Reducing Methane from Oil and Gas

A Path to a 65% Reduction in Sector Emissions

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Methane is a highly potent greenhouse gas that warms the climate dozens of times more than carbon dioxide, pound for pound. Currently, methane is warming our climate about half as much as CO_2.[1] The largest industrial source of methane in the U.S. is the oil and natural gas industry. In response to growing concerns over warming temperatures and other harmful effects from greenhouse gas pollution, in addition to the extremely rapid growth of oil and gas production in the United States over the past decade, many jurisdictions in the U.S. and elsewhere in North America have moved to reduce methane pollution from oil and gas by implementing regulations that require oil and gas operators to use equipment and practices that have been shown to reduce emissions.

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]

Our analysis is based upon a model built by CATF that uses EPA's U.S. Greenhouse Gas Inventory[3] (USGHGI), which breaks methane emissions down into dozens of categories, to estimate the benefits of specific regulatory approaches. The USGHGI

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[1] See G. Myhre *et al.* (2013) "Anthropogenic and Natural Radiative Forcing. In: *Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* Figure 8.17, (*available at* https://www.ipcc.ch/site/assets/uploads/2018/02/WG1AR5_Chapter08_FINAL.pdf).

[2] The metric is the 20-year Global Warming Potential for methane (87). See *Id.,* Table 8.7.

[3] EPA (2019), *Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2017*, (*available at* https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2017). See sections

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Table 1: Policies and Potential Reductions (in metric tons methane)

Source	Policy	Emissions Reduction in 2025
Leaks & Improper VOC / Upset Condition Emissions	Monthly leak detection and repair inspections or continuous monitoring	4,478,000
Pneumatic equipment	Replace with non-emitting equipment (air driven or electric controllers and pumps)	2,352,000
Storage tanks	Capture or control for all tanks with potential emissions of over two tons of VOC per year	55,000
Well completions / workovers	Diligently capture all emissions using reduced emission completion equipment	81,000
Compressors and dehydrators	Capture emissions for sale (compressors) or to fuel boilers (dehydrators)	581,000
Venting & flaring from oil wells	80% reduction	69,000
Maintenance venting	Waste minimization techniques	215,000
Total Methane Emission Reductions		**7,831,000**

figures are adjusted to account for the higher emissions from oil and gas production areas that have been documented in numerous independent research studies, and which were estimated at the national level by Alvarez et al.[4] The model then uses projections of oil and natural gas production and other quantities in future years from the U.S. Energy Information Administration to scale "potential emissions" – emissions without additional regulatory measures in place. Using the scaled potential emissions, together with calculations of benefits from specific regulations, we are able to project emissions for future years with specific regulatory standards in place. We have described this methodology in more detail elsewhere.[5]

The emissions mitigation approach described here focuses on full, broad application in the entire U.S. of proven approaches to greatly reduce methane pollution from a limited number of key sources, described below in this memo. As we also describe below, the measures that we call for have regulatory precedents in the U.S. or Canada (or both). However, these regulatory precedents are limited in scope. For example, many rules put in place by U.S. EPA only apply to new and modified equipment: under current federal regulations, older equipment is generally allowed to continue polluting at a higher level, despite the availability of cleaner equipment that can do the job. In other cases, regulations are less stringent in other ways, as described below. In this

3.6 and 3.7, and Annex 3 sections 3.5 and 3.6. While EPA, very recently, published the 2020 edition of the US GHG Inventory, we are still reviewing the estimates in that document and have not incorporated them into our model. Unfortunately, as we have noted in comments to EPA, the changes EPA made in 2020 to their methodology for calculating oil and gas emissions reduce the accuracy of the inventory, so we anticipate that in updating our model to incorporate the information from the 2020 inventory, additional adjustments may be needed to make the model as reflective as possible of real emissions.

[4] Alvarez, RA *et al.* (2018), "Assessment of Methane Emissions from the U.S. Oil and Gas Supply Chain," *Science* 361, 186 (*available at* https://science.sciencemag.org/content/361/6398/186). Alvarez et al. note that the evidence suggests that the extra emissions, that are missing from the USGHGI, are not from any one type of equipment or process. Rather, they are from very large, but relatively infrequent, emissions events resulting from problems and improper operations at oil and gas sites – issues such as hatches or valves that are left open, flares that have blown out, etc. Note that we also adjust emissions for prior years (including 2012) to account for these extra emissions.

[5] Clean Air Task Force (2019), *Memo: Modeled impacts from EPA methane rollbacks* (*available at* https://www.catf.us/resource/memo-modeled-impacts-from-epa-methane-rollbacks/).

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memo, we quantify the substantial emissions reductions that will occur if protective standards, largely modeled on the strong precedents from U.S. Federal, State, or Canadian rules, are generally applied to all equipment of a given class.

It is important to note that there are many additional sources of harmful methane pollution from oil and gas, beyond those described in this memo, that are technically feasible to mitigate. These sources, too, must be addressed, and as U.S. EPA implements standards to cut pollution from the sources described in the remainder of this memo, it should also work to develop standards to address these additional sources. However, addressing these additional sources is beyond the scope of this memo.

Regulatory Measures to Address Sources of Methane from Oil and Gas

Oil and gas methane emissions can be greatly reduced by widely implementing a handful of straightforward measures that have already been proven in one or more North American jurisdictions. These measures are briefly described below. More details and citations for some of the technologies described are available in the Appendix.

- *Frequent Leak Detection and Repair (LDAR)*. Leak detection programs can be used to find and fix everything from simple leaking components, such as valves, to super-emitters – the infrequent but very large emissions events that arise from some improper conditions at oil and gas sites. Super-emitters can be caused by valves and hatches that are stuck open, flares that are blown out (so gas simply is vented, rather than being combusted), or many other types of abnormal operating conditions at a site. Alvarez et al. noted that these types of emissions are probably the cause for much of the "missing emissions" that are observed from oil and gas sites, but not reflected in the USGHGI.[6]

Leaks and super-emitters together amount to more than half of total emissions from the oil and gas industry,[7] so frequent LDAR is the most essential element of an emissions reduction program for oil and gas.

Based on U.S. EPA data, emissions from leaks can be cut by about 90% with monthly LDAR.[8] EPA currently requires monthly inspections for some equipment at newer / recently modified refineries and chemical plants,[9] and Colorado requires monthly

[6] See Alvarez, RA *et al.* (2018), 186-187
[7] Based on the USGHGI, adjusted to account for the higher emissions from oil and gas production areas quantified by Alvarez *et al* (2018).
[8] EPA (2016) *Background Technical Support Document for the Final New Source Performance Standards 40 CFR Part 60, subpart OOOOa,* p. 41 (*available at* https://www.regulations.gov/document?D=EPA-HQ-OAR-2010-0505-7631).
[9] See 40 C.F.R. Part 60, Subparts VVa and GGGa (*available at* https://www.law.cornell.edu/cfr/text/40/part-60/subpart-VVa and https://www.law.cornell.edu/cfr/text/40/part-60/subpart-GGGa).

LDAR at larger oil and gas sites (new and existing).[10] Meanwhile, a number of technologies in development hold promise as potentially more efficient ways to reduce leaks and super-emitters. These technologies take diverse approaches: sensing methane from specialized road vehicles, towers, aircraft, or even satellites; or, alternatively, developing low-cost sensors that can detect emissions in real-time and be widely dispersed for use at individual wellpads or on vehicles servicing oil and gas sites. At the same time, regulators and others are developing methods to quantitatively compare these technologies to current LDAR approaches, so that the new, more efficient technologies can quickly be used once they are shown to be as effective as periodic leak detection surveys.[11] These efforts will reduce the cost of LDAR substantially over the coming years,[12] lowering the cost of aggressively reducing leak emissions, including those from super-emitters. For our analysis of potential reductions from comprehensive regulations, **we include a 90% reduction in leaks.** We estimate that such a policy could reduce emissions from leaks and super-emitters by almost **4.5 million tons of methane** in 2025.

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- *Replacement of gas-driven pneumatic equipment*. Traditionally, oil and gas operations in North America have relied heavily upon automated equipment which uses pressurized natural gas to pump liquids or open and shut valves. This was particularly convenient at isolated sites which did not have electric power from the grid available. Since the equipment is using the pressure of the gas to do work, it is designed to release the gas into the air as it operates. Across the industry, pneumatic equipment emits a huge amount of methane pollution – over two million metric tons per year.[13]

Fortunately, emissions from pneumatic equipment can be entirely avoided with the use of modern equipment. Gas-driven pneumatic equipment can be replaced with electric controllers and pumps, including electric equipment powered by solar, allowing use at sites off the electrical grid.[14] Alternatively, pneumatic equipment can be driven with compressed air instead of pressurized natural gas. This eliminates methane pollution from the equipment, since it vents air instead of natural gas. While air compressors for these systems were traditionally powered by gas-driven engines, electric compressors suitable for solar-powered systems are now on the market.[15] These options allow elimination of virtually all gas-driven pneumatic equipment. Canadian provincial regulations contain broad mandates for the use of non-emitting controllers for new

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[10] See 5 Colo. Code Regs. §§ 1001-9 D.II.E.3, Table 2 (compressor stations), D.II.E.4, Table 3 (well pads) (*available at* https://drive.google.com/file/d/16qTQLSTX1T49DYWp3voXRNl4_g-vbhQT/view?usp=sharing).
[11] See Appendix for citations of LDAR regulations designed to facilitate alternative leak detection approaches, and collaborative efforts to develop frameworks to evaluate potential alternative technologies in an appropriate and manner so that technologies can be adopted as soon as they are proven to work as well as LDAR with OGI.
[12] Current efforts to develop these technologies would be substantially boosted by national standards requiring frequent LDAR at existing sites across the oil and gas industry, as we call for here.
[13] Based on the USGHGI.
[14] See Carbon Limits (2016), *Zero emission technologies for pneumatic controllers in the USA: Applicability and cost effectiveness*, (*available at* https://www.catf.us/resource/zero-emission-technologies-for-pneumatic-controllers-usa/).
[15] See citations in Appendix.

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installations and some existing facilities.[16] For our analysis of potential reductions from comprehensive regulations**, we include a 95% reduction in emissions from pneumatic equipment**, since the vast majority of this equipment can be replaced with non-emitting equipment. We estimate that such a policy could reduce emissions from pneumatic equipment by over **2.3 million tons of methane** in 2025.

- *Reducing venting from storage tanks*. At most oil production well sites, oil is separated from gas and collected in tanks, where it is stored until it is trucked away. During this process, the oil releases methane and other pollutants dissolved in it; without controls to limit emissions, these pollutants are released into the air. These emissions can be controlled by capturing the methane and other hydrocarbon pollutants and using specialized compressors to inject the hydrocarbons into the natural gas pipelines at the wellsites. Alternatively, if this approach is not feasible, gas can be incinerated (flared), largely preventing release of methane.[17] Since incinerators emit CO_2 and other pollutants, and they waste the energy contained in the gas that they destroy, incineration is clearly not as good an option as capturing gas, but it is far better than venting the gas.

Nationwide EPA standards require operators to control emissions from new tanks installed in the past several years, but these rules do not apply to older tanks or tanks that emit below emissions thresholds in the rules. State rules in Colorado, in contrast, are applied to both new and existing tanks, including tanks with emissions significantly lower than the federal applicability threshold.[18]

For our analysis of potential reductions from comprehensive regulations, **we include a 95% reduction in emissions from uncontrolled larger tanks**, which reflects the abatement effectiveness used by EPA and other jurisdictions for well-implemented emission controls on tanks. We also include some additional abatement to account for better control of tanks which currently have less effective controls. Since many regulations exempt the lowest-emitting existing tanks from control requirements, **we only include 50% control for smaller tanks.** We estimate that this approach could reduce emissions from large and small tanks by **55,000 tons of methane** in 2025.

- *Minimizing emissions from well completions*. When oil and gas wells are hydraulically fractured, large volumes of water, sand, *and* chemicals are pumped into the well at high pressure, fracturing the rocks containing the oil and gas. The next step is to allow this liquid to flow back to the surface. However, the liquid is mixed with significant amounts of natural gas, which was typically vented to the atmosphere before

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[16] See Appendix for a brief description of these regulations and citations.
[17] Methane will still be released if these devices fail (for example if flames go out) and when flames do not completely destroy the methane in the gas they burn. Therefore, it is critical than any control equipment which uses combustors be well designed to burn methane robustly and completely, tested for high destruction effectiveness, and regularly inspected.
[18] See 5 Colo. Code Regs. §§ 1001-9 D.I.D.3.a (*available at* https://drive.google.com/file/d/16qTQLSTX1T49DYWp3voXRNl4_g-vbhQT/view?usp=sharing). These rules also have a number of provisions to ensure that control devices for tanks are highly effective at destroying hydrocarbons (see previous note.)

states and U.S. EPA put in place rules requiring operators to control emissions of this gas by capturing it or flaring it. These rules have reduced emissions, but the rules give industry a great deal of flexibility in the way they are applied, and there is reason to believe industry is abusing this flexibility in some cases. Future regulations should ensure that operators diligently apply emissions controls to truly minimize emissions: measurements have confirmed that when operators carefully work to limit emissions from well completions, they will be quite low – almost 99% below EPA's current estimate of emissions per completion.[19] Therefore, for our analysis **we include a 99% reduction in emissions from completions of oil and gas wells**. We estimate that this approach could reduce emissions from well completions by **81,000 tons of methane** in 2025.

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- *Compressors and dehydrators*. In general, this equipment is designed to release some of the methane and hydrocarbons it handles: compressors vent gas that passes through seals for moving parts (which are not designed to be hermetic) and dehydrators release methane and other hydrocarbon pollutants as they vent the water vapor that they remove from natural gas. These emission points can be effectively controlled, and rules in several jurisdictions require operators to do so, for many compressors and certain dehydrators.[20] However, EPA's nationwide standards exempt thousands of older compressors and only cover larger dehydrators at a limited number of large sites. For our analysis of potential reductions from comprehensive regulations, **we include a 95% reduction in emissions from compressors and dehydrators,** reflecting a policy generally requiring control of emissions from all compressors and dehydrators nationwide. These policies could reduce emissions by **580,000 tons of methane** in 2025.

- *Reducing venting and flaring of gas from oil wells*. As oil production has boomed in the Permian Basin in Texas and New Mexico and in the Bakken formation in North Dakota, wells have been drilled and completed so rapidly that the gas these wells co-produce overwhelms the pipelines and other infrastructure needed to handle and transport it. In some cases, new oil wells are drilled without any gas infrastructure. And many regulators allow oil producers to simply flare off this gas, rather than requiring operators to plan oil development so that gas infrastructure keeps pace with well drilling or utilize alternative approaches[21] to handle gas when pipelines are not available. An even more harmful practice is simply dumping gas from oil wells into the air (venting), without even flaring it off. This is more commonplace at older wells, but it

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[19] Based on data from DT Allen *et al* (2013), "Measurements of methane emissions at natural gas production sites in the United States," *Proc. Natl. Acad. Sci. USA* 110, 17768, (*available at* https://www.pnas.org/content/110/44/17768), and the US GHGI. See Appendix for details.

[20] See Appendix for examples. Current regulations for dehydrators are complex and it is beyond the scope of this memo to fully review them: for example, some regulations currently allow controls such as condensers which are effective for toxic hydrocarbons, but which are ineffective for methane. See https://www.regulations.gov/document?D=EPA-HQ-OAR-2010-0505-7032, at 1-2.

[21] Some alternatives to flaring gas when pipelines are not available are described a recent report. *See* Carbon Limits, *Improving Utilization of Associated Gas in U.S. Tight Oil Fields* (rev. Oct. 2015) (*available at* https://www.catf.us/wp-content/uploads/2015/04/CATF_Pub_PuttingOuttheFire.pdf).

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certainly happens at newer wells too, for example if flares go out and equipment designed to reignite the flame is not present or fails to operate.

Given market dynamics such as low prices for natural gas that do not incentivize capture and oil prices that make oil wells profitable without gas sales, wasteful flaring and venting of natural gas will likely persist in the U.S. as long as regulators allow it to continue. A number of U.S. states have rules in place to limit flaring, but some state regulators have relaxed rules or effectively chosen not to enforce them, rather than requiring operators to actually reduce flaring.[22] However, Colorado has recently finalized a strong rule which will eliminate flaring from new wells, and severely curtail flaring from existing wells.[23]

The U.S., together with many other countries, has committed to eliminating routine flaring by 2030, and many international oil producers have endorsed this pledge.[24] In order to meet that goal, federal regulations will be required. An interim goal will be important to ensure near-term progress to eliminate flaring; an 80% reduction in flaring emissions is an appropriate interim target for 2025[25] and **we therefore include a reduction of 80% in venting and flaring our analysis of potential reductions from comprehensive regulations in 2025.** These policies could reduce emissions by almost **70,000 tons of methane** in 2025.

- *Reducing venting during maintenance operations*. Natural gas operators routinely vent wells and equipment before performing maintenance work. Wells are vented primarily to make it quicker and easier to get water out of wells in a process referred to as "wellbore liquids unloading". Numerous technologies and management practices have been identified to reduce, or eliminate, emissions from this practice.[26]

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[22] For example, while Texas regulations nominally limit flaring from oil wells to the period shortly after the well is completed, over the past seven years the Texas oil and gas regulator has approved over 27,000 requests from operators to flare gas outside of the allowed time period, without denying a single request. See Kiah Collier, *Pipeline giant sues Railroad Commission, alleging lax oversight of natural gas flaring*, Texas Tribune, Dec. 3, 2019 (*available at* https://www.texastribune.org/2019/12/03/railroad-commission-sued-lax-oversight-natural-gas-flaring/). While North Dakota has quantitative standards in place for operators, nominally limiting the portion of gas that operators can flare, many operators have consistently failed to meet those standards, without being sanctioned. *See* Amy R. Sisk, *North Dakota Industrial Commission OKs order targeting gas capture, flaring*, Grand Forks Herald, Dec. 17, 2019 (*available at* https://www.grandforksherald.com/business/energy-and-mining/4827888-North-Dakota-Industrial-Commission-OKs-order-targeting-gas-capture-flaring); and Citizen Groups Comments on Waste Prevention, Production Subject to Royalties, and Resource Conservation: Rescission or Revision of Certain Requirements, Dkt. ID No. BLM-2018-0001-132411, at 69-77 (*available at* https://www.regulations.gov/document?D=BLM-2018-0001-132411, pages 69-77).

[23] Colorado Oil and Gas Conservation Commission, Rule 903(d) (November 23, 2020). (*available at https://drive.google.com/file/d/1ZdcnzIihnlhCWmOGSPmoi0Rl8WdBJmcd/view?usp=sharing.*)

[24] See https://www.worldbank.org/en/programs/zero-routine-flaring-by-2030#4.

[25] This 80% interim goal reflects the observation that the bulk of flaring will be fairly tractable to mitigate with proper planning of infrastructure development as new wells are drilled, etc., while only a portion of flaring will require longer lead times to eliminate. By way of comparison, North Dakota's Industrial Commission originally developed regulations to limit flaring in the second quarter of 2014, when the state was flaring between a quarter and a third of the gas it produced. As originally promulgated at in 2014, that rule mandated reducing the flaring *rate* to 15% in less by the beginning of 2016 – that is, in less than two years. Noting the difference between a standard for flaring rate and flaring volume, the aggressive schedule (a roughly 50% cut in the flaring rate over 2 years) in NDIC's original rules, which were developed in close consultation with industry, supports the 80% reduction over 5 years we suggest here.

[26] See EPA Natural Gas STAR Program (2011), *Options for Removing Accumulated Fluid and Improving Flow in Gas Wells*, (*available at* https://www.epa.gov/natural-gas-star-program/options-removing-accumulated-fluid-and-improving-flow-gas-wells).

At least two states have also put in place regulations requiring operators to generally use 'best practices' to minimize emissions, however these regulations lack clear performance standards and therefore their benefits are difficult to quantify.[27] More defined and enforceable emissions standards to eliminate unwarranted pollution from this practice are needed.

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Similarly, when aboveground equipment such as pipelines and compressors require maintenance, operators must depressurize the equipment before working on it. The quickest way to do this is to just dump the gas in the air, which some operators still do. However, numerous approaches have been identified to minimize emissions when depressurizing equipment, such as using specialized portable compressors to transfer gas out of equipment needing maintenance and into equipment not needing work.[28] Like wellbore liquids unloading, a few state regulations require operators to minimize emissions during these processes,[29] but these rules also generally only require operators to implement "best practices." As with liquids unloading, more defined and enforceable emissions standards are needed to eliminate unwarranted pollution from equipment blowdowns.

For our analysis of potential reductions from comprehensive regulations in 2025, **we assume a 60% reduction in emissions from venting during wellbore liquids unloading and equipment blowdowns.** We believe that a reduction of this magnitude is quite achievable with enforceable, quantitative standards, given the reductions in emissions from these sources that some firms/facilities have made, while emissions from other firms/facilities remain high. These policies could reduce emissions by **215,000 tons of methane** in 2025.

Results

We estimate that 2012 methane emissions from oil and gas systems were nearly 12 million metric tons of methane. This is based on the 2020 USGHGI estimate of 2012 emissions plus abnormal process conditions/super-emitters not captured in the Inventory, as described in Alvarez (2018).

If the current federal and state regulations (including changes finalized by EPA in 2020 and current state regulations) remain unchanged, we project that emissions in 2025 will be approximately 12 million metric tons of methane – roughly equal to 2012 emissions.

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[27] See 5 Colo. Code Regs. §§ 1001-9 D.II.G, and Wyoming Department of Environmental Quality (2018), *Oil and Gas Production Facilities, Chapter 6, Section 2 Permitting Guidance*, at 13 ("Blowdown/Venting") (*available at* http://deq.wyoming.gov/media/attachments/Air%20Quality/New%20Source%20Review/Guidance%20Documents/FINAL_2018_Oil%20and%20Gas%20Guidance.pdf).
[28] See Appendix for examples.
[29] See, e.g., Wyoming Department of Environmental Quality (2018), *Oil and Gas Production Facilities, Chapter 6, Section 2 Permitting Guidance*, at 13 ("Blowdown/Venting"), Pa. Dep't of Envtl. Prot., General Permit for Natural Gas Compression and/or Processing Facilities (Pennsylvania GP-5), Section A.9 (available at http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-105881/2700-PM-BAQ0205%20GP-5%20Permit%20SAMPLE.pdf) (requiring "Best Available Technology" to control air pollution to the maximum extent).

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However, with the measures discussed above in place, we project that oil and gas methane emissions in 2025 would be about four million metric tons – eight million metric tons lower than if current policies remain in place, and 65% lower than 2012 emissions. This projection is made using the "Reference" Scenario for oil and gas production in 2025, published in 2020 by the U.S. Energy Information Administration (EIA). Under this projection, 2025 oil production is expected to be 19% higher than in 2019, and 120% higher than in 2012; 2025 gas production is expected to be 14% and 54% higher than in 2019 and 2012, respectively. Despite the intense growth in hydrocarbon production, these measures dramatically reduce emissions, relative to past levels.

Table 2: Estimated Methane Emissions and Reductions (metric tons methane)

Source	**2012 Emissions Estimate**	**2025 Emissions Projections**		
		Emissions under current policy*	Emissions with 65% Policy	***Potential Reductions***
Leaks & Improper / Upset Condition Emissions **	5,684,000	5,589,000	1,112,000	*4,478,000*
Pneumatic equipment	2,297,000	2,487,000	136,000	*2,352,000*
Storage tanks	302,000	188,000	133,000	*55,000*
Well completions/ workovers	477,000	88,000	7,000	*81,000*
Compressors & dehydrators	673,000	687,000	105,000	*581,000*
Venting & flaring from oil wells	44,000	87,000	17,000	*69,000*
Maintenance venting	359,000	359,000	144,000	*215,000*
Other (not covered)	1,998,000	2,341,000	2,341,000	*0*
TOTAL	**11,835,000**	11,825,000	3,994,000	*7,831,000*

* Including changes finalized by EPA to NSPS Subpart OOOOa in late 2020 and current state regulations
** Includes abnormal condition emissions based on Alvarez 2018 and Marchese 2015

Alternatively, projected emissions in 2025 with these measures in place can be compared to expected emissions in that year with current policies in place. We estimate that these measures would reduce 2025 emissions by 66%, compared to expected emissions in that year under policies in place as of December 2020.[30]

[30] Emissions in 2025 will be substantially higher than under current policies, if the current administration succeeds in its current efforts to dramatically weaken the standards currently in place under NSPS Subpart OOOOa, as it

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We note that there is always significant uncertainty about the level of oil and gas production in future years. For example, it is possible that environmental policies will reduce demand for oil and gas, reducing prices and leading to decreases in production. In this case, emissions will be even lower under the policies described above. For example, in EIA's "Low Oil Price" scenario, with lower gas and production in 2025 than in the "Reference" scenario, 2025 oil and gas methane emissions would be more than 65% below 2012 emissions. Under certain other EIA scenarios, emissions would be even lower in 2025. However, EIA also publishes scenarios which project even higher oil and gas production in 2025 than anticipated in the "Reference" scenario; under those higher-production scenarios, 2025 emissions will be higher than we project under the "Reference" scenario.

Additionally, we can consider emissions if EPA takes a less ambitious path. For example, **if EPA revokes the changes made to NSPS OOOOa in 2020 and then implements nationwide existing source standards based upon NSPS OOOOa as it was finalized in 2016, emissions in 2025 would only be 22% lower than 2012 emissions levels**. Under this scenario, 2025 emissions would be five million metric tons higher than if the measures we call for above are implemented.

Finally, we note that further abatement of oil and gas climate and air pollution will be needed, beyond that described in this memo. The intention of this memo is not to fully examine all appropriate measures for reducing air pollution from this sector, but rather to demonstrate the feasibility of reducing oil and gas methane emissions 65% below 2012 levels by 2025. While examining measures beyond those described here is outside of the scope of this memo, the imperative for further reductions of methane from oil and gas, beyond 65%, is clear, given the importance of rapidly reducing climate pollution from all sectors. Additionally, oil and gas operations also emit very large amounts of carbon dioxide, the most important greenhouse gas, which also must be addressed as we work to mitigate climate pollution from the energy industry.

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has proposed to do. See Clean Air Task Force (2019), *Memo: Modeled impacts from EPA methane rollbacks* (Reference 4 above).

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Appendix

LDAR Regulations and Incorporation of New Leak Detection Technology. EPA, Canadian, and state / provincial leak detection and repair regulations generally require operators to either use OGI or EPA Method 21 to find leaks. However, many of these jurisdictions' regulations contain provisions which lay out criteria and a process for regulators to use to evaluate newer technologies for leak detection.

Examples:

- EPA New Source Rules (NSPS Subpart OOOOa): See 40 CFR §60.5398a. https://www.law.cornell.edu/cfr/text/40/60.5398a
- Colorado Regulations: See 5 Colo. Code Regs. §§ 1001-9 D.I.L.8. https://drive.google.com/file/d/16qTQLSTX1T49DYWp3voXRNl4_g-vbhQT/view?usp=sharing
- Canada: See Regulations Respecting Reduction in the Release of Methane and Certain Volatile Organic Compounds (Upstream Oil and Gas Sector), SOR/2018-66 (Can.) at 29(2), 35(1). https://laws-lois.justice.gc.ca/PDF/SOR-2018-66.pdf
- Pennsylvania: See Penna. Dept. of Enviro. Prot., General Permit GP-5A, § G.1.b. http://www.depgreenport.state.pa.us/elibrary/GetFolder?FolderID=36120

Recognizing the value of alternative methods of LDAR as a means of reducing the cost of methane mitigation, various entities have worked to better define how these technologies might be evaluated so that the process of determining whether a technology is equivalent to OGI or EPA Method 21 inspections at a given frequency is made more predictable for facility operators, developers of technologies, regulators, and other stakeholders.

For example, see:

- Center for Advanced Natural Gas Emissions Technology (CANGET) at Colorado State University. https://energy.colostate.edu/media/sites/147/2018/06/CANGET-White-Paper.pdf
- T.A. Fox *et al*. (2019), "A review of close-range and screening technologies for mitigating fugitive methane emissions in upstream oil and gas" *Environ. Res. Lett.,* **14** (053002). https://doi.org/10.1088/1748-9326/ab0cc3

Air Compressors Suitable for Solar-Power. These are developing rapidly in Canada, which has moved more aggressively than the U.S. to phase out traditional gas-powered pneumatic equipment.

- LCO Technology markets the Crossfire Instrument Air Compressor for exactly this purpose. https://lcotechnologies.com/crossfire-compressor.html
- Westgen Technology's Engineered Power on Demand (EPOD) unit is designed to provide sites with both compressed air and electricity. The unit derives most of its power from solar panels but supplements the solar with a

small gas-driven engine (needed particularly in Canadian winters).
https://westgentech.com/epod/

Canadian Provincial Regulations for Pneumatic Controllers. Both Alberta and British Columbia have regulations in place which will require very widespread use of non-emitting controllers (basically, electric controllers or air-driven pneumatic controllers) in future years.

- Alberta requires that beginning on 1 January 2022, 90% of all new controllers be non-emitting (electric or air-driven). This covers new controllers at new facilities, and new controllers at existing facilities that are installed on new equipment or simply used to replace older controllers as they wear out.
  See Alberta Energy Regulator Directive 060 § 8.6.1.
  https://www.aer.ca/documents/directives/Directive060_2020.pdf

- British Columbia requires that facilities such as wellsites and compressor stations that begin operations after 1 January 2021 cannot use any pneumatic controllers that vent gas to the atmosphere; additionally, operators of existing large compressor stations will no longer be allowed to use pneumatic controllers that vent to the atmosphere.
  See B.C. Regulation 282/2010, § 52.05.
  http://www.bclaws.ca/civix/document/id/regulationbulletin/regulationbulletin/Reg286_2018

Emissions from Well Completions Following Hydraulic Fracturing. The U.S. weighted average emissions factor for well completions after fracturing in the 2019 U.S. GHG Inventory (for completions in 2017) was ~4,700 kg methane per completion. Allen *et al.* (2013) studied emissions from well completions after hydraulic fracturing of gas wells extensively, carefully measuring emissions during 27 completions. (Data from these measurements is summarized in Table S1-6 of Allen *et al.* 2013.) While the average emissions per completion was 90 MCF per completion, several completions were well controlled with very low actual emissions. One completion (RM-7) only emitted 500 standard cubic feet (SCF) of gas, while another three completions (MC-3, -4, and -5) emitted 2,100 – 2,700 SCF per completion. We use a rough average of these three completions (roughly 2,500 SCF or about 50 kg methane per completion) to estimate emissions from well controlled completions, which is ~99% lower than the 2017 average emissions per completion.

Examples of Regulations for Dehydrators. While there are no federal methane standards for dehydrators, federal rules under section 112 of the Clean Air Act do limit hazardous air pollutants (HAPs) from some dehydrators: large dehydrators with high throughput and benzene emissions above a threshold, and smaller dehydrators located at a major source. See 40 CFR § 63.761. The stringency and applicability of those standards further depends on both the location and type of facility at which the dehydrator is located.

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State rules for dehydrators are also complex, with complicated variations in applicability and the required level of control based on location, installation date, and facility type. For example, see:

- Colorado: See 5 Colo. Code Regs. §§ 1001-9 D.I.H and D.II.D. https://drive.google.com/file/d/16qTQLSTX1T49DYWp3voXRNl4_g-vbhQT/view?usp=sharing

- Wyoming: See WYDEQ Oil and Gas Production Facilities Permitting Guidance (*last revised December 2018*) *at* 8, 9, 15, and 20. http://deq.wyoming.gov/media/attachments/Air%20Quality/New%20Source%20Review/Guidance%20Documents/FINAL_2018_Oil%20and%20Gas%20Guidance.pdf

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Reducing Emissions from Equipment Blowdowns. Numerous approaches have been developed to minimize emissions from blowdowns for maintenance, such as portable compression to transfer gas out of equipment requiring maintenance; modifications of compressors and other equipment so they can be kept pressurized when not running, and therefore not require blowdowns; equipment to allow operators to work on pipelines without blowing them down; devices to minimize the volume of pipeline requiring blowdown by inserting plugs; etc. For descriptions of these technologies, see:

- EPA Natural Gas STAR Program (2006), *Using Pipeline Pump-Down Techniques to Lower Gas Line Pressure Before Maintenance*. https://www.epa.gov/natural-gas-star-program/using-pipeline-pump-down-techniques-lower-gas-line-pressure-maintenance

- EPA Natural Gas STAR Program (2006), *Reducing Emissions When Taking Compressors Off-Line*. https://www.epa.gov/natural-gas-star-program/reducing-emissions-when-taking-compressors-line

- G. Jedrosko, "Venting Gas Recovery Systems and Gas Release Minimization Practices,"presented at Natural Gas STAR *Transmission and Storage: Partner Experiences in Methane Emissions Mitigation* Workshop, June 2018, Glen Allen, Virginia. https://www.epa.gov/natural-gas-star-program/venting-gas-recovery-systems-and-gas-release-minimization-practices

- V. Thompson, "Zero Emission Vacuum and Compressor (ZEVAC)," presented at Natural Gas STAR *Transmission and Storage: Partner Experiences in Methane Emissions Mitigation* Workshop, June 2018, Glen Allen, Virginia. https://www.epa.gov/natural-gas-star-program/zero-emission-vacuum-and-compressor-zevac-right-tools-can-change-operating

- A. Kapuga, "Utilizing Temporary Compression to Minimize Methane Emissions," presented at Natural Gas STAR *Transmission and Storage: Partner Experiences in Methane Emissions Mitigation* Workshop, June 2018, Glen Allen, Virginia. https://www.epa.gov/natural-gas-star-program/utilizing-temporary-compression-minimize-methane-emissions

- R. Loveless, "Methane Blowdown and Leak Mitigation Technologies on Pipelines and Compressor Stations," presented at Natural Gas STAR *Transmission and Storage:*

Partner Experiences in Methane Emissions Mitigation Workshop, June 2018, Glen Allen, Virginia.
https://www.epa.gov/natural-gas-star-program/methane-blowdown-and-leak-mitigation-technologies-pipelines-and-compressor

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