PATHWAYS FOR ALTERNATIVE COMPLIANCE

A Framework to Advance Innovation, Environmental Protection, and Prosperity

Environmental Defense Fund &
Environmental Council of the States
Shale Gas Caucus

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Contents

Executive summary

Leak detection and repair is a pressing concern for the oil and gas industry, as leaks profoundly undermine the industry's claim for part of the future energy mix. Companies are concerned about lost product, current and future regulations, and the impact on their reputations. State and federal authorities worry about damage to public health, climate change implications, and lost revenue. Innovators see a potential new market in solving all of these problems. Unfortunately, although the past couple of years have shown significant creativity in leak detection and repair strategies, many new technologies have stalled just past the pilot stage.

The challenge

The increasing pace of technological change poses both a challenge and an opportunity.

- Innovators and industry have said that lack of a pathway for approval of new methods as compliance tools for leak detection and repair is the single biggest barrier to investing in and deploying new solutions. Without a pathway for approval of new methods, innovation can slow or even stop once a regulatory mandate is established, with the result that best practice is frozen. For potential entrepreneurs serving the oil and gas industry, demonstrating approval as a compliance device, or at least a pathway to approval, is essential to securing the scarce resources that turn an idea into a commercial offering. A nonexistent, multi-year, or uncertain approval process may lock in legacy technologies, and inhibit operators from lowering the cost of compliance over time.

- For regulators, the broad and constantly changing array of potential new solutions can be daunting. They may question the quality of the data put forward by innovators, and lack the capacity to evaluate complex technologies and methods. Each regulator would need to match its ideal policy outcome with its legal authority, and engage other stakeholders such as local implementing and enforcing agencies, as appropriate.

The opportunity

Resolving these questions is necessary in order to to unleash the potential of innovation to achieve environmental protection and advance economic prosperity. There is uncommonly strong agreement among environmentalists, regulators, innovators, and operators that alternative compliance pathways are needed. Many new and different leak detection and repair solutions are already advertising themselves, and the pipeline of future innovation could be strong. All agree about the need to achieve environmental protection and economic growth at the lowest possible cost, because:

- Better technologies can achieve regulatory goals faster and at lower cost, and enable easier monitoring.
- Operators can lower their cost of compliance, report more effectively, and earn greater flexibility.
- Innovators can bring the best of the sensor and data revolution to solve environmental and business challenges.

This is a three-part report. The research questions were determined in collaboration with the Environmental Council of the States Shale Gas Caucus, and industry representatives, technology innovators, environmentalists, and federal regulators.

Lessons learned

We review applicable policies in six states and a rule promulgated by the U.S. Environmental Protection Agency (EPA). Colorado and EPA are the only jurisdictions with an express and existing pathway for the approval of alternatives. The experience with these constructive attempts offers lessons learned for those and other jurisdictions.

- The first and most important question raised by all stakeholders was how to demonstrate equivalency between the regulatory mandate and new methodologies. It is difficult to assess new techniques against the percentage reductions in emissions projected as the impact of current best practice. This pronounced difficulty is due to the shift from close-range technologies used on a fixed schedule to continuous or mobile approaches deployed over broader space and time.
- The process for approvals, even with recent revisions, is still considered too uncertain and slow by some. To promote confidence in the system, concerns about privacy need to be balanced with the goals of transparency and opportunity for public input.
- The consequences of an approval, for example on obligations to

inspect and report, can make a significant difference in the value of an approval, and therefore the incentive for operators and innovators to create new solutions in the first place. Stakeholders questioned how broadly an approval extends—one site at one operator, multiple sites of one operator, or even multiple similar sites and sources from different operators.
- Demand for innovation is also influenced by whether there is an off-ramp for the old approach, once a new methodology is approved, and whether new reporting and monitoring strategies may adapt to take advantage of technology capabilities. Many new digital technologies could allow operators to report more easily and more precisely on their own emissions, and give regulators faster and easier insights.
- Finally, the fact that an approval in one state may not advance an application in another jurisdiction dramatically reduces the potential market for innovation and discourages investment.

Evaluation Framework

We define a mathematical, technology-neutral framework for comparing emission reductions of different practices. It is important to note that the framework, and this report in general, concern methodologies, not technologies. The approach that reduces the most emissions in a given circumstance may combine different technologies used at different times and for different purposes. Even for one technology, the mitigation actions that the information triggers determine the emissions impact, not the technology specifications.

Recommendations

This evaluation framework can be applied in a regulatory process and as a tool to facilitate interjurisdictional collaboration:

- States and federal agencies can adopt the same model for evaluation of equivalency in leak detection and repair methodologies. Agencies can make their default approvable ranges for critical model inputs public, and even if they have different ranges, this still gives innovators and operators clearer goalposts for performance.
- A transparent and rapid process is also essential to encourage innovation and maintain public confidence.
- Allowing approved methodologies to be used as broadly as scientifically justified, providing an off-ramp for the status quo best practice, and allowing modified reporting and monitoring would all encourage innovation without sacrificing environmental impact.
- Finally, jurisdictions can collaborate to take advantage of the work done in prior assessments, increasing the potential market for new solutions and therefore encouraging investment in better leak detection and repair.

At heart, a regulatory framework that encourages innovation takes advantage of the fact that technology makes it faster and cheaper to understand the world, and creative methods using these new technologies can enable better detection, mitigation, and monitoring to reduce waste and protect the environment.

Regulatory context

EPA and Colorado have promulgated rules that allow for approval of novel leak detection methods. Since these two rules form the basis of established best practice, and experience with those rules has revealed opportunities for improvement, we summarize these rules in detail below. Other states with leak detection and repair requirements on oil and gas are also summarized.

EPA

In 2016 EPA finalized a rule that requires broad reductions in volatile organic compounds (VOCs) and methane from a suite of oil and gas equipment.[1] A key element of this rule is a requirement that oil and gas operators inspect for leaks at well sites, gas processing plants, and compressor stations. This "fugitive emissions monitoring" provision requires the use of either an optical gas imaging camera (OGI) or a Method 21 device.[2] Alternatively, owners or operators of well sites and compressors,[3] or, in the case of gas processing plants,[4] manufacturers, may apply to EPA for approval to use another means to conduct these inspections.

EPA's fugitive emissions monitoring requirement is a work practice standard. The Clean Air Act (CAA) authorizes EPA to establish work practice standards instead of standards of performance where "it is not feasible to prescribe or enforce a standard of performance."[5] The CAA further authorizes EPA to approve of alternative work practice standards provided that such standards "will achieve a reduction in emissions of any air pollutant at least equivalent to the reduction in emissions of such air pollutant achieved" under the required work practice standard.[6] Accordingly, any alternative method for

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[1] Envt'l Protection Agency, Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources, 81 Fed. Reg. 35824, 35861 (June 3, 2016) (final rule).
[2] 40 C.F.R. §§ 60.5397a(c)(2).
[3] 40 C.F.R. §§ 60.5398a(c), 60.5402a(c).
[4] Id. at § 60.5402a(c).
[5] 42 U.S.C. § 7411(h)(1).
[6] 42 U.S.C. § 7411(h)(3).

conducting fugitive emissions monitoring must achieve at least equivalent emissions reductions as inspections conducted using OGI or a Method 21 device.

Per EPA's 2016 rule, operators wishing to use an alternative fugitive emissions monitoring method must provide detailed information in order to demonstrate that the alternative qualifies as an alternative work practice standard.

First, the applicant must collect, verify, and submit 12 months of test data in its application.[7] This is the information upon which EPA relies in order to determine equivalency. In addition, the applicant must provide detailed information related to the alternative method. This information includes, but is not limited to, a description of the technology or process,[8] initial and ongoing quality assurance/quality control measures,[9] field data verifying viability and detection capabilities of the technology or process,[10] operation and maintenance procedures,[11] restrictions for using the technology or process,[12] and initial and continuous compliance procedures, including recordkeeping and reporting.[13]

All applications for alternative fugitive emissions monitoring are subject to public notice, hearing and comment.[14] As of August 2018, no applications had been made public. The rule does not provide a deadline by which EPA must publish an application for comment or make a final determination. In the final rule, EPA noted that it "intends" to publish a complete application within six months of receipt[15] and that it "intends" to make a final determination within six months after the the public comment period closes.[16] EPA's final determination[17] is published in the Federal Register along with the grounds for the determination. EPA may attach conditions of approval to an alternative work practice standard as necessary to ensure it meets the requirements of the rule and the CAA.[18]

Colorado

In 2014, Colorado became the first U.S. jurisdiction to promulgate a rule requiring comprehensive and robust reductions in methane from a suite of oil and gas equipment and facilities.[19] A hallmark provision of this rule is the requirement that operators inspect for leaks at various intervals, including quarterly and monthly.[20] The inspection interval is tied to production capability; larger-producing sites are subject to more frequent inspections. Per the rule, operators may use either an infrared camera, Method 21, or an alternative approved instrument monitoring method (AIMM) or program (alternative AIMM).[21] The 2014 alternative AIMM provision applied to well production

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7 40 C.F.R. at §§ 60.5398a(d)(1), 60.5402a(d)(1).
8 Id. at §§ 60.5398a(d)(1)(i), 60.5402a(d)(2)(i).
9 Id. at §§ 60.5398a(d)(1)(v), 60.5402a(d)(2)(v).
10 Id. at §§ 60.5398a(d)(1)(vii), 60.5402a(d)(2)(vii).
11 Id. at §§ 60.5398a(d)(1)(xi), 60.5402a(d)(2).
12 Id. at §§ 60.5398a(d)(1)(x), 60.5402a(d)(2)(x).
13 Id. at §§ 60.5398a(d)(1)(xii), 60.5402a(d)(3).
14 Id. at § 60.5398a(b), (e); § 60.5402a(b); 81 Fed. Reg. at 35861.
15 Id. at § 60.5398a(b), (e); § 60.5402a(b); 81 Fed. Reg. at 35851.
16 Id. at § 60.5398a(e); 81 Fed. Reg. at 35861.
17 Id.
18 Id. at § 60.5398a(f)(2).
19 CDPHE, Alternative AIMM Guidance and Procedures, p. 1 (May 31, 2018) (accessible at https://drive.google.com/file/d/1reFIFX_DVI_Wcu82853NNekmhjOtljui/view); see generally AQCC Reg. 7.
20 AQCC Reg. 7, §§ XVII.F.3.c, XVII.F.4.b, XVIIIF.2.a, XVIII.F.2.b.
21 AQCC Reg. 7, § XVII.A.2.

facilities and compressor stations in the gathering and boosting segment of the natural gas supply chain in the state. Owners or operators who opt to use a continuous emission monitoring system may apply to the Air Pollution Control Division (Division) for approval of a streamlined inspection, recordkeeping, and reporting program.[22]

While the 2014 rule allowed for the use of alternative AIMM, the rule provided no criteria to guide the approval process. Rather, the Division provided information related to the approval process, including the type of information applicants wishing to use alternative AIMM must supply to the Division, in a guidance document.

In terms of approval criteria, Colorado's alternative AIMM rule requires that an alternative AIMM be able to demonstrate that it is capable of achieving emission reductions that are at least as effective as the emissions reduction achieved using an infrared (IR) camera or EPA Reference Method 21.[23] In addition, the proposed alternative must be commercially available.[24] Applicants must provide detailed information on the alternative technology or method, including but not limited to, its limitations, the process for recordkeeping, whether it has been approved of for other applications or by other regulators, and any modeling results or test data.[25] Applicants must describe where they propose to use the alternative method. Information about weather may be relevant to any limitations or restrictions in use of the alternative and must be provided if this is the case.

Colorado allows manufacturers of alternative AIMM as well as operators to apply to gain approval for an alternative AIMM. Once approved, an AIMM may be used by any operator in Colorado to comply with well production facility and compressor station LDAR inspections, and operators may cease using the prior work practice. In addition, approved AIMM may be used to conduct inspections of pneumatic controllers in the Denver nonattainment area.[26] Since 2014 Colorado has approved two alternative AIMM: the Pixel Velocity Automated Hydrocarbon Leak Detection System and the Rebellion Photonics Gas Cloud Imager.[27] Pixel submitted its application for approval of its continuous emission monitoring system on May 31, 2016. After it had email and phone conversations and received supplemental information, the Division approved Pixel's application slightly under one year later, on May 17, 2017. The Division attached nine conditions of approval, including that an owner or operator wishing to use Pixel's monitoring system may apply for a streamlined recordkeeping and reporting program.[28]

In 2017 Colorado made revisions to its state implementation plan (SIP) for ozone. The CAA requires that SIPs and SIP elements be subject to EPA approval and public notice and comment.[29] When Colorado added the alternative AIMM provision to its SIP, it made the alternative AIMM federally enforceable. Accordingly, applications to use an alternative AIMM in the Denver ozone nonattainment area are subject to public notice and comment and an EPA approval process in addition to approval by the Division.[30] Due to stakeholder concerns about potential delays in EPA approval, the rule specifies that the Division will consider EPA inaction on an application after six months to constitute approval.[31] Applicants wishing to use an alternative AIMM outside of the ozone nonattainment area do not need to comply with the new notice and comment procedures, nor obtain EPA approval. The same approval criteria and informational requirements apply to applicants wishing to use an alternative AIMM in the ozone nonattainment areas and to those wishing to use an alternative AIMM outside of the nonattainment area.

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[22] Id.
[23] Id. at § XII.L.8.a(ii)(I); CDPHE, Alternative AIMM Guidance and Procedures, p. 1 (May 31, 2018) (accessible at https://drive.google.com/file/d/1reFIFX_DVI_Wcu82853NNekmhjOtljui/view).
[24] Id. at § XII.L.8.a(ii)(B); Alternative AIMM Guidance and Procedures, p. 2.
[25] Id. at § XII.L.8.a(i); Alternative AIMM Guidance and Procedures, p. 1.
[26] Alternative AIMM Guidance and Procedures, p. 1.
[27] Letter from Jennifer Mattox, CDPHE, to Robert Kester, Rebellion Photonics (Jan. 15, 2015) (accessible at https://www.colorado.gov/pacific/sites/default/files/AP-BusIndGuidance-AIMMapprovalRebellion.pdf); Letter from Jennifer Mattox, CDPHE, to Heather Grisham, Pixel Velocity (May 17, 2017) (accessible at https://www.colorado.gov/pacific/sites/default/files/AP-BusIndGuidance2-AIMMapproval_Pixel_Velocity.pdf).
[28] Letter from Jennifer Mattox to Heather Grisham.
[29] 42 U.S.C. § 7410.
[30] AQCC Reg. 7, § XII.L.8.
[31] Id. at § XII.L.8.a.(v).[32] PADEP, Gen. Plan Approval and/or Gen. Operating Permit BAQ-GPA/GP-5 (March 2018) (accessible at http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=12967&DocName=FINAL%20DRAFT%20GP-5%20-%20NATURAL%20GAS%20COMPRES SION%20STATIONS%2C%20PROCESSING%20PLANTS%2C%20AND%20TRANSMISSION%20STATIONS.PDF%20%20%3Cspan%20 style%3D%22color%3Ablue%3B%22%3E%3C%2Fspan%3E); PDEP, Gen. Plan Approval and/or Gen. Operating Permit BAQ-GPA/GP-5A (June 2018) (accessible at http://www.depgreenport.state.pa.us/elibrary/GetDocument?docId=19615&DocName=02%20GP-5A%20UNCONVENTIONAL%20NATURAL%20GAS%20WELL%20SITE%20OPERATIONS%20AND%20REMOTE%20PIGGING%20STATIONS%20 GENERAL%20PLAN%20APPROVAL%20AND/OR%20GENERAL%20OPERATING%20PERMIT.PDF%20%20%3Cspan%20style%3D%22color:blue%3b%22%3E%28NEW%29%3C/span%3E).

Pennsylvania

The Pennsylvania Department of Environmental Protection (PADEP) recently finalized two General Permits that require operators to reduce methane, VOC, and hazardous air pollutant emissions from a suite of equipment found at well sites, pigging stations, gas processing plants, and compressor stations.[32] A key element of these permits is a requirement that operators inspect for leaks on a quarterly basis. Operators of well sites and pigging operations may reduce the inspection frequency based on the percentage of leaking components detected over time. Operators may use an OGI camera, EPA Method 21, or an approved alternative.[33]

Any operator wishing to use the General Permits to authorize construction of a well site, compressor station, or gas processing may apply to use an alternative approved device for the purposes of conducting leak detection and repair (LDAR) inspections. However, it is not clear what the approval process would look like. Unlike Colorado and EPA, Pennsylvania has yet to develop a clear approval pathway; there is no rule governing the approval of alternative technologies or methods and PADEP has not issued any guidance materials. PADEP is currently working on developing guidance materials to provide criteria and informational requirements that will govern the alternative LDAR methods and technology approval process for new sources using the General Permits.

PADEP is also developing a separate rule that will require emission reductions from existing sources, including sources of fugitive emissions.[34] PADEP has broad authority to allow for the use of alternative LDAR methodologies. Pursuant to the Air Pollution Control Act, PADEP can "require the owner or operator of any air contamination source to install, use and maintain such air contaminant monitoring equipment or methods as the department may reasonably prescribe" and to "require the owner or operator of any air contamination source to sample the emissions thereof in accordance with such methods and procedures and at such locations and intervals of time as the department may reasonably prescribe and to provide the department with the results thereof."[35] Accordingly, when PADEP proposes a rule to require LDAR inspections at existing sources, it may include a robust compliance approval pathway for emerging methodologies.

Wyoming

Wyoming requires operators to inspect for leaks of VOCs on a quarterly basis at new and existing well sites in the Upper Green River Basin (UGRB) ozone nonattainment area if fugitive VOC emissions are equal to or greater than 4 TPY; otherwise semiannual monitoring is required. Semiannual monitoring is required for new and modified well sites in

[33] Gen. Plan Approval and/or Gen. Operating Permit BAQ-GPA/GP-5, p. 17; Gen. Plan Approval and/or Gen. Operating Permit BAQ-GPA/GP-5A, p. 18.
[34] PADEP, A Pa. Framework of Actions for Methane Reductions from the Oil and Gas Sector, p. 3 (Jan. 19, 2016) (accessible at http://files.dep.state.pa.us/Air/AirQuality/AQPortalFiles/Methane/DEP%20Methane%20Strategy%201-19-2016%20PDF.pdf).
[35] 35 P.S. § 4004(5),(6).

all other areas of the state. Quarterly inspections are also required for existing compressor stations in the basin, and for new and modified compressor stations in the basin and in all other areas of the state.[36] Operators of existing sites in the UGRB may use either OGI, Method 21, audio-visual-olfactory (AVO) inspections, other instrument-based technologies, or some combination of the above.[37] Operators of new and modified sites in the UGRB and the rest of the state are required to use optical gas imaging, Method 21, or an EPA-approved alternative method.[38]

In 2018, Wyoming updated its Oil and Gas Permitting Guidance to reflect that Wyoming will allow use of EPA-approved alternative fugitive emissions monitoring methods. Accordingly, applicants wishing to use an alternative method must demonstrate that it is an EPA-approved method. The Wyoming Department of Environmental Quality has yet to receive an application to use any alternative fugitive emissions monitoring technology or methods.[39]

Ohio

Ohio requires operators to conduct LDAR inspections at well sites and compressor stations. In Ohio, all control requirements must demonstrate Best Available Technology (BAT).[40] The Ohio EPA has determined that LDAR conducted with either a Forward Looking Infrared Camera or Method 21 is the current BAT. Pursuant to two General Permits, operators must use one of these two methods.[41] Because neither General Permit includes a provision allowing for the use of alternatives, operators must apply for an individual permit for each facility where the operator wishes to use the alternative method. An alternative LDAR would need to demonstrate that it constitutes BAT.[42]

A request to use an alternative LDAR as part of an individual permit application is noticed.[43] The public has an opportunity to request a hearing on the permit and may submit comments at the hearing or in writing.[44] The issuance or denial of a permit is a final agency action and can be appealed.[45] Ohio has yet to receive a request to use a non-standard LDAR approach.

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[36] Wyo. Air Quality Standards & Regs. Ch. 8, § 6(g)(i); WDEQ, Oil and Gas Prod. Facilities Chap. 6, Sec. 2 Permitting Guidance, pgs. 13, 16, 22 (December 2018) (accessible at http://deq.wyoming.gov/media/attachments/Air%20Quality/New%20Source%20Review/Guidance%20Documents/FINAL_2018_Oil%20and%20Gas%20Guidance.pdf; see also OOOOa as published in 81 Fed. Reg. 35824-35941 (June 3, 2016).

[37] Wyo. Air Quality Standards & Regs, Ch. 8, § 6(g)(i)

[38] WDEQ, Oil and Gas Prod. Facilities, Chap. 6, Sec 2, Permitting Guidance, pgs 13, 16, 22; WDEQ, Response to Comments, pg 5 (Response 11) and pg 8 (Response 1) (December 2018) (accessible at http://deq.wyoming.gov/media/attachments/Air%20Quality/New%20Source%20Review/Guidance%20Documents/FINAL_2018%20Response%20to%20Comments.pdf

[39] Email correspondence from Josh Nall, NSR Permitting Supervisor, Wyo. Dept. of Envt'l Quality (Apr. 30, 2018).

[40] OAC 3745-31-05(A)(3).

[41] Ohio EPA, General Permit 12.1 Template, pp. 42-46 (accessible at https://epa.ohio.gov/Portals/27/oil%20and%20gas/GP12.1_PTIOA20140403final.pdf); Ohio EPA, General Permit 18.1 Template, p. 5 (accessible at http://epa.ohio.gov/Portals/27/genpermit/GP18.1_TVF20170223.pdf).

[42] Id. (for permit approval, facility must employ BAT); See also Ohio. R.C. § 3704.03(T)(Requiring new and modified sources install BAT, with some exceptions).

[43] OAC 3745-31-29(D), 3745-31-06(H); Email correspondence from Mike Hopkins.

[44] Id. at 3745-31-06(H).

[45] Id. at 3745-31-29(D)(1), (D)(4); Email correspondence from Mike Hopkins.

For Ohio to facilitate alternative LDAR methods at new sources, it would need to revise its General Permits to specifically allow for the use of alternative methods. This would require a public notice and comment period, but not a rulemaking.[46] In order to allow for the use of alternative methods at existing sources, Ohio would need to promulgate a new rule. In practice, Ohio would also need to enable applications that encompass more than one facility.

California

The California Air Resources Board (CARB) finalized a comprehensive rule in 2017 that regulates methane from a suite of equipment at new and existing, upstream and midstream facilities.[47] The rule includes an LDAR provision that requires operators to conduct quarterly inspections at well sites, gas processing plants, natural gas storage facilities, and compressor stations using Method 21.[48]

While the rule does not allow for the use of alternative methods to conduct LDAR inspections at this time, CARB has acknowledged that it may revise its rule in the future to do so. Specifically, in response to comments suggesting that CARB allow for the use of alternatives, CARB noted:

> [C]ARB staff has also been in close contact with a number of instrument manufacturers, some of which have been developing newer instruments or newer types of technologies to speed up testing or provide for automated measurements. Throughout implementation of the regulation, staff plans to continue working with instrument manufacturers and perform studies to evaluate the effectiveness of these newer instruments or technologies, and to determine how they compare with Method 21. Given the results of these studies, staff may find a need to make future modifications to the regulation to allow for the use of these instruments.[49]

We identified no statutory barriers to CARB including a provision in its rule that allows for the approval of alternative LDAR technologies. Indeed, such a provision would be in line with the legislature's intent to "invest in the development of innovative and pioneering technologies"[50] in order to help California meet its GHG reduction goals and consistent with California's demonstrated leadership in implementing a suite of measures, including regulations and market-based compliance measures, to tackle climate change.

A change to the rule allowing for the use of alternative LDAR methods in addition to Method 21 would require CARB approval and be subject to public notice and comment.[51]

In addition, in order to ensure early detection of large leaks, such as the one that occurred from the Aliso Canyon storage facility in 2016, owners and operators of underground natural gas storage facilities must install continuous air monitoring to measure upwind and downwind ambient concentrations of methane and conduct daily screenings or continuous leak screenings at each injection/withdrawal wellhead assembly and attached pipelines.[52] Daily screenings may be conducted using Method 21, OGI, or "other natural gas leak screening instruments approved by the [C]ARB Executive Officer."[53] These daily screenings are separate from the quarterly LDAR Method 21 inspections, as screenings are limited to injection/withdrawal wellhead assembly and attached pipelines and are intended to "pinpoint a blowout or large leak at the well head assemblies," whereas LDAR inspections apply to other equipment at a facility "such as separator and tank systems, natural gas compressors, and other piping systems or components."[54] The daily or continuous monitoring requirement specifically allows for alternative compliance applications, although no specific guidance has been issued.

[46] Id. at 3745-31-06(H).
[47] 17 C.C.R. § 95665 et seq. (2017).
[48] Id. at § 95669(g).
[49] Id. at 106.
[50] West's Ann.Cal.Health & Safety Code § 38501(e).
[51] West's Ann.Cal.Health & Safety Code § 38500 et seq.
[52] Id. at § 95668(h)(5)(A), (h)(5)(B).
[53] Id. at § 95668(h).
[54] State of Cal. Air Res. Bd., Final Stmt. of Reasons, Reg. for Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities, p. 76 (May 2017) (accessible at https://www.arb.ca.gov/regact/2016/oilandgas2016/ogfsor.pdf).

Demonstrating equivalency over space and time

The primary question raised by stakeholders regarding approval of alternative methodologies concerned how to demonstrate equivalency. As of now, the question can only be asked of the Colorado and EPA rules, since these are the only two with clear and detailed approval pathways. The risk for regulators is that uncertainty regarding how to determine equivalency prompts the reviewing agency to reject an application, or even dissuade applicants in the first place. The risk for an operator or innovator is both that the proposed solution will not be approved, and that it will be approved, but the standards for approval will be so lax that the proposed solution will be underbid by less scrupulous competitors. This risk essentially dissuades innovators and operators from investing in the development of new solutions.

"The first step in determining equivalency is to understand: equivalent to what?"

The first step in determining equivalency is to understand: equivalent to what? In the final technical support document accompanying the adoption of its LDAR requirements, EPA determined that semi-annual inspections using OGI will reduce leaks by 60%.[55] For compressor stations, EPA determined an 80% reduction.[56] In coming to this conclusion, EPA considered the required inspection frequency, size of leaks detectable using both types of technology, and anticipated emissions reductions associated with repairs.

Colorado undertook essentially the same methodology in estimating anticipated emission reductions associated with its tiered LDAR requirements. The Division estimated that monthly inspections can reduce leak emissions by 80%, quarterly inspections can reduce such emissions by 60%, and semi-annual inspections can reduce emissions by 40%.[57] The Division assumed that Method 21 inspections were equally as effective in reducing leaks as IR camera inspections.[58]

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[55] U.S. EPA, Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources, Background Tech. Supp. Doc. for the Final NSPS, 40 CFR Part 60, subpart OOOOa, p. 41 (May 2016) (accessible at https://www.regulations.gov/document?D=EPA-HQ-OAR-2010-0505-7631).
[56] TSD at p. 49.
[57] Regulatory Analysis for Proposed Revisions to Colorado Air Quality Control Commission Regulation Numbers 3, 6 and 7 (February 11, 2014) (accessible at file:///C:/Users/anowlan/Downloads/RegulatoryAnalysisAttachment2013-01217.PDF)
[58] Id.

These statements of efficacy of OGI and Method 21 form the most detailed information available to operators or innovators interested in demonstrating the effectiveness of their proposed alternative methodologies. Prospective applicants must aim to demonstrate equivalent or greater reductions—40%, 60%, or 80%, according to the frequency and the target facility of the LDAR they seek to replace.

Feedback from stakeholders indicates that it is very difficult to assess leak detection methodologies and arrive at a metric of reductions required by these percentage targets. Public data are lacking about the size and timing of leaks to be expected for different kind of facilities or equipment—the base case scenario that any alternative would be compared against. It is also currently expensive and onerous to quantify methane emissions in the field. As a result, both the status quo and proposed impact of new methodologies are difficult to assess and compare.

For operators wishing to obtain approval for an alternative AIMM in Colorado, demonstrating equivalency appears even less clear. Colorado approvals apply to any facility, and the type of LDAR program required for each facility differs depending on type and production capability (or, in the case of compressor stations, capacity). Accordingly, an applicant wishing to obtain approval for an alternative AIMM may not know if the alternative must demonstrate a 40% or a 60% reduction in emissions. In addition, as Colorado and EPA estimate different emissions reductions from the same LDAR frequency, equivalency becomes even more complex.

The differences in the types of leak inspection methods being developed and the manner in which they can be deployed to identify leaks poses a challenge to the goal of developing and evaluating alternative LDAR methods. EPA and state LDAR requirements all prescribe the use of certain leak inspection technologies (e.g., infrared cameras) and the manner in which such technologies must be used (e.g., four times a year at one facility). The effectiveness of these LDAR requirements in reducing emissions is predicated on assumptions regarding the efficacy of the combination of the technology and the frequency of inspections, as well as assumptions regarding the efficacy of repairs. Emerging LDAR methods often are predicated on different types of technologies (e.g., lasers rather than optical gas imaging devices) and are deployed in a different manner (e.g., continuously at one location, or over broad geographies at great frequency). This poses a challenge to regulators attempting to compare anticipated emission reductions from very different types of technologies and leak detection methods.

Most traditional leak detection methods involve very close-range, individual evaluations of particular equipment, repeated on a fixed schedule. New continuous and mobile solutions cover larger geographic areas or are deployed over a longer period of time, or both. For example, mobile-based technologies affixed to a plane or vehicle are capable of inspecting multiple facilities a day, whereas a human holding a handheld device may only be able to get to one or two facilities per day. Continuous monitors can prompt a repair when a leak is detected, which nearly eliminates the time a leak continues unabated, and therefore dramatically reduces the associated emissions. The best methods likely combine instruments, for example by using an instrument with a high detection threshold to prompt a survey by a more sensitive handheld instrument. Independent test data used as inputs for sophisticated modeling can enable comparison of alternative methodologies that take advantage of the capabilities of new technologies and ways to combine them over space and time. However, regulators and operators both point to the time and expertise required to evaluate potential methodologies and model emissions reductions; little staff capacity exists for these new and important roles.

Process concerns and barriers

A number of stakeholders have raised questions regarding procedural elements of the approval of alternative leak detection methods. Questions of particular concern involve how much of an application will be public and whether regulators can assist applicants. The ideal balance here combines protection of business information to the minimum extent necessary, with transparency and opportunities for public comment, to maintain confidence in the system and ensure the environmental protection goals are being met.

In Colorado, whether an application to use an alternative LDAR approach is subject to public notice and comment depends on whether or not the alternative will be used solely outside the ozone nonattainment area. Alternatives that will be used solely outside the ozone nonattainment area are not made public.[59] By contrast, applications to use an alternative LDAR method in the ozone nonattainment area are subject to notice and comment procedures.[60] For such applications, all of the application, the Colorado Air Pollution Control Division's preliminary analysis, and the draft permit to be filed are public and subject to public comment.[61] Applicants can request that portions of an application remain confidential under the Division's confidential business information policy. Applicants must mark any information as "confidential business information." Information so marked will not be posted publicly on the Division's website.[62] The Colorado rule does not contain appeal procedures, so it is unclear whether or not a CDPHE or EPA approval decision, or failure to make a decision, may be appealed.

Stakeholders have also requested information regarding whether regulators interact with potential applicants. The Division can and does interact with potential applicants. In the case of the approval of the Pixel LDS, the Division corresponded with the applicant via conference call and e-mail four times following the applicant's original application.[63]

EPA also makes applications for alternative work practices public. EPA must publish the application, accept public comment, and publish its final determination including reasons for the denial or approval. EPA's decision with respect to an application to use an alternative work practice standard constitutes final agency action.[64] Accordingly, pursuant to the CAA, applicants may appeal the decision.[65]

Use of an approved method

The question of how broadly an approved alternative may be employed has significant implications for the market for that alternative, and consequently, the investment an innovator or operator will likely make in developing an alternative. On the other hand, a regulator is concerned with ensuring that an alternative is employed only in circumstances where the data support that equivalent reductions can be expected. For states that operate via permits at each facility, there may be structural limitations to approving an alternative methodology for multiple operators or facilities in one decision.

In Colorado, the approval is for a technology or a method — not for an individual operator or facility.[66] Accordingly, an approved method can be used by any operator of a non-Title V facility. Operators of Title V facilities must be specified within each Title V operating permit, and an operator of a Title V facility must first request a modification or revision to its permit before being able to use an alternative AIMM.[67]

[59] Alternative AIMM Guidance and Procedures, p. 7.
[60] AQCC Reg. § 7.XII.L.8.a(iv).
[61] AQCC Reg. § 3 Part B.III.C.4.
[62] CDPHE, Alternative AIMM Public Notices (accessible at https://www.colorado.gov/pacific/cdphe/air/alternative-aimm-public-notices).
[63] Letter from Jennifer Mattox to Heather Grisham, p. 1.
[64] 42 U.S.C. § 7607(b)(1).
[65] Id.
[66] Alternative AIMM Guidance and Procedures, p. 8.
[67] CDPHE, Approved Instrument Monitoring Method (AIMM) for Oil and Gas (accessible at https://www.colorado.gov/pacific/cdphe/AIMM).

Under the EPA rule, an approval of an alternative means of emissions limitation constitutes a required work practice, equipment, design or operational standard within the meaning of 42 U.S.C. 7411(h).[68] The 111h standards, once adopted, are treated as standards of performance.[69] Standards of performance apply to sources, not individual facilities.[70] Accordingly, although not explicitly stated it would appear that once EPA approves an alternative it may be used at any source, not just by the owner or operator of a particular facility or group of facilities that applied.

Consequences for recordkeeping, reporting, and monitoring

Many stakeholders indicated that new technologies can change the way recordkeeping and reporting is done. Many new technologies send data electronically to analytics databases and dashboards. A significant area of shared interest would be to take advantage of capabilities of new technologies to reduce the recordkeeping and reporting burden on operators and improve transparency to regulators. For example, in Colorado, approved continuous monitoring AIMMs are eligible for approval of a streamlined inspection, recordkeeping, and reporting program.[71]

Some stakeholders have expressed concern regarding how a regulator would enforce an alternative LDAR provision. For example, during the rule development in California, CARB considered allowing operators to use optical gas imaging cameras in addition to Method 21 devices. Local air districts, which are responsible for implementing the regulation, expressed concern regarding enforcement of non-quantitative leak detection methods. Local air districts currently have rules requiring the inspection and repair of VOC leaks using Method 21 only. Concerns about enforceability ultimately resulted in California not including a pathway for alternative compliance methodologies, despite stakeholder requests that it do so.

Regulator and implementing agency (if different from the regulator) comfort with the enforceability of new methodologies is therefore an important aspect to consider when advocating for a rule that allows alternative applications, and in the context of individual applications when the rules permit them. This is another area where the capabilities of new technologies, deployed creatively, could be used to build consensus between operators, innovators, and regulators. For example, ongoing monitoring or verification, such as continuous monitoring at a representative subset of facilities, could give both regulators and operators much-needed data to demonstrate that new methodologies are working and offer opportunities for improvements if results do not live up to expectations.

Reciprocity with other jurisdictions

Given the time and effort required for approval in one jurisdiction, and the fact that oil and gas operations are spread across the country and around the world, reciprocity between jurisdictions offers a powerful tool to build the market, encourage innovation, and reduce the burden on any one regulator. Already in Colorado, approval by other jurisdictions or use for other purposes (such as pipeline leak monitoring) is a factor the Division considers when reviewing alternative AIMM applications.[72] However, approval by other jurisdictions or use for other purposes is not per se grounds for approval. Other state regulators also indicated that they would consider approvals granted by other regulators as relevant information when assessing alternative LDAR methods to be used for compliance with state rules. The technology comparison framework below, and recommendations concerning a shared model, are intended to facilitate this interjurisdictional collaboration.

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[68] 40 C.F.R. § 60.5398a(f)(2).
[69] 42 U.S.C. § 7411 (h)(5) (providing that "[A]ny design, equipment, work practice, or operational standard, or any combination thereof, described in this subsection shall be treated as a standard of performance for purposes of the provisions of this chapter (other than the provisions of subsection (a) of this section and this subsection.")
[70] Id. at § 7411(b)(1)(B)(providing that standards of performance for new sources within such category).
[71] Id. at §§ XII.B.3, XVII.A.2.
[72] Id. at §§ XII.B.3, XVII.A.2.

Technology comparison framework

In this section, we describe a technology comparison framework that provides a clear, transparent, and scientifically rigorous approach to compare diverse leak detection methods based on their estimated emission reductions. In summary, the framework uses a combination of empirical data and standardized assumptions to model the impact of leak detection methods and associated repair protocols on aggregate emissions from a population of facilities. The framework adheres to several principles:

1. **Technologies are assessed as part of an LDAR protocol.** Leak detection technologies do not reduce emissions alone but instead provide stakeholders with data that informs mitigation. In order to estimate emission reductions, it is necessary to determine both which emission sources are detected and the mitigation actions that are triggered when emissions are detected. For example, some detected emissions may be intentional, vented sources or judged too small to cost-effectively repair. The evaluation process must include a clear protocol that describes how data provided by the technology lead to actions to mitigate those emissions, including decisions about which sources to repair and the time required between detection and mitigation.

2. **Emission reductions are determined in aggregate.** O&G emission sources have highly skewed distributions at both the component and site level, with the top 5% highest emitting sources typically accounting for over half of the total emissions from that source.[73] Many of these high emitting sources are

"Leak detection technologies do not reduce emissions alone but instead provide stakeholders with data that informs mitigation."

[73] Adam Brandt, Garvin Heath, and Daniel Cooley, 50 Environ. Sci. Technol. 22, 12512-12520 (2016).

stochastic,[74] and therefore leak detection technologies likely will be deployed across a population of sites that can include a relatively small but shifting subpopulation of super-emitters. A consequence of this skewed distribution is that technologies with higher detection limits may yield equivalent or greater emission reductions than low detection limit technologies if used in a fashion that leads to quicker detection and mitigation of high emitting sources. However, this equivalency only holds if emission reductions are compared in the aggregate, such as the annual emission reductions from all of an operator's well pads in a basin. A few sites will likely account for the bulk of emissions, but it is impossible (thus far) to predict in advance where super-emitters will occur. As a result, a regulator must assess a method over a group of sites and a period of time. Otherwise, high detection limit, fast-response technologies will appear less effective at relatively low-emission sites but much more effective in the super-emitter sub-population compared to a lower detection limit, low-frequency approach such as semi-annual OGI. If there are regulatory constraints that require emission reductions to be assessed at the facility level, then an alternative but mathematically similar approach could be to compare reductions at model sites with a probabilistic emissions profile representing a larger population.

3. **Empirical data are used to assess the probability of leak detection.**
   The initial phase of estimating emission reductions is to determine the minimum detection limit of a technology. For most technologies, the detection limit will not be a single value but a function of parameters such as wind speed and distance from source. This is especially true for systems that use dispersion modeling or other algorithms to infer emission rates from ambient concentrations, as this relationship is highly dependent on meteorological conditions.

   A multi-step process may be required to accurately assess the probability of leak detection. First, laboratory testing can evaluate the accuracy, precision, and stability of methane concentration sensors that are a key component of some technologies. These highly controlled tests can gauge sensor performance at measuring methane concentrations under variable conditions such as temperature, relative humidity, and potential cross-sensitive gases.[75] Next, controlled field experiments can be used to determine the probability of detecting different emission rates under a range of known conditions. For example, a Stanford team[76] determined the relationship of detection probability, emission rate, and view distance for OGI by assessing the ability of an OGI camera operator to detect a series of controlled releases

"A multi-step process may be required to accurately assess the probability of leak detection."

[74] Aerial Surveys of Elevated Hydrocarbon Emissions from Oil and Gas Production Sites, David R. Lyon et al., 50 Environ. Sci. Technol. 9, 4877-4886 (2016)

[75] Environmental Defense Fund Methane Detectors Challenge (accessible at http://business.edf.org/projects/featured/natural-gas/methane-detectors-challenge)

[76] Arvind Ravikumar et al., "Good versus Good Enough?" Empirical Tests of Methane Leak Detection Sensitivity of a Commercial Infrared Camera, 52 Environ. Sci. Technol. 4, 2368-2374 (2018).

at the Methane Emissions Technology Evaluation Center (METEC) at Colorado State University. Moving forward, METEC or facilities like it could play an important role as a respected, independent source for empirical assessments of methane detection methodologies. Ideally, testing should be performed repeatedly under diverse conditions representing the full range that may be encountered in actual use, but in reality this may be difficult to achieve due to the rarity of some meteorological conditions. At a minimum, it is important to challenge technologies with potentially adverse conditions such as extreme heat and cold, stagnant and high winds, and precipitation events. For technologies with well-understood physical principles, physics-based modeling could be used to augment empirical testing by predicting performance under untested conditions.[77]

4. **Standardized models are used to predict emission reductions.** Once there is sufficient empirical data to understand the probability of leak detection under diverse conditions, computer modeling can be used to predict emission reductions from use of the method as part of an LDAR protocol. Models are necessary because the skewed emission rate distribution of O&G facilities means that empirical testing will not fully characterize the impact of a technology across a population of sites. If tests were performed at low-emission sites, then results would be biased towards technologies with the lowest detection limits, while technologies with the shortest detection time would be favored by tests at high emission sites. Theoretically, empirical testing could be performed at a large number of facilities that are statistically representative of the full population, but this likely would be cost prohibitive and require widespread deployment of a technology prior to approval as a valid alternative. Therefore, a rigorous, transparent model is the most cost-effective and quickest approach for predicting emission reductions from leak detection technologies and associated repair protocols. The most likely form of these models is a probabilistic simulation of source-level emissions on a large scale (e.g., the full population of well pads in a state or basin) that uses clearly defined functions and assumptions to predict the detection and mitigation of emissions.

   A rigorous model requires three components to accurately predict reductions: a function defining the probability of detection, a representative emissions profile of the population, and a function defining mitigation in response to detection. The detection function is the direct result of empirical testing and associated physics-based modeling discussed in the previous principle. For any set of valid conditions, the function should return the probability of detection; this function could include a time element since some technologies may use algorithms that have increasing probability to detect leaks as more data are collected. The second

[77] Chandler Kemp, Arvind Ravikumar, and Adam Brandt, Comparing Natural Gas Leakage Detection Technologies Using an Open-Source "Virtual Gas Field" Simulator, 50 Environ. Sci. Technol. 8 4546-4553 (2016)

component is a quantitative description of emission sources in the population, including their emission rate, source type (as it relates to mitigation), and probability of occurring at a site; this may also include a time component describing the frequency and duration of intermittent emission sources. The third component is a quantitative description of the mitigation response to detected emission sources, which should be based on the repair protocol associated with the technology. For each source type, the emission rate that triggers action to eliminate or reduce emissions from the source should be defined. The temporal aspect is particularly important for this component because the value of high detection limit technologies is dependent on how quickly large emission sources are mitigated. For some approaches, this may be a multi-step process: a technology that detects a high emission rate may trigger a follow-up survey by another technology such as OGI. Therefore, the mitigation response must include the time to initial detection, follow-up detection, and repair. The standardization of the second and third components will be discussed in the final principle.

5. **Model inputs are transparent and rely on best available data**
   Although models are necessary for a cost-effective, timely comparison of methodologies, they can be misused if model inputs are chosen to produce a particular result rather than an objective comparison. Requiring model assumptions to be transparent and scientifically justified can minimize this risk. When possible, inputs such as emission rate distributions should be based on empirical, representative data. For example, if technologies are being compared for their effectiveness in a single state or province, then measurement data collected in that jurisdiction may be most appropriate. In many cases, there may be insufficient data from a specific area, so models will need to use best available data compiled from multiple sources across many areas. To assure consistency across comparisons, it will be advantageous to develop standardized datasets and assumptions to use when more localized data are lacking. For some data parameters, such as emission rate distributions, there is an abundance of publically available data, but other parameters, such as leak recurrence, are either sparse or not in the public domain. The ability to fairly compare technologies can be greatly enhanced by developing open, representative datasets for key model parameters. One approach would be to use an independent party to collect and aggregate data from multiple operators; this would assure the scientific rigor of inputs without revealing sensitive business information. These standardized datasets, which could be regularly updated as new data are available, would improve the transparency and consistency of technology comparisons.

"Requiring model assumptions to be transparent and scientifically justified can minimize this risk."

Recommendations

The first step to encouraging innovation is setting out a rule that permits alternative compliance methodologies and issuing detailed guidance for those who would use the rule. The rule and associated guidance should include guidance on field testing requirements, the approved technology comparison model, submission requirements, and the process for obtaining approval of alternative methodologies. For states that already allow for the use of alternative methodologies, either by rule or general permit, but have not included all of these elements in the alternative compliance provision, only a guidance document may be required rather than a rule or rule revision.

One helpful aspect of the rule and associated guidance should be a clarification that testing a new methodology does not trigger other regulatory requirements. For example, an alert from a novel system should not trigger the requirement to fix a leak or report a leak. The method is by definition in the process of being validated, so it is not yet clear that the alert is accurate. And the risk of triggering mitigation, reporting, and other requirements can deter testing of new methodologies in the most important locations—active oil and gas facilities.

Adopt a shared model for equivalency

The backbone of a methane rule enabling alternative compliance methodologies should be a model that applicants can employ to justify their claim to equal or greater emissions reductions using the proposed methodology. The Technology Comparison Framework section above explains why measurement and modeling must be combined to demonstrate potential impact, how such a model would work, what it can accomplish, and its limitations. A jurisdiction should set out in advance the default assumptions on key variables in the model that it considers reasonable. Approving a model in advance and articulating approvable ranges of values can provide a framework for innovators and operators to direct their thinking as they design new methodologies. Setting approved default ranges for key assumptions encourages innovation because it sets goalposts for innovation and increases the likelihood that an application within bounds will be approved. This reduced uncertainty makes it easier to justify the significant time and energy required to develop and test new methane reduction methodologies.

Comparing the impacts of different methods is a complex exercise, and ozone compliance planning provides a useful example. EPA and states routinely rely on modeling to assess the impact of proposed controls on various goals such as the ability of states to meet national ambient air quality standards for ozone and the amount of anticipated emission reductions from a particular regulatory strategy. Ozone models are capable of accounting for a suite of factors that affect control effectiveness, including meteorology, the fate and transport of ozone precursors, and the source and regional contribution of a specific air contaminant.

The Fugitive Emissions Abatement Simulation Testbed (FEAST) model developed at Stanford is an example of a rigorous model that could be used to evaluate a wide range of technologies.[78] The open-source, field-level model uses a probabilistic Markov model to simulate which components in a field are leaking, with emission rates drawn from existing, empirical datasets. Several different functions are used to determine the probability of detection; for example: 1) Gaussian dispersion modeling to predict detection by distributed methane concentration sensors, and 2) physics-based modeling to predict detection by OGI. Additional functions are used to model the rates at which detected emission sources are repaired and new leaks occur. The model outputs emission reductions over time from each technology's LDAR protocol, plus cost-effectiveness if the inputs include valid cost assumptions. For data elements that are sparse, operators, regulators, and facilities such as METEC can collaborate to fill in the gaps. Operators have an incentive to be forthcoming with data they may otherwise consider private if it is a constructive step toward gaining more flexibility in leak detection and mitigation.

Transparent and rapid process

In order to encourage innovation in methane management, a process that is transparent and fast is just as important as clear submissions guidelines. An alternative compliance rule and associated guidance should lay out the process for approvals, including the opportunities for public comment. Approving the model for evaluating methodologies in advance should facilitate faster and more predictable decision-making on individual applications.

An innovation-encouraging process should include:

- A streamlined **timeline** for decisions;
- A mechanism for applications to be made by operators, technology innovators, and **other interested parties**;
- Opportunities for **public notice and comment**;
- A mechanism to submit information and request it to be **kept out of the public domain** based on legitimate confidentiality concerns;
- A mechanism to submit **one application for multiple sites** (especially relevant in states such as Ohio that operate via individual permits);
- A **public decision**.

Key elements to require in submissions include:

- **Testing results**, preferably independent or verified by a third party;
- **Details of the proposed methodology**, including which instruments will be used where for fixed systems, or with what frequency for mobile systems, and what the mitigation response will be. The submission should also specify how the method combines different instruments—for example, a leak alert from a fixed or mobile monitor triggers a follow-up scan with a more sensitive hand-held instrument
- **Conditions and facilities** where the methodology is proposed to be deployed;

[78] C.E. Kemp, A.P. Ravikumar, and A.R. Brandt, FEAST: Fugitive Emissions Abatement Simulation Toolkit (2016) (accessible at https://eao.stanford.edu/research-areas/FEAST).

- **Modeling** that justifies the claim to equal or greater emissions reductions, including any divergence of inputs from pre-approved ranges;
- Proposed **reporting** and **monitoring** procedures, if different from status quo procedures;
- A proposed **phaseout** of existing detection, monitoring, and reporting requirements

Approvals with powerful benefits

The consequences of an approval, designed well and spelled out in advance, can also encourage time and money to be directed to methane innovation and improve the regulator's ability to accomplish environmental goals.

For **regulators**, approved methodologies can improve the ability to monitor operating conditions and enforce the rules. One opportunity that strengthens a regulator is the ability to adapt reporting requirements to take advantage of the capabilities of new technologies. Many new technologies stream data real-time or employ advanced analytics. Regulators who streamline reporting directly from the systems that operators are already using could see dramatically improved transparency at much lower cost. Regulators can also take advantage of more effective monitoring opportunities. An alternative methodology can combine novel instruments in creative ways. A proposal could include, for example, continuous monitoring at a representative sample of locations for a trial period in order to demonstrate to a regulator that the new method is working and identify opportunities for improvements.

For **innovators**, one regulatory element that expands the potential market is the ability of follow-on operators to use an alternative methodology once it is approved. For similar conditions and similar facilities, a follow-on operator should be able to publicly notify a regulator of the intention to use an approved methodology, which is deemed approved unless the regulator takes action within a short time period. The Colorado rule exemplifies this, as approval of an alternative AIMM can be used by anyone—not just the applicant—so long as the alternative AIMM approval requirements are met.

For **operators**, one regulatory element that encourages collaboration on new methodologies is the prospect of no longer being subject to the existing requirements. If an approved application describes how to phase out use of the status quo for LDAR, the applicant and approved followers should be able to ramp down one methodology after ramping up the alternative.

Interjurisdictional collaboration

The opportunity for regulations to encourage innovation is even stronger with interjurisdictional collaboration. It can take months, and possibly more than a year, for an operator and innovator to test and receive approval for a new methodology in one jurisdiction. The prospect of doing that more than once to receive approval in a subsequent jurisdiction could significantly stifle innovation. On the other hand, the potential of a multi-state market is a strong incentive to invest in the development of better methane management tools and strategies.

The path to streamline interjurisdictional collaboration begins with jurisdictions approving the same model to evaluate alternative methodologies and issuing guidance on assumptions they deem reasonable. An application in a subsequent jurisdiction can then specify how, if at all, the application differs from the first—for example due to different conditions or facilities. If the method, conditions, or facilities are not sufficiently different, new testing does not need to be carried out. The submission may be streamlined, and it may be deemed approved within a reasonable period of time.

As much as possible, all testing should be carried out for the first application. If further testing is required, however, for example because testing was not carried out in extremely low or high temperatures in the first state, then a subsequent state may request more testing. This new testing should be limited to the conditions or facilities that are outside the bounds of the assumptions approved in the first state. In this way, states can encourage innovation that achieves regulatory goals faster and less expensively.