health and the environment; and conserve our national treasures and monuments, places that secure our national memory. Where the Federal Government has failed to meet that commitment in the past, it must advance environmental justice. In carrying out this charge, the Federal Government must be guided by the best science and be protected by processes that ensure the integrity of Federal decision-making. It is, therefore, the policy of my Administration to listen to the science; to improve public health and protect our environment; to ensure access to clean air and water; to limit exposure to dangerous chemicals and pesticides; to hold polluters accountable, including those who disproportionately harm communities of color and low-income communities; to reduce greenhouse gas emissions; to bolster resilience to the impacts of climate change; to restore and expand our national treasures and monuments; and to prioritize both environmental justice and the creation of the well-paying union jobs necessary to deliver on these goals.")

[8] UNEP & CCAC (2021) GLOBAL METHANE ASSESSMENT: BENEFITS AND COSTS OF MITIGATING METHANE EMISSIONS.

[9] Intergovernmental Panel on Climate Change [IPCC] (2021) *Summary for Policymakers, in* CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS, Masson-Delmotte V., *et al.* (eds.), SPM-36 ("Strong, rapid and sustained reductions in CH_4 emissions would also limit the warming effect resulting from declining aerosol pollution and would improve air quality."). *See also* Naik V., *et al.* (2021) *Chapter 6: Short-lived climate forcers, in* CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS, Masson-Delmotte V., *et al.* (eds.), Intergovernmental Panel on Climate Change, 6-7, 6-8 ("Across the SSPs, the collective reduction of CH_4, ozone precursors and HFCs can make a difference of global mean surface air temperature of 0.2 with a very likely range of [0.1–0.4] °C in 2040 and 0.8 with a very likely range of [0.5–1.3] °C at the end of the 21st century (comparing SSP3-7.0 and SSP1-1.9), which is substantial in the context of the Paris Agreement."); Intergovernmental Panel on Climate Change (2018) *Summary for Policymakers*, *in* GLOBAL WARMING OF 1.5 °C, Masson- Delmotte V., *et al.* (eds.), SPM-15 ("In model pathways with no or limited overshoot of 1.5 °C, global net anthropogenic CO2 emissions decline by about 45% from 2010 levels by 2030 (40–60% interquartile range), reaching net zero around 2050 (2045–2055 interquartile range).... Modelled pathways that limit global warming to 1.5 °C with no or limited overshoot involve deep reductions in emissions of methane and black carbon (35% or more of both by 2050 relative to 2010)."); UNEP & CCAC (2021) GLOBAL METHANE ASSESSMENT: BENEFITS AND COSTS OF MITIGATING METHANE EMISSIONS, 17 ("Mitigation of methane is very likely the strategy with the greatest potential to decrease warming over the next 20 years."); *and* Shindell D. & Smith C. J. (2019) *Climate and air-quality benefits of a realistic phase-out of fossil fuels*, NATURE 573: 408–411, Addendum "Methods" ("We note that, although this study focuses on the effects of fossil-fuel related emissions, accounting for the effects of reductions in greenhouse gases from non-fossil sources—including fluorinated gases and both methane and nitrous oxide from agriculture—along with biofuels that are a large source of warming black carbon, could eliminate any near-term penalty entirely. In fact, given that the net effect of the fossil-fuel phase-out on temperature is minimal during the first 20 years (Fig. 3), reducing those other emissions is the only plausible way in which to decrease warming during that period.").

[10] IPCC (2021) *Summary for Policymakers, in* CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS, Masson-Delmotte V., *et al.* (eds.), Figure SPM.2]

[11] Xu Y., Ramanathan V., & Victor D. G. (2018) *Global warming will happen faster than we think*, Comment, NATURE 564(7734): 30–32, 30–31 ("But the latest IPCC special report underplays another alarming fact: global warming is accelerating. Three trends—rising emissions, declining air pollution and natural climate cycles—will combine over the next 20 years to make climate change faster and more furious than anticipated. In our view, there's a good chance that we could breach the 1.5 °C level by 2030, not by 2040 as projected in the special report (see 'Accelerated warming'). The climate-modelling community has not grappled enough with the rapid changes that policymakers care most about, preferring to focus on longer-term trends and equilibria.").

[12] Naik V., *et al.* (2021) *Chapter 6: Short-lived climate forcers, in* CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS, Masson-Delmotte V., *et al.* (eds.), Intergovernmental Panel on Climate Change, 6–7, 6–8 ("Across the SSPs, the collective reduction of CH_4, ozone precursors and HFCs can make a difference of global mean surface air temperature of 0.2 with a very likely range of [0.1–0.4] °C in 2040 and 0.8 with a very likely range of [0.5–1.3] °C at the end of the 21st century (comparing SSP3-7.0 and SSP1-1.9), which is substantial in the context of the Paris Agreement. Sustained methane mitigation, wherever it occurs, stands out as an option that combines near- and long-term gains on surface temperature (*high confidence*) and leads to air quality benefits by reducing surface ozone levels globally (*high confidence*). {6.6.3, 6.7.3, 4.4.4}"; "Additional CH_4 and BC mitigation would contribute to offsetting the additional warming associated with SO_2 reductions that would accompany decarbonization (*high confidence*).").

[13] Standards of Performance and Emissions Guidelines for Oil and Natural Gas Sector Climate Review, 86 Fed. Reg. 63,110, 63,114 (proposed Nov. 15, 2021) (to be codified at 40 C.F.R. pt. 60) ("The IPCC AR6 assessment found that ''Over time scales of 10 to 20 years, the global temperature response to a year's worth of current emissions of SLCFs (short lived climate forcer) is at least as large as that due to a year's worth of CO2 emissions.'' 4 The IPCC estimated that, depending on the reference scenario, collective reductions in these SLCFs (methane, ozone precursors, and HFCs) could reduce warming by 0.2 degrees Celsius (°C) (more than one-third of a degree Fahrenheit (°F) in 2040 and 0.8 °C (almost 1.5 °F) by the end of the century, which is important in the context of keeping warming to well below 2 °C (3.6 °F). As methane is the most important SLCF, this makes methane mitigation one of the best opportunities for

reducing near term warming. Emissions from human activities have already more than doubled atmospheric methane concentrations since 1750, and that concentration has been growing larger at record rates in recent years.5 In the absence of additional reduction policies, methane emissions are projected to continue rising through at least 2040.") [hereinafter "Proposed Rule"].

[14] UNEP & CCAC (2021) GLOBAL METHANE ASSESSMENT: BENEFITS AND COSTS OF MITIGATING METHANE EMISSIONS, 21 ("The short lifetime of methane, and the quick response of methane abundance to reduced emissions described earlier, mean that any action taken to reduce emissions will have an immediate pay off for climate in addition to the current and near-future human health and agricultural production. Observations over the past few decades have shown that decreased emissions lead quickly to lower methane levels relative to those that could be expected in the absence of the decreases. That is, there are no mechanisms that offset the decreases even though there are significant natural sources. Simply put, natural emissions do not make up for the decrease in anthropogenic emission. Indeed, the expectation that a reduction in emissions will yield quick results, in the order of a decade, is confirmed and emphasizes the importance of methane.").

[15] Ocko I. B., Sun T., Shindell D., Oppenheimer M., Hristov A. N., Pacala S.W., Mauzerall D. L., Xu Y., & Hamburg S. P. (2021) *Acting rapidly to deploy readily available methane mitigation measures by sector can immediately slow global warming*, ENVIRON. RES. LETT. 16(5): 054042 ("Pursuing all mitigation measures now could slow the global-mean rate of near-term decadal warming by around 30%, avoid a quarter of a degree centigrade of additional global-mean warming by midcentury, and set ourselves on a path to avoid more than half a degree centigrade by end of century. On the other hand, slow implementation of these measures may result in an additional tenth of a degree of global-mean warming by midcentury and 5% faster warming rate (relative to fast action), and waiting to pursue these measures until midcentury may result in an additional two tenths of a degree centigrade by midcentury and 15% faster warming rate (relative to fast action).").

[16] Naik V., *et al.* (2021) *Chapter 6: Short-lived climate forcers, in* CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS, Masson-Delmotte V., *et al.* (eds.), Intergovernmental Panel on Climate Change, 6-7 ("Sustained methane mitigation, wherever it occurs, stands out as an option that combines near- and long-term gains on surface temperature (*high confidence*) and leads to air quality benefits by reducing surface ozone levels globally (*high confidence*). {6.6.3, 6.7.3, 4.4.4}"); *see also* UNEP & CCAC (2021) GLOBAL METHANE ASSESSMENT: BENEFITS AND COSTS OF MITIGATING METHANE EMISSIONS, 17 ("Mitigation of methane is very likely the strategy with the greatest potential to decrease warming over the next 20 years."); Intergovernmental Panel on Climate Change (2021) *Summary for Policymakers, in* CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS, Masson-Delmotte V., *et al.* (eds.), SPM-36 ("Strong, rapid and sustained reductions in CH_4 emissions would also limit the warming effect resulting from declining aerosol pollution and would improve air quality.").

[17] *See generally* IGSD, *The Need for Fast Near-Term Climate Mitigation to Slow Feedbacks and Tipping Points* (Updated 17 November 2021). *See also* Timothy Lenton, *et al*. (2019) *Climate tipping points—too risky to bet against*, Comment, NATURE, 575(7784): 592–595, 592 ("We think that several cryosphere tipping points are dangerously close, but mitigating greenhouse-gas emissions could still slow down the inevitable accumulation of impacts and help us to adapt.").

[18] Drijfhout S., Bathiany S., Beaulieu C., Brovkin V., Claussen M., Huntingford C., Scheffer M., Sgubin G., & Swingedouw D. (2015) *Catalogue of abrupt shifts in Intergovernmental Panel on Climate Change climate models*, PROC NAT'L ACAD SCI 112(43): E5777–E5786, E5777 ("Abrupt transitions of regional climate in response to the gradual rise in atmospheric greenhouse gas concentrations are notoriously difficult to foresee. However, such events could be particularly challenging in view of the capacity required for society and ecosystems to adapt to them. We present, to our knowledge, the first systematic screening of the massive climate model ensemble informing the recent Intergovernmental Panel on Climate Change report, and reveal evidence of 37 forced regional abrupt changes in the ocean, sea ice, snow cover, permafrost, and terrestrial biosphere that arise after a certain global temperature increase. Eighteen out of 37 events occur for global warming levels of less than 2°, a threshold sometimes presented as a safe limit."). *See also* Lenton T. M., Rockstrom J., Gaffney O., Rahmstorf S., Richardson K., Steffen W., & Schellnhuber H. J. (2019) *Climate tipping points—too risky to bet against,* Comment, NATURE 575(7784): 592–595, 593 ("A further key impetus to limit warming to 1.5 °C is that other tipping points could be triggered at low levels of global warming. The latest IPCC models projected a cluster of abrupt shifts between 1.5 °C and 2 °C, acidification) the time and/or scenario dimensions remain critical, and a simple and robust relationship with global warming level cannot be established (high confidence)... The response of biogeochemical cycles to anthropogenic perturbations can be abrupt

at regional scales and irreversible on decadal to century time scales (high confidence). The probability of crossing uncertain regional thresholds increases with climate change (high confidence). It is very unlikely that gas clathrates (mostly methane) in deeper terrestrial permafrost and subsea clathrates will lead to a detectable departure from the emissions trajectory during this century. Possible abrupt changes and tipping points in biogeochemical cycles lead to additional uncertainty in 21st century atmospheric GHG concentrations, but future anthropogenic emissions remain the dominant uncertainty (*high confidence*). There is potential for abrupt water cycle changes in some high-emission scenarios, but there is no overall consistency regarding the magnitude and timing of such changes. Positive land surface feedbacks, including vegetation, dust, and snow, can contribute to abrupt changes in aridity, but there is only low confidence that such changes will occur during the 21st century. Continued Amazon deforestation, combined with a warming climate, raises the probability that this ecosystem will cross a tipping point into a dry state during the 21st century (*low confidence*). {TS3.2.2, 5.4.3, 5.4.5, 5.4.8, 5.4.9, 8.6.2, 8.6.3, Cross-chapter Box 12.1}"); *and* Lee J. Y., *et al.* (2021) *Chapter 4: Future Global Climate: Scenario-Based Projections and Near-Term Information*, in CLIMATE CHANGE 2021: THE PHYSICAL SCIENCE BASIS, Masson-Delmotte V., *et al.* (eds.), Intergovernmental Panel on Climate Change, 4-96 (Table 4.1 lists 15 components of the Earth system susceptible to tipping points).

[19] DeConto R.M., Pollard D., Alley R.B., Velicogna I., Gasson E., Gomez N., Sadai S., Condron A., Gilford D.M., Ashe E.L., Kopp R.E., Li D., & Dutton A. (2021) *The Paris Climate Agreement and future sea-level rise from Antarctica*, NATURE 593(7857): 83–89, 88 ("We find that without future warming beyond 2020, Antarctica continues to contribute to 21st-century sea-level rise at a rate roughly comparable to today's, producing 5 cm of GMSL rise by 2100 and 1.34 m by 2500 (Fig. 3, Table 1). Simulations initially following the +3 °C pathway, but with subsequent CDR delayed until after 2060, show a sharp jump in the pace of 21st-century sea-level rise (Fig. 3b). Every decade that CDR mitigation is delayed has a substantial long-term consequence on sea level, despite the fast decline in CO_2 and return to cooler temperatures (Fig. 3c). Once initiated, marine-based ice loss is found to be unstoppable on these timescales in all mitigation scenarios (Fig. 3). The commitment to sustained ice loss is caused mainly by the onset of marine ice instabilities triggered by the loss of ice shelves that cannot recover in a warmer ocean with long thermal memory (Fig. 3c).").

[20] Lenton T. M., Rockstrom J., Gaffney O., Rahmstorf S., Richardson K., Steffen W., & Schellnhuber H. J. (2019) *Climate tipping points—too risky to bet against*, Comment, NATURE 575(7784): 592–595, 594 ("In our view, the clearest emergency would be if we were approaching a global cascade of tipping points that led to a new, less habitable, 'hothouse' climate state11. Interactions could happen through ocean and atmospheric circulation or through feedbacks that increase greenhouse-gas levels and global temperature. Alternatively, strong cloud feedbacks could cause a global tipping point12,13.We argue that cascading effects might be common. Research last year14 analysed 30 types of regime shift spanning physical climate and ecological systems, from collapse of the West Antarctic ice sheet to a switch from rainforest to savanna. This indicated that exceeding tipping points in one system can increase the risk of crossing them in others. Such links were found for 45% of possible interactions14. In our view, examples are starting to be observed. … If damaging tipping cascades can occur and a global tipping point cannot be ruled out, then this is an existential threat to civilization. No amount of economic cost–benefit analysis is going to help us. We need to change our approach to the climate problem. … In our view, the evidence from tipping points alone suggests that we are in a state of planetary emergency: both the risk and urgency of the situation are acute…."). *See also* Steffen W., *et al*. (2018) *Trajectories of the Earth System in the Anthropocene*, PROC. NAT'L. ACAD. SCI. 115(33): 8252–8259, 8254 ("This analysis implies that, even if the Paris Accord target of a 1.5 °C to 2.0 °C rise in temperature is met, we cannot exclude the risk that a cascade of feedbacks could push the Earth System irreversibly onto a "Hothouse Earth" pathway. The challenge that humanity faces is to create a "Stabilized Earth" pathway that steers the Earth System away from its current trajectory toward the threshold beyond which is Hothouse Earth (Fig. 2). The humancreated Stabilized Earth pathway leads to a basin of attraction that is not likely to exist in the Earth System's stability landscape without human stewardship to create and maintain it. Creating such a pathway and basin of attraction requires a fundamental change in the role of humans on the planet. This stewardship role requires deliberate and sustained action to become an integral, adaptive part of Earth System dynamics, creating feedbacks that keep the system on a Stabilized Earth pathway (Alternative Stabilized Earth Pathway).").

[21] UNEP & CCAC (2021) GLOBAL METHANE ASSESSMENT: BENEFITS AND COSTS OF MITIGATING METHANE EMISSIONS, 11 ("Methane contributes to the formation of ground-level ozone, a dangerous air pollutant. Ozone attributable to anthropogenic methane emissions causes approximately half a million premature deaths per year globally and harms ecosystems and crops by suppressing growth and diminishing production.").

[22] UNEP & CCAC (2021) Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions, 11 ("Methane contributes to the formation of ground-level ozone, a dangerous air pollutant. Ozone attributable to anthropogenic methane emissions causes approximately half a million premature deaths per year globally and harms ecosystems and crops by suppressing growth and diminishing production.").

[23] UNEP & CCAC (2021) Global Methane Assessment: Benefits and Costs of Mitigating Methane Emissions, 8 ("This assessment found that every million tonnes (Mt) of methane reduced: - prevents approximately 1 430 annual premature deaths due to ozone globally. Of those, 740 would have died from respiratory disease and 690 from cardiovascular disease. Every million tonnes of reduced methane emissions could also avoid approximately 4 000 asthma-related accident and emergency department visits and 90 hospitalizations per year. (Section 3.4) - avoids losses of 145 000 tonnes of wheat, soybeans, maize and rice ozone exposure every year. This is roughly equivalent to increased global yields of 55 000 tonnes of wheat, 17 000 tonnes of soybeans, 42 000 tonnes of maize, and 31 000 tonnes of rice annually for every million tonnes of methane reduced. (Section 3.5) - avoids the annual loss of roughly 400 million hours of work, approximately 180 000 years, globally due to extreme heat. Employment within those sectors of the economy that are affected by heat exposure varies between genders, leading to disparities in the impacts for men and women that differ across countries. (Section 3.4)")

[24] EPA (2021) *Regulatory Impact Analysis for the Proposed Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review,* 3-18, 3-19.

[25] EPA (2021) *Regulatory Impact Analysis for the Proposed Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review*, 2-30, Table 2-6

[26] EPA (2021) *Regulatory Impact Analysis for the Proposed Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review*, 2-30.

[27] EPA (2021) *U.S. Inventory of Greenhouse Gas Emissions and Sinks 1990-2019,* at 2-12, tbl. 2-4: Emissions from Energy (Showing 2019 levels).

[28] U.S. Department of State (19 February 2021) *The United States Officially Rejoins the Paris Agreement*, Press Release ("On January 20, on his first day in office, President Biden signed the instrument to bring the United States back into the Paris Agreement. Per the terms of the Agreement, the United States officially becomes a Party again today.")

[29] United Nations Framework Convention on Climate Change, *The Paris Agreement* (last visited 8 Dec. 2021) ("The Paris Agreement is a legally binding international treaty on climate change. It was adopted by 196 Parties at COP 21 in Paris, on 12 December 2015 and entered into force on 4 November 2016. Its goal is to limit global warming to well below 2, preferably to 1.5 degrees Celsius, compared to pre-industrial levels. To achieve this long-term temperature goal, countries aim to reach global peaking of greenhouse gas emissions as soon as possible to achieve a climate neutral world by mid-century.")

[30] United States of America (2021*) Nationally Determined Contribution*, 1 ("After a careful process involving analysis and consultation across the United States federal government and with leaders in state, local, and tribal governments, the United States is setting an economy-wide target of reducing its net greenhouse gas emissions by 50-52 percent below 2005 levels in 2030.") 5 ("The United States also recognizes the crucial importance of reducing non-CO2 greenhouse gases, including methane, hydrofluorocarbons and other potent short-lived climate pollutants. Actions to be pursued include, for example: • Non-CO2 Greenhouse Gas Emissions: The United States will implement the American Innovation and Manufacturing (AIM) Act to phase down the use of hydrofluorocarbons. To address methane, the United States will update standards and invest in plugging leaks from wells and mines and across the natural gas distribution infrastructure. In addition, it will offer programs and incentives to improve agricultural productivity through practices and technologies that also reduce agricultural methane and N2O emissions, such as improved manure management and improved cropland nutrient management.")

[31] United States of America (2021*) Nationally Determined Contribution*, 1 ("After a careful process involving analysis and consultation across the United States federal government and with leaders in state, local, and tribal governments,

the United States is setting an economy-wide target of reducing its net greenhouse gas emissions by 50-52 percent below 2005 levels in 2030.") 5 ("The United States also recognizes the crucial importance of reducing non-CO2 greenhouse gases, including methane, hydrofluorocarbons and other potent short-lived climate pollutants. Actions to be pursued include, for example: • Non-CO2 Greenhouse Gas Emissions: The United States will implement the American Innovation and Manufacturing (AIM) Act to phase down the use of hydrofluorocarbons. To address methane, the United States will update standards and invest in plugging leaks from wells and mines and across the natural gas distribution infrastructure. In addition, it will offer programs and incentives to improve agricultural productivity through practices and technologies that also reduce agricultural methane and N2O emissions, such as improved manure management and improved cropland nutrient management.")

[32] *Methane matters* (2021) NAT. GEOSCI., editorial 14:875 875 ("Many countries also revised their Nationally Determined Contributions (NDCs), which outline their proposed actions to limit national greenhouse gas emissions. Optimistically assuming that all of the pledges and promises made at COP26 will be kept, early estimates suggest that this would limit global warming to 1.8 °C by the end of the century. However, on the basis of policies in place now, we are still on course for at least 2.6 °C of warming. Although COP26 has delivered some much-needed progress, we remain well behind if we are to achieve the 1.5 °C target set out in the Paris Agreement."). *See also* Hausfather Z., & Forster P., CarbonBrief (10 Nov. 2021) *Analysis: Do COP26 promises keep global warming below 2C?* ("The analysis reveals widespread agreement between four different groups assessing the climate outcomes of COP26. They suggest that current policies will lead to a best-estimate of around 2.6C to 2.7C warming by 2100 (with an uncertainty range of 2C to 3.6C). If countries meet both conditional and unconditional nationally determined contributions (NDCs) for the near-term target of 2030, projected warming by 2100 falls to 2.4C (1.8C to 3.3C).Finally, if countries meet their long-term net-zero promises, global warming would be reduced to around 1.8C (1.4C to 2.6C) by 2100, though temperatures would likely peak around 1.9C in the middle of the century before declining.").

[33] U.S. Department of State (11 October 2021) *Joint U.S.-EU Statement on the Global Methane Pledge* ("Countries joining the Global Methane Pledge commit to a collective goal of reducing global methane emissions by at least 30 percent from 2020 levels by 2030 and moving towards using highest tier IPCC good practice inventory methodologies to quantify methane emissions, with a particular focus on high emission sources. Successful implementation of the Pledge would reduce warming by at least 0.2 degrees Celsius by 2050.").

[34] EPA (2021) *Regulatory Impact Analysis for the Proposed Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review,* 2-30, tbl. 2-6.

[35] Clean Air Task Force (December 2020) *Reducing Methane from Oil and Gas* ("Given the urgency of the climate crisis, the U.S. Environmental Protection Agency should very rapidly put in place a framework to regulate methane emissions from new and existing oil and natural gas sites, nationwide. In this memo, we describe how ambitious regulations can readily reduce methane emissions in 2025 from oil and gas to at least 65% below 2012 levels, with brief descriptions of the specific measures that could accomplish this. As shown in Table 1, these reductions will reduce methane emissions in 2025 by 7.8 million metric tons of methane compared to current policies, equivalent to 680 million metric tons CO2-equivalent (using a metric that assesses the climate damage from methane over the next two decades).2").

[36] *See generally* White House Office of Domestic Climate Policy (2021) *U.S. Methane Emissions Reduction Action Plan.*

[37] The White House (29 June 2016) *Leaders' Statement on a North American Climate, Clean Energy, and Environment Partnership,* Press Release ("Today, Mexico will join Canada and the United States in committing to reduce their methane emissions from the oil and gas sector – the world's largest industrial methane source – 40% to 45% by 2025, towards achieving the greenhouse gas targets in our nationally determined contributions. To achieve this goal, the three countries commit to develop and implement federal regulations to reduce emissions from existing and new sources in the oil and gas sector as soon as possible. We also commit to develop and implement national methane reduction strategies for key sectors such as oil and gas, agriculture, and waste management, including food waste."). *See also* The White House (29 June 2016) *North American Climate, Clean Energy, and Environment Partnership Action Plan*, Press Release ("Reduce methane emissions from the oil and gas sector, the world's largest industrial methane source, 40-45% by 2025 towards achieving the greenhouse gas targets in our nationally determined contributions, and explore additional opportunities for methane reductions. The three countries commit to develop and

implement federal regulations for both existing and new sources as soon as possible to achieve the target. We intend to invite other countries to join this ambitious target or develop their own methane reduction goal.").

[38] The White House (18 November 2021) *FACT SHEET: Key Deliverables for the 2021 North American Leaders' Summit* ("Recognizing the incredible challenges posed by the climate crisis to the world, the Leaders pledged to take concrete actions such as: Creating a North American Strategy on Methane and Black Carbon to reduce methane emissions from all sectors, especially oil and gas. We will also focus on reducing black carbon from diesel vehicles and engines, flaring, wood-burning appliances, and shipping.")

[39] EPA (2021) *Regulatory Impact Analysis for the Proposed Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review*, 2-30, Table 2-6

[40] Proposed Rule at 63,146.

[41] Proposed Rule at 63,120.

[42] Proposed Rule at 63,183.

[43] Cushing L., Chau K., Franklin M., & Johnston J. E. (2021) *Up in smoke: characterizing the population exposed to flaring from unconventional oil and gas development in the contiguous US*, ENVIRON. RES. LETT. 16:1–10, 7 ("In prior work we used satellite observations to measure flaring activity in the Eagle Ford Shale of South Texas (Franklin et al 2019, Johnston et al 2020), and found that exposure to significant levels of flaring during pregnancy was associated with increased risk of preterm birth among women living within 5 km of flares (Cushing et al 2020)"); *See also* Cushing L., Vavra-Musser K., Chau K., Franklin M., & Johnston J. E., (2020) *Flaring from Unconventional Oil and Gas Development and Birth Outcomes in the Eagle Ford Shale in South Texas*, ENVIRON. HEALTH PERSPECT. 128:077003- 1–077003-9, 077003-1("Flaring and fetal growth outcomes were not significantly associated. Women exposed to a high number of wells (fourth quartile, ≥27≥27) vs. no wells within 5km5km had a higher odds of preterm birth [OR=1.31OR=1.31 (95% CI: 1.14, 1.49)], shorter gestation [−1.3−1.3 (95% CI: −1.9−1.9, −0.8−0.8) d], and lower average birthweight [−19.4−19.4 (95% CI: −36.7−36.7, −2.0−2.0) g].").

[44] Cushing L., Chau K., Franklin M., & Johnston J. E. (2021) *Up in smoke: characterizing the population exposed to flaring from unconventional oil and gas development in the contiguous US*, ENVIRON. RES. LETT. 16: 1–10, 7 ("Increasing atmospheric NOx concentrations over the Bakken shale and Permian Basin have also been attributed to flaring (Duncan et al 2016). Nitrogen oxides contribute to the development and exacerbation of asthma as well as the formation of ground-level ozone, which in turn is linked with effects on the respiratory, cardiovascular, and nervous systems and with reproductive effects and mortality (U.S. Environmental Protection Agency 2016, 2020)."). *See also* Duncan B. N., Lamsal L. N., Thompson A. M., Yoshida Y., Lu Z., Streets D. G., Hurwitz M. M., & Pickering K.E. (2016), *A space-based,high-resolution view of notable changes in urban NOx pollution around the world (2005–2014),* J GEOPHYS RES ATMOS 121, 976–996, 981 ("These increases (10–30%) may be associated with the rapid expansion of oil and natural gas extraction activities over the Williston Basin of western North Dakota and the Permian Basin and Eagle Ford shale play areas of western Texas [U.S. Energy Information Administration (USEIA), 2013, 2015a]. The growth in NOx emissions is associated with the (1) consumption of fossil fuels by the heavy machinery and vehicles used to extract and transport the oil and natural gas and (2) other processes, such as flaring. Lights associated with these activities are observable from space, such as the Visible Infrared Imaging Radiometer Suite (VIIRS) on the Suomi National Polar-orbiting Partnership (NPP) satellite [Hillger et al., 2013]. There is a general match of shape of the area of NO2 increases with the distribution of lights in all three regions (Figure 5), which suggests that the increases are associated with increased NOx emissions from the oil and natural gas extraction activities."); *and* United States Environmental Protection Agency (Apr 2020) *Integrated Science Assessment (ISA) for Ozone and Related Photochemical Oxidants: Executive Summary,* at ES-2 ("The general photochemistry of tropospheric ozone is well-established. Ozone is produced in urban areas and downwind of sources mainly by the reaction of volatile organic compounds (VOCs) with oxides of nitrogen (NOX) in the presence of sunlight, and outside of polluted areas mainly by reactions of carbon monoxide (CO) and methane (CH4) with NOX (Section 1.4)."), ES-6, Table ES-1

[45] Cushing L., Chau K., Franklin M., & Johnston J. E. (2021) *Up in smoke: characterizing the population exposed to flaring from unconventional oil and gas development in the contiguous US*, ENVIRON. RES. LETT. 16:1–10, 7 ("Lab-

based investigations and field studies from North Dakota, the Niger Delta, and Alberta, Canada have moreover shown that flaring emits hydrocarbons—including benzene and polycycic aromatic hydrocarbons (PAHs)—as well as particulate matter in the form of black carbon (Strosher 1996, Ana et al 2012, Mcewen and Johnson 2012, Fawole et al 2016, Weyant et al 2016, Gvakharia et al 2017). Benzene and some PAHs are well established carcinogens (Agency for Toxic Substances and Disease Registry 1995, Agency for Toxic Substances Control Registry 2007, Kim et al 2013) and have also been linked to birth defects (Lupo et al 2011, 2012). Exposure to black carbon is associated with higher rates of all-cause and cardiovascular mortality as well as cardiopulmonary hospital admissions (Janssen et al 2011, 2012).").

[46] Cushing L., Chau K., Franklin M., & Johnston J. E. (2021) *Up in smoke: characterizing the population exposed to flaring from unconventional oil and gas development in the contiguous US*, ENVIRON. RES. LETT. 16:1–10, 7 ("Flaring operations pro- duce heat and noise (Abdulkareem and Odigure 2006, Nwoye et al 2014), and evidence suggests noise pollu- tion in other contexts may have effects on cognition, mental health, wellbeing, and quality of life (Clark et al 2020). In an online survey, residents of the Per- mian Basin indicated increased distress in response to UOG-related environmental degradation (Elser et al 2020). Psychosocial stress has been linked to adverse health outcomes including hypertension and cardi- ovascular disease, and can exacerbate the effects of air pollutant and other chemical exposures (Clougherty et al 2010, Vesterinen et al 2017).")

[47] Motte J., Alvarenga R. A. F., Thybaut J. W., & Dewulf J. (2021) *Quantification of the global and regional impacts of gas flaring on human health via spatial differentiation,* ENVIRON. POLLUT. 291:1–6, 2 ("These gas flaring emissions have numerous environmental consequences, at both the global and local scale. First, the emissions of CO_2, CH_4 and black carbon cause climate change (Fawole et al., 2016). Second, flaring can also cause negative local effects such as terrestrial acidification.")

[48] Agerton M., Gilbert B., & Upton Jr. G. B. (2020) *Working Paper: The Economics of Natural Gas Flaring in U.S. Shale: An Agenda for Research and Policy*, 28 ("If flares do not achieve efficient combustion, they may vent methane and have a greater climate impact relative to capturing the gas. Engineering studies have found that cross-winds and other factors reduce the percentage of methane fully combusted in flares below theoretical efficiencies (Johnson and Kostiuk 2002; Johnson 2008; Leahey, Preston, and Strosher 2001; Mc- Daniel 1983; Pohl et al. 1986; Strosher 2000). Flares can also fail to light. A recent, non-peer reviewed satellite-based methane inventory from a private firm, GHGSat, found that unlit flares are the oil and gas might be the industry's biggest source of methane emissions (Anchondo 2019; Malik 2019). US Environmental Protection Agency (1996) estimates that upstream flares vent 2% of their methane due to incomplete combustion. A survey done by the Environmental Defense Fund (EDF) suggests that two percent may be too low. EDF sampled 300 Permian flares using remote sensing equipment and found that more than 10 percent of flares either had incomplete combustion or the flare became unlit. Based on this data, the EDF estimates that on average, flares release seven percent of their methane into the atmosphere. Methane has a global warming potential of 28–36 times that of CO2 over 100 years.26 Inefficient combustion of methane under real-world conditions could have 2.9–3.5 times the warming impact of burning gas at 100% efficiency. Thus, capturing associated gas instead of flaring it may have significant climate benefits."). *See also* Irakulis-Loitxate I., *et al.* (2021) *Satellite-based survey of extreme methane emissions in the Permian basin,* SCI. ADV. 7:1-8, 4 ("Second, we find a surprisingly high share of emissions (21%, in terms of both number of plumes and amount of emitted methane) from active flaring processes (see fig. S15 for an example of a large methane plume being emitted during flaring). The flux rates of the detected emissions from flaring are between 1640 and 2640 kg $hour^{-1}$ (see table S1). Although this range is in the lower half of our emission distribution (Fig. 2), such high emission rates can only be explained by inefficient or malfunctioning flaring operations (*7*, *34*). This finding agrees with a study in the Bakken Shale, which estimated that incomplete combustion from flares contributed almost 20% of the total field emissions of methane, most of which was due to a small number of low-efficiency flares (*35*).").

[49] Cushing L., Chau K., Franklin M., & Johnston J. E. (2021) *Up in smoke: characterizing the population exposed to flaring from unconventional oil and gas development in the contiguous US*, ENVIRON. RES. LETT. 16:1–10, 2 ("However, because the practice is largely unregulated, information on flaring from UOG varies by state and is often limited to aggregate (e.g. monthly, field-level) data self-reported by industry operators. A recent analysis in Texas suggests that flaring volumes reported to state regulators represent about one half of actual flare activity, highlighting the limitations of state regulatory data to assess gas flaring activity (Willyard and Schade 2019). The lack of detailed and objective information on the location of flaring from UOG also means that the number of people residing in close proximity to UOG flaring who could be exposed to flaring-related air pollutants is poorly characterized.")

[50] Cushing L., Chau K., Franklin M., & Johnston J. E. (2021) *Up in smoke: characterizing the population exposed to flaring from unconventional oil and gas development in the contiguous US*, ENVIRON. RES. LETT. 16:1–10, 7 ("Our findings also show that flaring is an environ- mental justice issue. Flaring in the Williston Basin dis- proportionately impacts Native Americans, particularly members of the Mandan, Hidatsa, and Arikara Nation living on the Fort Berthold Indian Reservation. In the Permian and Western Gulf (Eagle Ford) basins, the majority of the population are people of color (table 2). These rural regions are also among some of the poorest in Texas (Tunstall 2015).")

[51] Johnston J. E., Chau K., Franklin M., and Cushing L., (2020) *Environmental Justice Dimensions of Oil and Gas Flaring in South Texas: Disproportionate Exposure among Hispanic communities***,** ENVIRON. SCI. & TECH. 54: 6289–6298, 6289 ("We found that Hispanics were exposed to more flares despite being less likely than non-Hispanic White residents to live near unconventional oil and gas wells. Our findings suggest Hispanics are disproportionately exposed to flares in the Eagle Ford shale, a pattern known as environmental injustice, which could contribute to disparities in air pollution and other nuisance exposures.") *See also* Juhasz A. (13 Dec 2021) Halting the Gas Export Boom On Louisiana's Gulf Coast, the fossil fuel industry is planning a massive expansion of LNG exports. One woman is determined to stop them**,** Sierra Club **(***last visited* 5 Jan 2022) ("LAKE CHARLES IS A SMALL CITY of some 80,000 people located in the southwest corner of Louisiana, not far from the Texas border. On the surface, it might seem tailor-made for a massive new build-out of industrial facilities designed to export gas. There's plenty of gas produced in the region, there's a well-developed network of pipelines to deliver the fuel from fracking fields farther away, and the Gulf of Mexico is just 35 miles due south, offering a portal to overseas markets. Lake Charles is also situated in the heart of Trump country, and local and state governments have long been committed to the fossil fuel industry. Incidents of local resistance to fossil fuel and chemical corporations have been few and far between, and resolutely squashed. Today, no national environmental groups have a presence in Lake Charles, where nearly half the residents are Black."). *See also* Cushing L., Chau K., Franklin M., & Johnston J. E. (2021) *Up in smoke: characterizing the population exposed to flaring from unconventional oil and gas development in the contiguous US*, ENVIRON. RES. LETT. 16:1–10, 1 ("We estimated that over half a million people in these basins reside within 5 km of a flare, and 39% of them lived near more than 100 nightly flares. Black, indigenous, and people of color were disproportionately exposed to flaring.")

[52] Cushing L., Chau K., Franklin M., & Johnston J. E. (2021) *Up in smoke: characterizing the population exposed to flaring from unconventional oil and gas development in the contiguous US*, ENVIRON. RES. LETT. 16:1–10, 7 ("In this comprehensive assessment, we estimated that three oil and gas producing regions accounted for over 80% of all UOG flaring activity in the contiguous US over the 8 year study period (March 2012– February 2020). The Permian Basin in West Texas and Eastern New Mexico accounted for the greatest number of individual nightly flares, while the flaring intensity of oil production was highest in the Williston Basin (Bakken Shale) in North Dakota and Montana. We estimate that over 535 000 people live within 5 km of flaring in these three regions, and among these, over 210 000 live within 5 km of 100 or more individual nightly flare events.")

[53] Juhasz A. (13 Dec 2021) *Halting the Gas Export Boom***,** Sierra Club **(***last visited* 5 Jan 2022) ("'They flare at night every night,' Ozane says. 'It's never dark in Southwest Louisiana, because the skies are lit up from the industries. We call it the 'second sunrise.'").

[54] Colorado Oil and Gas Conservation Commission Rule 903 (2021) ("Venting and Flaring of natural gas represent waste of an important energy resource and pose safety and environmental risks. Venting and Flaring, except as specifically allowed in this Rule 903, are prohibited.").

[55] New Mexico Administrative Code Title 19, Chapter 15, Part 27 (Venting and flaring of natural gas).

[56] California Officer of Governor (21 Oct. 2021) *California Moves to Prevent New Oil Drilling Near Communities, Expand Health Protections,* Press Release ("Moving to protect communities as the state works to phase out fossil fuels, Governor Gavin Newsom today announced that the Department of Conservation's Geologic Energy Management Division (CalGEM) has released a proposed regulation that would prohibit new wells and facilities within a 3,200-foot exclusion area – or setback – from homes, schools, hospitals, nursing homes and other sensitive locations. It would also require pollution controls for existing wells and facilities within the same 3,200-foot setback area.") ("The state is proposing a 3,200-foot setback in order to protect public health. A 15-member public health expert panel selected by University of California, Berkeley and Physicians, Scientists, and Engineers (PSE) for Healthy Energy helped inform the draft rule announced today. The panel concluded that when oil and gas developments are within 3,200 feet, there is a strong connection to higher rates of adverse birth outcomes, respiratory

diseases such as asthma, and heart disease, among other health impacts. The panel's research supports both moving oil production farther away from communities in combination with pollution controls for operating wells.")

[57] Barkley Z. R., *et al.*, (2021) *Analysis of Oil and Gas Ethane and Methane Emissions in the Southcentral and Eastern United States Using Four Seasons of Continuous Aircraft Ethane Measurements*. GEOPHYS RES ATMOS 126, ("In this study, we perform an inverse analysis on 200 h of atmospheric boundary layer C_2H_6 measurements to estimate C_2H_6 emissions from the US O&G sector. Measurements were collected from 2017 to 2019 as part of the Atmospheric Carbon and Transport (ACT) America aircraft campaign and encompass much of the central and eastern United States. We find that for the fall, winter, and spring campaigns, C_2H_6 data consistently exceeds values that would be expected based on EPA O&G leak rate estimates by more than 50%. C_2H_6 observations from the summer 2019 data set show significantly lower C_2H_6 enhancements in the southcentral region that cannot be reconciled with data from the other three seasons, either due to complex meteorological conditions or a temporal shift in the emissions. Combining the fall, winter, and spring C_2H_6 posterior emissions estimate to an inventory of O&G CH_4 emissions, we estimate that O&G CH_4 emissions are larger than EPA inventory values by 48%–76%.").

[58] Lin J. C, Bares R., Fasoli B., Garcia M., Crosman E., Lyman S., (2021) *Declining methane emissions and steady, high leakage rates observed over multiple years in a western US oil/gas production basin*. SCI REP 11, 22291, 1-12, 1 ("Here we present a unique analysis of one of the longest-running datasets of in-situ methane observations from an oil/gas production region in Utah's Uinta Basin. The observations indicate Uinta methane emissions approximately halved between 2015 and 2020, along with declining gas production. As a percentage of gas production, however, emissions remained steady over the same years, at ~ 6–8%, among the highest in the U.S. Addressing methane leaks and recovering more of the economically valuable natural gas is critical, as the U.S. seeks to address climate change through aggressive greenhouse emission reductions.")

[59] McGee M., (23 Sept. 2021) *New Aircraft Measurements Once Again Detect High Levels of Methane in Permian Basin, Environmental Defense Fund* (*last visited* 5 Jan 2022) ("The new data was collected during an 11-day period in August by Carbon Mapper as part of EDF's PermianMAP initiative. The aircraft detected over 900 plumes of methane from more than 500 sources. As with previous surveys of the area, this new data again confirm that super emitting sites continue to be a problem across the Permian.")

[60] Proposed Rule at 63,171.

[61] Colorado Department of Public Health and Environment, Air Quality Control Commission Regulation Number 7: CONTROL OF OZONE VIA OZONE PRECURSORS AND CONTROL OF HYDROCARBONS VIA OIL AND GAS EMISSIONS (EMISSIONS OF VOLATILE ORGANIC COMPOUNDS AND NITROGEN OXIDES), (2021), 1-404, 287 ("'Well production facilities' are also subject to leak detection and repair requirements and storage tank maintenance requirements. This definition is meant to include all of the emission points, as well as any other equipment and associated piping and components, owned, operated, or leased by the producer located at the same stationary source (a defined term specific to permitting). The 'owned, operated, or leased' qualifier in the definition is not meant to reduce the stringency of LDAR requirements in situations where there are multiple owners or operators of the well production facility. This definition is meant to exclude natural gas compressor stations from 'well production facility' and avoid overlapping LDAR requirements. This definition is also meant to exclude natural gas storage wells."); *See also* Environmental Defense Fund (17 Dec. 2021) *With Powerful New Oil and Gas Rules, Colorado Sets Bar for Nation-leading Protections,* Press Release ("Today the Colorado Air Quality Control Commission voted unanimously to adopt landmark rules limiting oil and gas methane and air pollution. The rules will require frequent inspections for all wells, including smaller, leak-prone ones which have been shown to be responsible for an outsized share of emissions. In addition, the rules will prohibit venting of methane during maintenance activities.")

[62] Boulder Country (17 Dec. 2021) *Air Commission strengthens oil and gas leak repair requirements, but fails to ensure Colorado will meet its climate goals* (*last visited* 5 Jan. 2022) ("The new regulations will move Colorado towards the targets set by a 2021 environmental justice law (HB21-1266), but the state will fall short of the goal of 60 percent reductions by 2030. Additional emissions reductions will still be needed to meet that goal. HB21-1266 also requires these regulations to provide extra protections for communities that are disproportionately impacted by oil and gas pollution, as well as by climate change. The rules adopted today do require more frequent inspections and repairs at sites near where people live, work and play. But some provisions do not extend to disproportionately impacted communities statewide — only in the ozone-impacted Front Range.")

[63] Proposed Rule at 63,177.

[64] Proposed Rule at 63,241.

[65] *See* Kang M., *et al*. (2021) *Orphaned oil and gas well stimulus–Maximizing economic and environmental benefits*, ELEMENTA 9:1–13, 8 ("Monitor representative populations of plugged and unplugged abandoned wells across multiple basins to understand the ability of plugging to address the full suite and interdependency of environmental risks (Table 1). Ongoing analysis of monitoring results and well attributes are needed to identify representative populations of wells. Moreover, it is important to perform pre- and postplugging monitoring and understand short-term variations (i.e., daily and seasonal)."); Williams J.P., Regehr A., & Kang M. (2021) *Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States*, ENVIRON. SCI. & TECH. 55:563–570, 569 ("Only 10 high-emitting wells with over 100 g/h have been measured to date, yet they contribute roughly 65% of cumulative emissions (i.e., superemitters) from all studies. Although mitigating a small number of sites can reduce a large percentage of methane emissions, it also means that AOG wells with methane flow rates much higher than those measured to date may exist. Gathering new measurements from regions without prior data may greatly enhance the representativeness of emission factors, help characterize and identify the highest emitters that heavily influence emission factors, and provide information on how these emissions are distributed regionally and across well classifications.").

[66] *See generally* Rotblat C. (2017) *Caring for the Orphans: Approaches for Mitigating Fugitive Methane Emissions from Orphaned Oil and Gas Wells,* ENVIRON. L. REP. NEWS & ANALYSIS 47:10529–10541, 10535.

[67] Williams J.P., Regehr A., & Kang M. (2021) *Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States*, ENVIRON. SCI. & TECH. 55:563–570, 568 ("In the U.S. from 2000 to 2013, an average of 18,600 wells were abandoned per year, with a maximum of 35,500 in 2008 and a minimum of −4000 in 2009. The negative numbers of AOG wells drilled per year, represent a decrease in total AOG well numbers, and is likely a result of idle/inactive wells being re- entered into the production life cycle. Overall, the growing number of AOG wells implies that methane emissions from AOG wells are likely to be increasing.").

[68] EPA (2021) *U.S. Inventory of Greenhouse Gas Emissions and Sinks 1990-2019,* 3-111.

[69] Budryk Z. (5 January 2022), *Interior: US has twice as many abandoned oil and gas wells as previously thought*, THE HILL ("In a memo Wednesday, the department said there are currently more than 130,000 documented abandoned, or orphaned, wells. Comparatively, a 2019 report from the Interior documented a total of 56,600 orphaned wells across 30 states. Across the entire country they found that the number of abandoned wells in that report ranged from zero to 13,226.").

[70] Proposed Rule at 63,240; EPA (2021) *U.S. Inventory of Greenhouse Gas Emissions and Sinks 1990-2019,* 3-111, tbl. 3-96 (2021).

[71] Williams J.P., Regehr A., & Kang M. (2021) *Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States*, ENVIRON. SCI. & TECH. 55:563–570, 568 ("Our estimates for annual methane emissions from AOG wells are consistently higher than those reported in the latest inventory report by 150%2 for Canada and by 20% for the U.S.1 The reasons for the larger degree of underestimation in the Canadian inventory are due to our use of a larger number of wells and higher emission factors. In contrast, the difference in the U.S. inventory is primarily due to our use of a larger number of wells. Nevertheless, emissions factors for the "entire U.S." relied on data that were not distributed throughout the country but focused on western states, Wyoming, Utah, and Colorado and missing data from major oil- and gas-producing states such as Texas, Oklahoma, and California."); Kang M., *et al*. (2021) *Orphaned oil and gas well stimulus–Maximizing economic and environmental benefits*, ELEMENTA 9:1–13, 3 ("According to state and provincial/territorial records, there are 4,653,000 historic and active oil and gas wells in the United States and another 788,000 in Canada (Tables S3 and S4). Of these, 1,954,000 (42%) and 313,000 (40%) wells are active in the United States and Canada, respectively. In the active well counts, we include wells drilled for enhanced recovery (e.g., injection wells) and disposal wells (e.g., salt water disposal well that was formerly producing gas) in addition to those drilled to produce oil and gas. In the United States, 1,519,000 (33%) wells are plugged; while in Canada, 351,000 (45%) are plugged. Thus, two of three wells ever drilled in the United States are currently inactive, but only one in three are plugged (Tables S3 and S4).").

[72] Williams J.P., Regehr A., & Kang M. (2021) *Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States*, ENVIRON. SCI. & TECH. 55:563–570, 569 ("Our estimates for annual methane emissions from AOG wells are consistently higher than those reported in the latest inventory report by 150%2 for Canada and by 20% for the U.S.1 The reasons for the larger degree of underestimation in the Canadian inventory are due to our use of a larger number of wells and higher emission factors. In contrast, the difference in the U.S. inventory is primarily due to our use of a larger number of wells. Nevertheless, emissions factors for the "entire U.S." relied on data that were not distributed throughout the country but focused on western states, Wyoming, Utah, and Colorado and missing data from major oil- and gas-producing states such as Texas, Oklahoma, and California.").

[73] *E.g.* Kang M., *et al*. (2021) *Orphaned oil and gas well stimulus–Maximizing economic and environmental benefits*, ELEMENTA 9:1–13, 2 ("In the first half of 2020, 30 oil and gas exploration and production companies filed for bankruptcy or receivership in the United States and Canada (Tables S1 and S2). Across the United States and Canada, these companies operate 116,245 wells in 32 states and four Canadian provinces/territories, with the most in California (37,620), Texas (16,529), and Oklahoma (12,258; Figure 2). Wells operated by companies going bankrupt are not necessarily orphaned but may change ownership or continue to produce within the restructured company (Schuwerk and Rogers, 2020). In some cases, wells change hands multiple times before being abandoned. As a result, available data cannot yet be used to understand precisely how many of the wells operated by bankrupt companies are being, or will be, orphaned across the United States and at what timescale (Figure S2). Nevertheless, data from Alberta show that a drop in oil price leads to an increase in the number of orphaned wells in the following approximately 3 years (Figure S3).").

[74] *See e.g.* Williams J.P., Regehr A., & Kang M. (2021) *Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States*, ENVIRON. SCI. & TECH. 55:563–570, 567 ("States with the highest AOG well counts in the U.S. are Texas, Pennsylvania, Kansas, West Virginia, and Oklahoma, which collectively account for 65% of the total [abandoned oil and gas (AOG)] well count in the U.S.").

[75] Williams J.P., Regehr A., & Kang M. (2021) *Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States*, ENVIRON. SCI. & TECH. 55:563–570, 568 ("We estimate annual methane emissions from AOG wells across the U.S. to be 0.32 (1Total) to 0.36 (3east/west) MMt of CH4 emitted annually (Figure 4). All five scenarios show higher methane emissions than the U.S. EPA's estimate for 2018 of 0.28 MMt of methane per year. The states with the most methane emitted annually, on average, are Pennsylvania (0.088 MMt of methane), Texas (0.086 MMt of methane), West Virginia (0.051 MMt of methane), and Kansas (0.027 MMt of methane). Breakdowns of emissions by the well type and plugging status for all five scenarios are shown in Figure S5 of the Supporting Information."). *See also* Lee M. (23 Dec 2021) *Tribe's 1,600 abandoned wells a test for U.S. cleanup push* (*last visited* 5 Jan 2022) ("That's set to change, as the infrastructure law signed by President Biden last month pumps $150 million into cleaning up abandoned oil and gas wells on tribal lands. But the Osage Nation's experience, gained partly from plugging wells the last three years, shows that even that sum may not be enough. 'We are going to run into wells that are going to be very expensive,' said Waller, who chairs the Osage Minerals Council. One well on the Osage reservation cost $238,000 to plug, and sealing off the old wells in the lake bed could cost as much as $1 million apiece, according to congressional testimony. At that rate, the Osage reservation alone could run through the entire amount set aside for tribal well plugging nationwide.")

[76] Cal. Pub. Rec. Code § 3237 (2020).

[77] Williams J.P., Regehr A., & Kang M. (2021) *Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States*, ENVIRON. SCI. & TECH. 55:563–570, 569 ("Only 10 high-emitting wells with over 100 g/h have been measured to date, yet they contribute roughly 65% of cumulative emissions (i.e., superemitters) from all studies. Although mitigating a small number of sites can reduce a large percentage of methane emissions, it also means that AOG wells with methane flow rates much higher than those measured to date may exist. Gathering new measurements from regions without prior data may greatly enhance the representativeness of emission factors, help characterize and identify the highest emitters that heavily influence emission factors, and provide information on how these emissions are distributed regionally and across well classifications.").

[78] 42 U.S.C. §15907(b); Infrastructure Investment and Jobs Act, H.R. 3684, 117th Cong. §40601(b) (2021) ("ii) ranking those orphaned wells for priority in plugging, remediation, and reclamation, based on-- ``(I) public health and safety; ``(II) potential environmental harm; and ``(III) other subsurface impacts or land use priorities;").

[79] Rotblat, C. (2017) *Caring for the Orphans: Approaches for Mitigating Fugitive Methane Emissions from Orphaned Oil and Gas Wells,* ENVIRON. L. REP. NEWS & ANALYSIS 47:10529–10541, 10535 ("States use these funds to maintain prioritized lists of orphaned wells and, as funding permits, to plug the highest priority wells. In 2008, the Interstate Oil and Gas Compact Commission (IOGCC) 97 developed a suggested prioritization schedule for plugging orphaned wells involving 10 factors related to the hazards posed by each well to health, safety, and the environment. However, states still maintain slightly different prioritization systems. For instance, in Texas, prioritization is based on 'well completion,' 'wellbore conditions,' 'well locations with respect to sensitive areas,' and 'unique environmental, safety or economic concern.'99 In Kansas, prioritization is based on the risk posed by the well to surface water, groundwater, and public safety. 100 And in Pennsylvania, prioritization is based on 'whether the well is on public or private land; its distance from public or private water supplies, accessible areas or buildings; its distance from streams, bodies of water, or wetlands; and whether or not it is in a special protection watershed.' 101 The volume of methane gas leaking from an orphaned well is often taken into account as a public safety factor, due to the risk of ignition or explosion, 102 but the climate change impacts of methane leaks do not appear to be part of any published prioritization system. As a result, even wells leaking significant amounts of methane may remain unplugged for extended periods if they are not located near a water source or occupied buildings. 103").

[80] Williams J.P., Regehr A., & Kang M. (2021) *Methane Emissions from Abandoned Oil and Gas Wells in Canada and the United States*, ENVIRON. SCI. & TECH. 55:563–570, 569 ("Only 10 high-emitting wells with over 100 g/h have been measured to date, yet they contribute roughly 65% of cumulative emissions (i.e., superemitters) from all studies. Although mitigating a small number of sites can reduce a large percentage of methane emissions, it also means that AOG wells with methane flow rates much higher than those measured to date may exist. Gathering new measurements from regions without prior data may greatly enhance the representativeness of emission factors, help characterize and identify the highest emitters that heavily influence emission factors, and provide information on how these emissions are distributed regionally and across well classifications.").

[81] *E.g.* Kang M., *et al*. (2021) *Orphaned oil and gas well stimulus–Maximizing economic and environmental benefits*, ELEMENTA 9:1–13, 8 ("Here, we outline six policy recommendations for monitoring and managing abandoned oil and gas wells including orphaned wells: 1. Monitor representative populations of plugged and unplugged abandoned wells across multiple basins to understand the ability of plugging to address the full suite and interdependency of environmental risks (Table 1). Ongoing analysis of monitoring results and well attributes are needed to identify representative populations of wells. Moreover, it is important to perform pre- and postplugging monitoring and understand short-term variations (i.e., daily and seasonal). 2. Study the long-term—decadal to century- scale—impacts of abandoned wells. Such studies should include monitoring at the same wells over decades. 3. Monitor and manage abandoned wells regionally to account for interwellbore communication and complex subsurface leakage pathways. The region to investigate will depend on the geology, hydrogeology, and the history of oil and gas and other subsur- face activities. Additional research involving field and modeling work is needed to develop a framework for selecting these regions. 4. Find and document wells that are not in current databases so that they can be ad- dressed through plugging and site restoration in a systematic manner. 5. Develop national and international standards for documenting historical and modern wells to improve the long-term maintenance and usability of databases. 6. Train workers on well plugging, site restoration, environmental monitoring, and other jobs that will remain available during and after the transition to clean energy.").