Caring for the Orphans: Approaches for Mitigating Fugitive Methane Emissions From Orphaned Oil and Gas Wells

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Summary

Recent scientific research indicates fugitive methane emissions from abandoned oil and gas wells may contribute more to climate change than methane leakage from oil and gas production. Yet current orphaned well regulations fail to ensure that such wells are plugged in a timely fashion. This Article applies domestic comparative law to identify three promising alternative approaches to the current system of orphan well reclamation funds: cooperative federal grant programs, joint and several liability of potentially responsible parties, and carbon offsets credits. By providing more equitable funding, expanded liability, and market-based incentives, these approaches can complement existing efforts and help mitigate fugitive methane emissions from orphaned wells.

For the past half-century, state regulators have recognized that abandoned unplugged oil and gas wells can contaminate freshwater aquifers and surface environments, and in extreme cases can pose a risk of ignition or explosion. States generally seek to mitigate these risks by imposing bonding requirements on current well operators and by plugging the most hazardous abandoned wells using money from orphaned well reclamation funds. However, in most states, these accounts remain significantly underfunded, providing state regulators only enough money to plug the most immediately hazardous wells and forcing regulators to leave other abandoned wells unplugged for years, and in some cases decades, while listed on priority plugging lists.

New research suggests that cumulative fugitive emissions from abandoned wells, particularly from unplugged "super-emitters," may contribute more to climate change than methane leakage from oil and gas production. Considering the failure of the current regulatory scheme to plug even abandoned wells that have already been identified and documented, let alone the hundreds of thousands of undocumented orphaned wells from the early days of the oil industry, new alternative approaches are needed.

Drawing upon lessons from other state and federal regulatory regimes addressing orphaned pollution,[1] this Article identifies three promising alternative approaches for mitigating fugitive emissions from unplugged orphaned oil wells. First, the "historical coal grants" implemented as part of the Surface Mining Control and Reclamation Act (SMCRA) of 1977[2] provide a model for a cooperative federal granting program that would help fund the plugging of orphaned wells in states without significant current oil and gas production. Second, the system of "potentially responsible parties" (PRPs) implemented by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980[3] provides a model for a broad liability scheme that would allow regulators to recover plugging costs from any past operator of an orphaned well and from any current operator drilling nearby. Finally, the California Air Resources Board's (CARB's) Mine Methane Capture Projects Compliance Offset Protocol provides a potential future model for market-based incentives to offset a portion of the cost of plugging orphaned wells. Adopting elements of these regulatory approaches will enable state regulators (and incentivize private parties) to more quickly

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1. Rhett B. Larson, *Orphaned Pollution*, 45 Ariz. St. L.J. 991 (2013) ("Orphaned pollution is persistent contamination of natural resources from sources for which no party can be held financially liable for clean-up costs.").
2. 30 U.S.C. §§1201 et seq.; ELR Stat. SMCRA §§101-908.
3. 42 U.S.C. §§9601-9675; ELR Stat. CERCLA §§101-405.

plug "super-emitting" wells than under the current system of orphaned well reclamation funds, thus mitigating the climate change effects of fugitive methane emissions from orphaned oil and gas wells.

The existing literature on the regulation of oil and gas well abandonment has focused primarily on the use of financial surety bonds to prevent additional wells from becoming orphaned.[4] Schemes for plugging previously orphaned wells have received scant scholarly attention. This Article addresses this gap by analyzing both existing and alternative approaches to orphaned well plugging. It proceeds in four parts. Part I explains the basics of well plugging and decommissioning, and examines startling new research on the scale of fugitive methane emissions from unplugged wells. Part II analyzes existing orphaned well regulations and the failure of current approaches to identify and plug wells in a timely and efficient manner. Part III applies a domestic comparative law approach, and argues that other existing regimes for orphaned pollution represent alternative methods for better mitigating fugitive emissions from orphaned wells. Part IV summarizes the lessons from the domestic comparative law approach for orphaned well regulation, and concludes.

I. A Newly Recognized Problem From an Old Source

A. *Orphaning of Wells*

When oil and gas wells are no longer producing at economically viable levels, they must be plugged to prevent natural geological pressure from forcing oil, gas, or contaminated water to migrate up the well. These migrating fluids can contaminate freshwater aquifers, or can seep to the surface.[5] Therefore, at the end of well production, all U.S. jurisdictions require the plugging of oil and gas wells with the setting of "mechanical or cement plugs in the wellbore at specific intervals to prevent fluid flow."[6] Properly placed plugs confine oil, gas, and water resources to their original geological strata.[7]

The American Petroleum Institute (API) standards provide specific plugging procedures and cement composition. Depending on the particulars of the well, this standard process generally takes workers "two days to a week."[8] If an operator intends to permanently abandon a well, it will remove any remaining equipment, shear off exposed casings, and restore the natural surface. Once a well is plugged and the surrounding site is restored, a well is considered properly decommissioned.[9]

In the early days of the American oil industry, wells were regularly left unplugged or were plugged with materials insufficient to prevent fluid migration. In California, Illinois, Pennsylvania, Texas, and other states with early oil and gas discoveries, decades went by between the beginning of drilling and the first regulations requiring the plugging of wells at the end of their useful lives.[10] As a result, "early wells could simply be abandoned as gaping holes in the ground . . . with little to no information recorded on the location or construction of the wells."[11] When operators did in fact decide to plug their wells, they would use "stumps, logs, animal carcasses, and mud."[12]

Even after states started to regulate the plugging of wells in the 1930s and 1940s, the quality of such early cement plugs remained "questionable,"[13] since "cement was poorly understood" and "lacked crucial additives."[14] This changed in 1952, when the API published its cement classification system specifying particular mixtures for use at certain depths and pressures.[15] Additionally, after the U.S. Congress passed the Safe Drinking Water Act in 1974, many states updated and strengthened their plugging regulations to minimize the risk of fluid migration into freshwater aquifers.[16] Plugging and abandoning techniques today remain almost unchanged since the 1970s.[17]

However, even today serious challenges remain, as operators may be unwilling or unable to plug non-producing wells. Plugging "takes capital to complete and provides no return on the investment for the oil companies."[18] As a result, "the end of commercial production brings with it a very large expense just when there no longer is enough

4. *See* Gerard David & Elizabeth J. Wilson, *Environmental Bonds and the Challenge of Long-Term Carbon Sequestration*, 90 J. Envtl. Mgmt. 1097 (2009) (providing a literature review on the use of financial surety bonding to address environmental challenges).
5. National Petroleum Council, Plugging and Abandonment of Oil and Gas Wells (2011) (Paper #2-25), *available at* http://www.npc.org/Prudent_Development-Topic_Papers/2-25_Well_Plugging_and_Abandonment_Paper.pdf.
6. *Id.*
7. Jacqueline Ho et al., Resources for the Future, Plugging the Gaps in Inactive Well Policy 6-7 (2016), *available at* http://www.rff.org/files/document/file/RFF-Rpt-PluggingInactiveWells.pdf.
8. National Petroleum Council, *supra* note 5, at 6. The American Petroleum Institute (API) is the national trade association of the U.S. oil and gas industry and it maintains 685 standards and recommended practices for petroleum and petrochemical equipment and operations. *See* API, *About API*, http://www.api.org/about (last visited Apr. 18, 2017).
9. Ho et al., *supra* note 7, at 4.
10. Oil and gas drilling began in Pennsylvania in 1859 and the first plugging regulations were not implemented until the 1890s. In Texas, large-scale commercial drilling of the Mid-Continental Oil Field began in 1893 and the Texas Railroad Commission only gained authority to regulate well plugging in 1919. In California, commercial drilling of the Los Angeles Basin began in the 1890s and well plugging became mandatory in 1915. *See* National Petroleum Council, *supra* note 5, at 6-5; S. Taku Ide et al., *CO_2 Leakage Through Existing Wells: Current Technology and Regulations*, Proc. 8th Int'l Conf. on Greenhouse Gas Control Techs. 2-3 (2006), *available at* https://sequestration.mit.edu/pdf/GHGT8_Ide.pdf.
11. National Petroleum Council, *supra* note 5, at 6-7. For instance, it is estimated that by the time California set up a regulatory body for oil and gas drilling, more than 30,000 wells had already been drilled. Similarly, around 55,000 wells had been drilled in Indiana by the time the Indiana Oil and Gas Division was established. *See* Ide et al., *supra* note 10, at 2.
12. *Id.*
13. Shane Hoover, *Special Report: Ohio Invests More Money Into Well Plugging, Revamps Program*, CantonRep, July 13, 2015, http://www.cantonrep.com/article/20150713/SPECIAL-REPORTS/150719946.
14. Ide et al., *supra* note 10, at 3.
15. National Petroleum Council, *supra* note 5; *see also* Charles V. Millikan, *Cementing*, *in* John E. Brantly, History of Oil Well Drilling (1973) (discussing the history of the API cement classification system).
16. Ho et al., *supra* note 7, at 10.
17. National Petroleum Council, *supra* note 5, at 5.
18. *Id.* at 6.

current revenue to cover it."[19] Moreover, wells nearing the end of their productive lives may often be "pass[ed] from large companies to smaller ones without wherewithal to plug them."[20] Small family-owned "stripper" firms often purchase oil and gas wells nearing the end of their production in the hope of stripping out the very last resources from the wells.[21]

During periods of low oil prices, these smaller companies may be at a particularly high risk of bankruptcy. For instance, thousands of wells across the United States "were left unplugged after the 1986 oil bust as many companies became insolvent."[22] And during the ongoing oil glut,[23] states are being put "on the hook for thousands of newly abandoned drilling sites."[24] Non-producing and unplugged wells for which the operator is unknown or insolvent are called "orphaned wells." Since the "well owners might have ceased to exist as a business entity or might never have been known," it falls to the states to "properly plug the well and restore the location."[25]

B. Fugitive Methane Emissions and Climate Change

While state regulators have long understood the risk of groundwater and surface contamination from drilling, only recently have scientists recognized that significant methane leaks from oil and gas infrastructure—including from orphaned wells—may also contribute to climate change. Methane, the primary component of natural gas, is a potent greenhouse gas when it is released into the atmosphere without having been burned. After carbon dioxide (CO_2), methane is the second largest contributor to anthropogenic climate change, and is estimated to be responsible for 25% of current global warming.[26] It persists in the atmosphere for a shorter time than CO_2 but it has greater warming potential as it traps more heat. Over a 20-year period, methane is 86 times more potent as a greenhouse gas than CO_2,[27] and over a 100-year period, it is between 25 and 34 times more potent.[28]

Over the past 250 years, the concentration of methane in the atmosphere increased by 160%.[29] Since 1990, methane emissions in the United States have decreased by 11%, largely due to decreased emissions from natural gas transmission, storage, and distribution,[30] but methane still represents nearly 9% of all greenhouse gas emitted as a result of human activity in the United States.[31]

According to the U.S. Environmental Protection Agency (EPA), natural gas and petroleum systems are the largest source of methane emissions in the United States, responsible for roughly 33% of total U.S. methane emissions.[32] Methane emissions occur throughout the entire natural gas system as a result of both intentional venting and unintentional leaks. Methane is vented into the atmosphere by "the continuous bleed of gas from pneumatic devices (that control gas flows, levels, temperatures, and pressures in the equipment)" and by "well completions during production."[33] Additionally, methane losses can occur from leaks "in all parts of the infrastructure, from connections between pipes and vessels, to valves and equipment."[34] These "intentional or unintentional release[s] of greenhouse gases . . . during the extraction, processing and delivery of fossil fuels" are labeled "fugitive emissions."[35] Fugitive

19. Alan V. Hager & Kevin L. Shaw, *Idle and Deserted Wells: Who Plugs and Who Pays?*, 45 Proc. Ann. Inst. Rocky Mtn. Min. L. Inst. 4 (1999), *available at* https://m.mayerbrown.com/files/Publication/a60f90b5-4e96-4830-8609-133cb24eef73/Presentation/PublicationAttachment/2275b5bc-6f79-4840-b48c-199951cb9f76/idleanddesertedwells.pdf.
20. Dan Frosch & Russell Gold, *How "Orphan" Wells Leave States Holding the Cleanup Bag*, Wall St. J., Feb. 25, 2015, http://www.wsj.com/articles/how-orphan-wells-leave-states-holding-the-cleanup-bag-1424921403.
21. Clifford Krauss, *Falling Oil Prices Force Cutbacks at Smallest Companies*, N.Y. Times, Feb. 24, 2016, http://www.nytimes.com/2016/02/25/business/energy-environment/falling-oil-prices-force-cutbacks-at-smallest-companies.html.
22. Ide et al., *supra* note 10, at 5.
23. Oil prices began to plunge two years ago due to a global glut of crude from $100 per barrel in 2014 to less than $50. *See*, *e.g.*, Clifford Krauss, *Oil Glut? Here Comes Some More!*, N.Y. Times, Oct. 5 2016, http://www.nytimes.com/2016/10/06/business/energy-environment/oil-glut-here-comes-some-more.html; Neanda Salvaterra, *Oil Prices Fall as Energy Meeting Kicks Off—Energy Journal*, Wall St. J., Sept. 27, 2016, http://blogs.wsj.com/moneybeat/2016/09/27/oil-prices-fall-as-energy-meeting-kicks-off-energy-journal/.
24. Paul J. Weber, *Texas Facing Massive Well Cleanup Costs After Oil Bust*, Dallas News, June 19, 2016, http://www.dallasnews.com/business/business/2016/06/19/texasfacing-massive-cleanup-costs-oil-bust.
25. Orphaned Well Plugging Initiative, Interstate Oil & Gas Compact Commission, Protecting Our Country's Resources: The States' Case (2008), *available at* http://iogcc.publishpath.com/Websites/iogcc/pdfs/2008-Protecting-Our-Country's-Resources-The-States'-Case.pdf.
26. Environmental Defense Fund, *Methane: The Other Important Greenhouse Gas*, https://www.edf.org/methane-other-important-greenhouse-gas (last visited Apr. 8, 2017).
27. Gayathri Vaidyanathan, *How Bad of a Greenhouse Gas Is Methane?*, Sci. Am., Dec. 22, 2015, https://www.scientificamerican.com/article/how-bad-of-a-greenhouse-gas-is-methane/.
28. U.S. Environmental Protection Agency (EPA), *Overview of Greenhouse Gases—Methane*, https://www.epa.gov/ghgemissions/overview-greenhouse-gases#methane (last updated Apr. 14, 2017).
29. U.S. EPA, Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2014, at ES-13 (2016) (EPA 430-R-16-002), *available at* https://www3.epa.gov/climatechange/Downloads/ghgemissions/US-GHG-Inventory-2016-Main-Text.pdf.
30. EPA's Natural Gas STAR Program, started in 1993, has played an important role in this reduction, providing a framework for companies to "implement methane reducing technologies and practices and document their voluntary emission reduction activities." U.S. EPA, *Natural Gas STAR Program, About EPA's Oil and Gas Methane Partnerships*, https://www.epa.gov/natural-gas-star-program/about-epas-oil-and-gas-methane-partnerships (last updated Jan. 10, 2017).
31. The White House, Climate Change Action Plan Strategy to Reduce Methane Emissions 1 (2014), *available at* https://obamawhitehouse.archives.gov/sites/default/files/strategy_to_reduce_methane_emissions_2014-03-28_final.pdf.
32. U.S. EPA, *supra* note 29, at ES-13. However, some studies suggest that "official inventories consistently underestimate actual [methane] emissions, with the [natural gas] and oil sectors as important contributors." Adam R. Brandt et al., *Methane Leaks From North American Natural Gas Systems*, 343 Science 733 (2014), *available at* http://science.sciencemag.org/content/sci/343/6172/733.full.pdf; *see also* Scott M. Miller et al., *Anthropogenic Emissions of Methane in the United States*, 110 Proc. Nat. Acad. Sci. 20018 (2013), *available at* http://www.pnas.org/content/110/50/20018.full ("We find greenhouse gas emissions from agriculture and fossil fuel extraction and processing (i.e., oil and/or natural gas) are likely a factor of two or greater than cited in existing studies.").
33. U.S. EPA, *Natural Gas STAR Program, Overview of the Oil and Natural Gas Industry*, https://www.epa.gov/natural-gas-star-program/overview-oil-and-natural-gas-industry#sources (last updated Aug. 31, 2016).
34. *Id.*
35. John N. Carras et al., *Fugitive Emissions*, *in* 2 2006 IPCC Guidelines for National Greenhouse Gas Inventories (Simon Eggleston et al. eds.,

emissions have recently become a topic of concern due to the North American shale gas boom[36]—with some studies going as far as to challenge the climate change benefits of switching from coal to natural gas due to the global warming potential of such emissions.[37]

Both federal and state governments have sought to reduce methane emissions from the oil and gas industry. In 2014, Colorado become the first state to comprehensively regulate methane pollution from oil and gas operations by requiring "companies to utilize air pollution control systems to limit . . . emissions and requir[ing] leak detection and repair regardless of the date of construction of the affected facility."[38] Producers are required to routinely inspect well sites for leaks, and discovered leaks must be fixed within 15 days.[39]

In January 2015, the Barack Obama Administration announced a goal to cut methane emissions from the oil and gas sector by 40 to 45% from 2012 levels by 2025.[40] As part of these efforts, in May 2016, EPA finalized a set of rules under the New Source Performance Standards of §111 of the Clean Air Act (CAA)[41] that would require the oil and gas industry to limit releases of methane from hydraulically fractured oil well completions, natural gas processing plants, and compressor stations.[42] It was estimated that the regulations would cost the industry $530 million while lowering methane emissions by 510,000 tons by 2025.[43] However, in April 2017, EPA, now headed by the Donald Trump Administration appointee Scott Pruitt, announced its intention to reconsider these rules and delayed the original June 3, 2017, compliance deadline for at least another 90 days.[44]

Yet, at the state level, regulators continue to consider additional methane emission regulations. CARB recently proposed new rules on greenhouse gas emissions standards for oil and natural gas facilities,[45] and the Pennsylvania Department of Environmental Protection (DEP) is also considering new regulations to limit methane emissions from new well pads and to curb leaks from existing production, gathering, transmission, and distribution lines.[46] However, as environmental advocates have noted, none of these regulations apply to abandoned and orphaned wells.[47]

C. *Methane Leaks From Abandoned and Orphaned Wells*

A handful of recent studies on methane leaks from abandoned wells have suggested that such emissions may in fact represent a significant share of total anthropogenic methane emissions in certain areas of the country.[48] The potential scale of these leaks was first identified by a 2014 study of 19 abandoned wells, both plugged and unplugged, in the Appalachian Basin of Pennsylvania.[49] Rough esti-

2006), *available at* http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_4_Ch4_Fugitive_Emissions.pdf.

36. Environmental Defense Fund, *The Climate Impacts of Methane Emissions*, https://www.edf.org/energy/methaneleakage (last visited Apr. 8, 2017).
37. *See* Anna Karion et al., *Methane Emissions Estimate From Airborne Measurements Over a Western United States Natural Gas Field*, 40 Geophysical Res. Letters 4393 (2013), *available at* http://onlinelibrary.wiley.com/doi/10.1002/grl.50811/full; Jeff Peischl et al., *Quantifying Sources of Methane Using Light Alkanes in the Los Angeles Basin, California*, 118 J. Geophysical Res. 4974 (2013), *available at* http://onlinelibrary.wiley.com/doi/10.1002/jgrd.50413/abstract; Gabrielle Pétron et al., *Hydrocarbon Emissions Characterization in the Colorado Front Range: A Pilot Study*, 117 J. Geophysical Res. D04304 (2012), *available at* http://onlinelibrary.wiley.com/doi/10.1029/2011JD016360/abstract.
38. Caitlin Stafford, *The Great Escape: Addressing the Problem of Fugitive Methane Emissions From the Conventional Natural Gas System Under the Clean Air Act*, 26 Colo. Nat. Resources, Energy & Envtl. L. Rev. 352 (2015), *available at* http://www.colorado.edu/law/sites/default/files/351-383%20Stafford.pdf. *See* Kathleen C. Becker, *Federal Methane Guidelines, Modeled on Colorado's Rule, Also Necessary*, Denver Post, Aug. 4, 2016, http://www.denverpost.com/2016/08/04/federal-methane-guidelines-modeled-on-colorados-rule-also-necessary/; Grace Hood, *Colorado Leads U.S. in Control of Methane Gas Emissions*, NPR, May 13, 2016, http://www.npr.org/2016/05/13/477974522/colorado-leads-u-s-in-control-of-methane-gas-emissions.
39. 5 Colo. Code Regs. 1001-9 §XVII.F.7 (2016).
40. Fact Sheet, The White House, Administration Takes Steps Forward on Climate Action Plan by Announcing Actions to Cut Methane Emissions (Jan. 14, 2015), https://obamawhitehouse.archives.gov/the-press-office/2015/01/14/fact-sheet-administration-takes-steps-forward-climate-action-plan-anno-1.
41. 42 U.S.C. §§7401-7671q; ELR Stat. CAA §§101-618.
42. Oil and Natural Gas Sector: Emission Standards for New, Reconstructed, and Modified Sources, 81 Fed. Reg. 35823 (Aug. 2, 2016).
43. *See* Coral Davenport, *E.P.A. Methane Leak Rules Take Aim at Climate Change*, N.Y. Times, May 12, 2016, http://www.nytimes.com/2016/05/13/us/obama-methane-epa.html; Jim Malewitz, *EPA's Final Methane Rules Would Hit Oil and Gas Industry Hardest*, Governing, May 13, 2016, http://www.governing.com/topics/transportation-infrastructure/tns-epa-methane-emissions.html.
44. U.S. EPA, *EPA to Reconsider Oil and Gas Rule*, https://www.epa.gov/newsreleases/epa-reconsider-oil-and-gas-rule (last updated Apr. 19, 2017). *See also* Timothy Gardner, *Trump's EPA to Reconsider Oil and Gas Emissions Rule*, Reuters, Apr. 19, 2017, http://www.reuters.com/article/us-usa-epa-idUSKBN17L215 (discussing the EPA decision to reconsider the rule).
45. CARB, *Notice of Public Hearing to Consider the Proposed Regulation for Greenhouse Gas Emission Standards for Crude Oil and Natural Gas Facilities*, https://www.arb.ca.gov/regact/2016/oilandgas2016/oilandgas2016.htm (last visited Apr. 14, 2017); *see also* Tim O'Connor, *California Proposes Strong Oil & Gas Methane Rule, Leaves Major Loophole*, Envtl. Defense Fund, May 31, 2016, https://www.edf.org/media/california-proposes-strong-oil-gas-methane-rule-leaves-major-loophole (analyzing the proposed regulation).
46. *See* Marie Cusick, *New Methane Rules Coming for Pennsylvania's Oil and Gas Industry*, StateImpact Pa., Nov. 21, 2016, https://stateimpact.npr.org/pennsylvania/2016/11/21/new-methane-rules-coming-for-pennsylvanias-oil-and-gas-industry/; Marie Cusick, *DEP Offers More Details on Plans to Curb Methane Leaks*, StateImpact Pa., Feb. 12, 2016, https://stateimpact.npr.org/pennsylvania/2016/02/12/dep-offers-more-details-on-plans-to-curb-methane-leaks/.
47. Krishnadev Calamur, *The EPA's New Methane Rules for the Oil and Gas Industry*, Atlantic, Aug. 18, 2015, http://www.theatlantic.com/business/archive/2015/08/epa-methane-emissions-oil-gas-industry/401651/ ("Kate DeAngelis, who is with the environmental group Friends of the Earth, cheered the changes but added: We have a serious problem with existing and abandoned wells, and the final rule needs to address them."); Marie Cusick, *State Commission OK's New Oil and Gas Regulations*, StateImpact Pa., Apr. 21, 2016, https://stateimpact.npr.org/pennsylvania/2016/04/21/state-commission-oks-new-oil-and-gas-regulations/ ("'There are many costs being borne by the public,' says Nadia Steinzor of Earthworks . . . 'over 200,000 abandoned and orphaned wells currently leaking down into the ground and up into the air.'").
48. *See* Amy Townsend-Small et al., *Emissions of Coalbed and Natural Gas Methane From Abandoned Oil and Gas Wells in the United States*, 43 Geophysical Res. Letters 2283 (2016), *available at* http://onlinelibrary.wiley.com/doi/10.1002/2015GL067623/full (identifying "only three" recent studies that have "reported [methane] leakage rates from abandoned wells").
49. Mary Kang et al., *Direct Measurements of Methane Emissions From Abandoned Oil and Gas Wells in Pennsylvania*, 111 Proc. Nat. Acad. Sci. 18173 (2014), *available at* http://www.pnas.org/content/111/51/18173.abstract.

mates of total methane emissions from abandoned oil and gas wells in the state suggested that "cumulative emissions from abandoned wells may be significantly larger than the cumulative leakage associated with oil and gas production, which has a shorter lifetime of operation."[50] An expanded 2016 follow-up study of 88 abandoned oil and gas wells in the state estimated that abandoned wells emitted 0.04 to 0.07 megatons of methane (CH_4) per year, which would represent 5-8% of annual anthropogenic methane emissions in Pennsylvania.[51]

A 2016 study by a different group of researchers confirmed that the average emission rate for abandoned wells in Ohio was similar to the rate identified in Pennsylvania,[52] but also identified "significant regional variation" in methane emissions from abandoned wells.[53] Comparing measurements from 138 abandoned oil and gas wells in Colorado, Ohio, Utah, and Wyoming, the researchers found emissions from wells in the eastern United States to be "significantly higher" than in the western United States.[54] The study suggested the variation is most likely due to the age of the abandoned wells, as wells in Ohio and Pennsylvania are among some of the oldest in the country, while many in Colorado, Utah, and Wyoming only date to the 1970s and 1980s.[55] Due to this regional variation, the study estimated the national emissions from onshore abandoned wells to be 0.14 megatons CH_4 per year.[56]

These studies have also suggested significant variation in methane emissions depending on plugging status. A 2016 study of 102 decommissioned oil and gas wells in the United Kingdom (U.K.) found that wells that had been decommissioned to meet U.K. standards ("cutoff, sealed, buried to 2 m, and vegetated including being returned to agricultural use") had a mean fugitive emission of less than "that for the agricultural activities that would take place on the reconstituted land." However, a control well that had been drilled in 1917 and abandoned "prior to the introduction of contemporary decommissioning regulations," with a visible well casing and observable gas discharge through a puddle, was estimated to have methane emissions 23 times as high as decommissioned wells.[57]

The 2016 study of abandoned wells in Colorado, Ohio, Utah, and Wyoming similarly found that "emissions from plugged and abandoned wells were significantly lower than from unplugged wells," as only one plugged well was a positive source of methane, while eight out of 20 unplugged wells were a positive source of atmospheric methane.[58] The 2016 follow-up study of abandoned wells in Pennsylvania similarly found unplugged gas wells to be particularly high methane-emitters.[59] In short, findings suggest that "plugging is essential for mitigation of methane emissions from abandoned wells,"[60] and that government regulators should focus on targeting "unplugged gas wells in noncoal areas" (wells drilled through mineable coal seams pose unique mitigation challenges, which are beyond the scope of this Article).[61] Thus, successful state regulation of orphaned wells can play a role in mitigating climate change.

II. Existing Orphaned Well Regulations

To mitigate the environmental harms caused by unplugged wells, states must: (1) prevent the additional orphaning of unplugged wells by current oil and gas operators, and (2) plug the wells that have already been orphaned without proper plugging and decommissioning. Generally, states address the first task by requiring financial assurances from operators, and address the second task by maintaining orphaned well reclamation funds.

A. Bonding and Financial Assurances

To ensure that operators properly plug and decommission their oil and gas wells, states require operators to post a financial assurance for the well at the time it is drilled. While states may accept a wide range of assurances, such as cash, certificates of deposit, or letters of credit, the most common form of assurance is a surety bond.[62] The bond functions as a type of insurance policy for the state in the event that a well is not properly decommissioned. If the company properly decommissions the well per state regulations, the bond is returned along with its accrued interest. If the company for any reason fails to properly decommis-

50. *Id.*
51. Mary Kang et al., *Identification and Characterization of High Methane-Emitting Abandoned Oil and Gas Wells*, 113 Proc. Nat. Acad. Sci. 13636 (2016), *available at* http://www.pnas.org/content/113/48/13636.full.
52. Townsend-Small et al., *supra* note 48 (identifying average emission rates observed from abandoned wells in the eastern United States of 14 grams of CH_4 per hour (g/h) as similar to the average emission rate from Pennsylvania (11 g/h)).
53. *Id.*
54. *Id.*
55. *Id.*
56. This is roughly equivalent to the annual greenhouse gas emissions from a coal fired power plant or from 739,317 passenger vehicles. *See* U.S. EPA, *Greenhouse Gas Equivalencies Calculator*, https://www.epa.gov/energy/greenhouse-gas-equivalencies-calculator (last updated Jan. 24, 2017).
57. The estimation was 8,604 kilograms (kg) carbon dioxide equivalent well per year (CO_2e/well/yr.), compared to properly decommissioned wells with an average of 364 kg CO_2e/well/yr. Ian M. Boothroyd et al., *Fugitive Emissions of Methane From Abandoned, Decommissioned Oil and Gas Wells*, 547 Sci. Total Env't 461 (2016), *available at* http://www.sciencedirect.com/science/article/pii/S0048969715312535.
58. Townsend-Small et al., *supra* note 48.
59. Kang et al., *supra* note 51.
60. Townsend-Small et al., *supra* note 48.
61. Plugged wells in mineable coal areas are also high emitters, as regulations generally required such wells to be vented in order to mitigate the danger of methane-induced risk of coal mine explosions. *See* Kang et al., *supra* note 51 (noting that "[s]tates that require venting in coal areas may want to consider alternatives that ensure safety while reducing methane emissions"); Ho et al., *supra* note 7, at 37 (identifying states with "special decommissioning requirements for well bores that pass through coal seams (related to environmental externalities, resource protection, and worker safety concerns)").
62. *See* Hager & Shaw, *supra* note 19, at 18 ("Requiring an operator to provide security, such as a bond or certificate of deposit, is the most common statutory response to the problem of assuring available funds for plugging a well at the end of its commercial life."); *see also* Ho et al., *supra* note 7, at 21-28 (comparing and assessing state bonding requirements).

sion the well, the state keeps the bond and puts the funds toward the cost of plugging the well.[63]

The bonds are underwritten by a third-party surety company that agrees to pay out claims to the state and charges the operator a premium (usually based on its credit worthiness and its compliance record).[64] Surety bonds help reduce moral hazard on the part of operators, as a poor decommissioning record will have a direct effect on the premium charged by the surety company.[65] States offer operators a choice between posting individual bonds (covering a single well) or blanket bonds (covering multiple wells). Individual bond amounts are generally based on well depth, while blanket bond amounts are generally based on an operator's number of wells and its compliance history.[66] When a well is sold, the new operator becomes responsible for the financial assurance and the former operator is released from the bonding requirement for that well, thus ensuring that there is no lapse in bond coverage.[67]

Theoretically, properly calibrated financial assurance would ensure that either operators properly decommission wells or the state receives funds sufficient to cover the cost of decommissioning any wells left unplugged.[68] Thus, financial surety bonding requirements have been implemented across all oil-producing states, as well as in many oil-producing countries abroad.[69] Numerous studies have supported bonding requirements in principle, but have criticized current state requirements as "wholly insufficient"[70] and "set too low to cover decommissioning costs."[71] Many state bonding levels have not been updated to keep pace with inflation or estimated reclamation costs.[72]

In particular, bonding levels often do not reflect the higher cost of decommissioning deep horizontal wells (the new norm in hydraulic fracturing, or fracking) compared to traditional shallow vertical wells.[73] Common suggested reforms include increasing bonding amounts,[74] better calibrating bonding requirements to account for a variety of factors influencing plugging and reclamation cost,[75] and ending the practice of blanket bonding.[76] Such critiques are having some effect. This past year, Missouri and Wyoming increased both their blanket and individual bonding rates.[77]

B. Orphaned Well Reclamation Funds

While bonding requirements can minimize (or ideally eliminate) the need for state funds to cover the cost of plugging any oil and gas wells improperly abandoned in the future, a separate program is needed to address the unplugged and improperly plugged wells that have already been orphaned. Most oil and gas producing states have set up orphaned well reclamation funds to cover the cost of plugging such wells.[78] Yet, in states with a long history of oil and gas drilling, orphaned well reclamation funds generally remain underfunded and poorly equipped to address the environmental challenges posed by the presence of hundreds of thousands of orphaned wells.

The money for state orphaned well reclamation funds generally comes from production taxes, fees, or other payments related to the oil and gas industry.[79] The most common approach is to impose a severance tax on the oil and gas produced in the state.[80] For example, funding for the Oil Field Cleanup Program of the Railroad Commission of Texas is derived primarily from taxes on gas (one-fifteenth of one cent for each thousand cubic feet) and oil (five-eighths of one cent on each barrel of 42 standard gallons) produced in the state.[81] California,[82] Colorado,[83] Louisiana,[84]

63. Benjamin Storrow, *Wyoming Raises Bonding Requirements for Oil and Gas Wells*, Casper Star Trib., Dec. 8, 2015, http://trib.com/business/energy/wyoming-raises-bonding-requirements-for-oil-and-gas-wells/article_74fe1dff-3305-5e5d-881a-27a6d6b874c8.html.
64. Vic Lance, *New Surety Bond Amounts for Missouri Oil and Gas Well Operators*, DrillingInfo, May 3, 2016, http://info.drillinginfo.com/new-surety-bond-amounts-for-missouri-oil-and-gas-well-operators/.
65. Lucas W. Davis, *Policy Monitor—Bonding Requirements for U.S. Natural Gas Producers*, 9 Rev. Envtl. Econ. Pol'y 128 (2015), *available at* http://reep.oxfordjournals.org/content/9/1/128.
66. Ho et al., *supra* note 7, at 21-28.
67. Davis, *supra* note 65, at 139.
68. Hager & Shaw, *supra* note 19, at 46 ("If the bonding scheme is appropriately crafted and is properly administered, then neither the landowner nor the public should be at risk for any exposure to the costs of any unplugged wells at lease termination.").
69. *See* State of Alaska, Department of Natural Resources, Division of Oil and Gas, Decommissioning, Removal, and Restoration Regulatory Review (2014), *available at* http://dog.dnr.alaska.gov/publications/Documents/OtherReports/DRR-ArcadisReport-20141128.pdf.
70. Danielle Changala et al., *Comparative Analysis of Conventional Oil and Gas and Wind Project Decommissioning Regulations on Federal, State, and County Lands*, 25 Electricity J. 29 (2012), *available at* http://www.sciencedirect.com/science/article/pii/S1040619011003198.
71. Ho et al., *supra* note 7, at 46; *see also* Daryl G. Purpera, Louisiana Legislative Auditor, Office of Conservation—Department of Natural Resources, Regulation of Oil and Gas Wells and Management of Orphaned Wells, Performance Audit 2 (2014), *available at* http://app.lla.state.la.us/PublicReports.nsf/0/D6A0EBE279B83B9F86257CE700506EAD/$FILE/000010BC.pdf ("In addition, [Office of Conservation's] financial security amounts, when required, are not sufficient to cover the cost to plug all wells").
72. For instance, until they were raised in 2012, Pennsylvania blanket bonding levels had remained the same since 1984. Laura Legere, *Bill Would Raise Shale Well Site Bonds*, PowerSource, Aug. 30, 2016, http://powersource.post-gazette.com/powersource/policy-powersource/2016/08/30/Bill-would-raise-oil-gas-well-site-bonds-Pennsylvania-Marcellus-shale/stories/201608300010.
73. State of Alaska, *supra* note 69, at ES-13.
74. Frosch & Gold, *supra* note 20 ("Lucas Davis, an associate economics professor at University of California, Berkeley, says current bonding levels are 'unreasonably low' and should be raised in anticipation of abandoned wells from fracking.").
75. Ho et al., *supra* note 7, at 47.
76. Lucas Davis, The Hamilton Project, Modernizing Bonding Requirements for Natural Gas Producers 19 (2016), *available at* http://www.hamiltonproject.org/assets/legacy/files/downloads_and_links/06_bonds_davis.pdf.
77. Lance, *supra* note 64; Storrow, *supra* note 63.
78. Orphaned Well Plugging Initiative, *supra* note 25, at 8-9.
79. *Id.*
80. *See id.*; *see also* Western Organization of Resource Councils, Reclamation Funds, *available at* http://www.worc.org/media/Reclamation-Fund-Fact-Sheet.pdf (discussing variation in funding of reclamation funds in western states).
81. Tex. Nat. Res. Code §81.116.
82. Cal. Pub. Res. Code §3263.
83. Colo. Rev. Stat. §34-60-122.
84. Fact Sheet, Louisiana Department of Natural Resources, Louisiana's Orphaned Well Program (June 30, 2010), http://www.dnr.louisiana.gov/index.cfm?md=newsroom&tmp=detail&aid=17.

Michigan,[85] Mississippi,[86] New Mexico,[87] Oklahoma,[88] Utah,[89] and Wyoming[90] all similarly fund orphaned well programs through severance taxes on oil and gas production within a mill rate set by statute.

The second-most common approach is to fund orphaned well programs through drilling permit fees. For example, in Pennsylvania, the DEP's Orphan and Abandoned Well Plugging Program is funded through orphan well surcharges of $200 and $100 for gas and oil well permits, respectively, and a $50 abandoned well surcharge on all well permits.[91] Illinois,[92] New York,[93] North Dakota,[94] and West Virginia[95] all follow a similar approach. While many states also provide for proceeds from the sale of salvaged equipment or of the remaining production potential of orphaned wells to be dedicated to orphaned well reclamation funds, older orphaned wells rarely offer much in the way of salvage value.[96]

States use these funds to maintain prioritized lists of orphaned wells and, as funding permits, to plug the highest priority wells. In 2008, the Interstate Oil and Gas Compact Commission (IOGCC)[97] developed a suggested prioritization schedule for plugging orphaned wells involving 10 factors related to the hazards posed by each well to health, safety, and the environment.[98] However, states still maintain slightly different prioritization systems.

For instance, in Texas, prioritization is based on "well completion," "wellbore conditions," "well locations with respect to sensitive areas," and "unique environmental, safety or economic concern."[99] In Kansas, prioritization is based on the risk posed by the well to surface water, groundwater, and public safety.[100] And in Pennsylvania, prioritization is based on "whether the well is on public or private land; its distance from public or private water supplies, accessible areas or buildings; its distance from streams, bodies of water, or wetlands; and whether or not it is in a special protection watershed."[101] The volume of methane gas leaking from an orphaned well is often taken into account as a public safety factor, due to the risk of ignition or explosion,[102] but the climate change impacts of methane leaks do not appear to be part of any published prioritization system. As a result, even wells leaking significant amounts of methane may remain unplugged for extended periods if they are not located near a water source or occupied buildings.[103]

In most states, orphaned well programs only have enough funds to plug a limited number of wells each year in comparison to the lengthy list of wells needing to be plugged. As of the end of the 2016 fiscal year, the Railroad Commission of Texas reported 10,161 orphaned wells in the state in violation of the commission's plugging rules.[104] Based on its 2015 rate of plugging roughly 290 orphaned wells per year, it would take more than 30 years to plug just the wells already placed on the commission's list.[105] Moreover, since 2012, the number of orphaned wells in the state has been increasing, as more wells have been added to the commission's list than have been plugged.[106]

Texas is not an outlier. At their current rates, Louisiana's orphaned well program would require roughly 30 years to plug the orphaned wells already on its list,[107] Ohio's orphaned well program would require 24 years to plug all those on its list,[108] and New York's program would require 15 years to do the same.[109] In Pennsylvania, it takes at least 10 years for orphaned wells that do not appear to pose an immediate risk to nearby structures to be plugged.[110] The last national survey of orphaned well reclamation funds in 2008 found similar problems nationwide, with the reported balances in state funds "insufficient to cover the probable plugging costs" of the orphaned wells already on the states' waiting lists.[111] It was estimated that plugging all identified orphaned wells would cost state oil and gas regulatory agencies in excess of $668 million, at a time when state orphaned well reclamation funds totaled only $2.8 million.[112]

85. Michigan Department of Environmental Quality, *Orphan Well Program Overview*, http://www.michigan.gov/deq/0,4561,7-135-3311_4231-112026--,00.html (last visited Apr. 18, 2017).
86. Miss. Code §53-1-73 (2013).
87. N.M. Stat. Ann. §§7-30-1 to 7-30-27.
88. *See* Charlie Passut, *Oklahoma Forced to Divert Well Plugging Funds, Unveiling New Quake Plan Monday*, NGI's Shale Daily, Mar. 4, 2016, http://www.naturalgasintel.com/articles/105586-oklahoma-forced-to-divert-well-plugging-funds-unveiling-new-quake-plan-monday.
89. Utah Code Ann. §40-6-14.
90. Wyo. Stat. §30-5-116 (2015).
91. DEP, Abandoned and Orphan Oil and Gas Wells and the Well Plugging Program (8000-FS-DEP1670), *available at* http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-116343/8000-FS-DEP1670.pdf.
92. 225 Ill. Comp. Stat. 725/1.
93. New York State Department of Environmental Conservation, *Well Plugging (2014)*, http://www.dec.ny.gov/energy/92920.html (last visited Apr. 18, 2017).
94. N.D. Cent. Code §38-08-04.5.
95. W. Va. Code §22-6-29.
96. Orphaned Well Plugging Initiative, *supra* note 25, at 13.
97. The IOGCC is a multistate government agency that serves as a forum for governors, state appointees, and key policy staff focusing on promoting the conservation and efficient recovery of key oil and natural gas resources. *See* IOGCC, *Homepage*, http://iogcc.publishpath.com/ (last visited Apr. 18, 2017).
98. IOGCC, Plugging Prioritization Schedule for Orphaned and Abandoned Well Sites (2008), *available at* http://groundwork.iogcc.ok.gov/sites/default/files/09IOG5571_PluggingPrioritySchedule.pdf.
99. Railroad Commission of Texas, Oil and Gas Division, Oil Field Cleanup Program Annual Report—Fiscal Year 2016 (2016), *available at* http://www.rrc.state.tx.us/media/37219/ogrc-annual-report-2016.pdf.
100. Kansas Corporation Commission, Abandoned Oil & Gas Well Status Report 2016 (2016), *available at* http://www.kcc.state.ks.us/legislative_reports/2016_abandoned_oil_gas_well_status_report.pdf.
101. DEP, Pennsylvania's Plan for Addressing Problem Abandoned Wells and Orphaned Wells (2000) (550-0800-001), *available at* http://www.elibrary.dep.state.pa.us/dsweb/Get/Document-48262/550-0800-001.pdf.
102. Kansas Corporation Commission, *supra* note 100.
103. Scott Detrow, *Perilous Pathways: Hunting for Hidden Wells*, StateImpact Pa., Oct. 11, 2012, https://stateimpact.npr.org/pennsylvania/2012/10/11/perilous-pathways-hunting-for-hidden-wells/.
104. Railroad Commission of Texas, *supra* note 99.
105. Frosch & Gold, *supra* note 20.
106. Railroad Commission of Texas, *supra* note 99.
107. Purpera, *supra* note 71.
108. Hoover, *supra* note 13.
109. New York State Department of Environmental Conservation, *supra* note 93.
110. David Conti, *Efforts Under Way to Find Abandoned Pa. Gas, Oil Wells*, TribLIVE, Mar. 12, 2016, http://triblive.com/business/headlines/10023211-74/wells-abandoned-state.
111. Orphaned Well Plugging Initiative, *supra* note 25, at 11.
112. *Id.*

While the orphaned wells already on state priority lists pose a significant challenge to orphaned well reclamation funds, those wells represent only the tip of the iceberg. Since decades often passed between the beginning of drilling in a state and the implementation of permitting and registration requirements,[113] states with early oil and gas plays may have hundreds of thousands of unrecorded abandoned wells, many of which may be unplugged. For example, the Independent Petroleum Association of America and the Pennsylvania DEP estimate that approximately 325,000 total oil and gas wells have been drilled in Pennsylvania.[114] Officials acknowledge that since the state only has records of roughly 120,000 wells on file (of which 88,300 are currently operating wells), there are "close to 200,000 wells that are largely or relatively unaccounted for in the commonwealth."[115] Both their location and plugging status remain unknown. Researchers have suggested that at minimum 30% of such wells are unplugged, but the actual percentage could be much higher.[116] Thus, conservative estimates would suggest that Pennsylvania has at least 60,000 unplugged orphaned wells that have not yet been added to its priority list. In comparison, the state has plugged only 3,000 such wells over the past 30 years.[117]

Other states with long histories of oil and gas extraction face similar problems. New York State reports suggest that the locations of more than one-half of the state's orphaned oil and gas wells are unknown.[118] The IOGCC found nationwide that the estimated number of undocumented or unidentified orphaned wells in need of plugging was roughly double the number of orphaned wells on existing plugging lists and exceeded the total number of wells plugged nationwide between 1992 and 2006. (Illinois, Pennsylvania, and Texas, three states known to have particularly high numbers of undocumented orphaned wells, did not provide estimates).[119] In short, plugging wells on existing lists represents less than one-half of the task.

Even before the discovery of the potential climate change impact of fugitive methane leaks from unplugged orphaned wells, states' plugging funds were acknowledged to be "insufficient to address timely cleanup of the remaining orphan wells."[120] Yet, very few concrete suggestions have been offered for reducing the population of orphaned wells. In its 2008 survey, the IOGCC suggested that states "continue to explore innovative and financial means to plug all existing orphan wells."[121] In a 2014 study of the state's management of orphaned wells, the Louisiana legislative auditor suggested "increasing production fees and identifying other sources of funds, such as permit fees, civil penalties, and inactive well fees" to generate additional funding for the state's plugging program.[122] In its 2016 study of inactive well policies, Resources for the Future suggested "states should develop more sustainable means of funding their orphaned well plugging programs."[123]

Undoubtedly, states should consider increasing existing fees and taxes to better fund orphaned well reclamation programs as a first step. However, given the current geographical distribution of oil and gas drilling as well as the political concerns of state officials, it is highly unlikely that existing approaches alone can effectively address the challenge. First, certain states with large numbers of orphaned wells have little to no contemporary oil and gas drilling through which to fund their well plugging programs.[124] In these states, where funding for well plugging must come out of general appropriations, orphaned well reclamation funds are a regular target of budget cuts and freezes,[125] and, in some cases, money may be transferred out of plugging funds to balance state general operating budgets.[126]

Second, even in states with active oil and gas drilling, efforts to increase severance taxes have become protracted political battles,[127] in part due to officials' unfounded fears that increased fees will disadvantage the state vis-à-vis other states in oil and gas development.[128] Moreover, when sev-

113. *Id.* at 3 ("On average, 60 years elapsed between the drilling of the first exploratory well and the establishment of a formal regulatory system.").
114. Scott Detrow, *Perilous Pathways: Behind the Staggering Number of Abandoned Wells in Pennsylvania*, StateImpact Pa., Oct. 10, 2012, https://stateimpact.npr.org/pennsylvania/2012/10/10/perilous-pathways-behind-the-staggering-number-of-abandoned-wells-in-pennsylvania/ (discussing the slowing of the Marcellus Shale boom leading to a slowdown in orphan well plugging).
115. *Id.*
116. Kang et al., *supra* note 51.
117. Jennifer Oldham, *In the Birthplace of U.S. Oil, Methane Gas Is Leaking Everywhere*, Bloomberg, June 20, 2016, https://www.bloomberg.com/news/articles/2016-06-20/in-the-birthplace-of-u-s-oil-methane-gas-is-leaking-everywhere.
118. Ronald E. Bishop, *Historical Analysis of Oil and Gas Well Plugging in New York: Is the Regulatory System Working?*, 23 New Solutions 103 (2013), *available at* https://www.ncbi.nlm.nih.gov/pubmed/23552650 ("reports from 2002 onward suggest that the locations of fully half of our orphan abandoned oil and gas wells are not known").
119. Orphaned Well Plugging Initiative, *supra* note 25, at 8.
120. *Id.* at 17.
121. *Id.*
122. Purpera, *supra* note 71, at 25.
123. Ho et al., *supra* note 7, at 48.
124. For further discussion of the challenges posed by this geographic variation, see Part III.A., *infra*.
125. *See* Joe Wertz, *As Budgets Narrow and Dedicated Funds Are Diverted, Agency Slows Plugging of Abandoned Wells*, StateImpact Okla., Mar. 3, 2016, https://stateimpact.npr.org/oklahoma/2016/03/03/as-budgets-narrow-and-dedicated-funds-are-diverted-agency-slows-plugging-of-abandoned-wells/.
126. *See* Marty Hobe, *Well-Sealing Efforts Could Dry Up With State Funds*, Register-Mail, June 21, 2015, http://www.galesburg.com/article/20150621/NEWS/150629992.
127. *See* Jeremy Pelzer, *Like Ohio, Pennsylvania Embroiled in Political Fight Over Fracking Taxes*, Clevland.com, Nov. 2, 2015, http://www.cleveland.com/open/index.ssf/2015/11/like_ohio_pennsylvania_embroil.html:
> A severance tax has been a sticking point in a four-month-long budget impasse in Pennsylvania. And in Ohio, lawmakers removed Kasich's severance tax plan from the budget and have worked in vain for more than a year to find a compromise between the governor's office and the oil and gas industry, which opposes any tax increase.

128. Barry G. Rabe & Rachel L. Hampton, *Taxing Fracking: The Politics of State Severance Taxes in the Shale Era*, 32 Rev. Pol'y Res. 389 (2015):
> Our findings generally suggest that state officials have become more cautious in setting statutory rates for severance taxes, with some pursuing rate reduction strategies in an effort to gain a competitive advantage over other states. There is little empirical evidence to suggest statutory rates are significant drivers behind investment decisions related to drilling in recent years but many state legislators and governors have raised these questions in exploring possible rate reductions or opposing increases.

erance taxes do produce significant revenue for orphaned well plugging, legislators may seek to divert funds from plugging efforts to instead help balance state or municipal budgets.[129] In short, state orphan well reclamation funds are likely to remain insufficient to quickly address the challenge of plugging orphaned wells. Thus, states should consider alternative approaches to the problem based on other efforts to address orphaned pollution.

III. Alternative Approaches From Domestic Comparative Law

The regulatory challenges posed by fugitive methane emissions from orphaned wells are similar to the challenges posed by abandoned coal mines and abandoned hazardous waste sites, as all three share the same general characteristics of orphaned pollution. They were often abandoned by their original profit-making owners long before the development of environmental protection regulations imposing site remediation requirements. Third parties are likely to have little interest in acquiring such sites, as the value of remaining resources (or the remaining use value of the sites) are almost always less than the cost of required remediation.[130] Thus, without some type of state intervention, such sites would remain unremediated and continue to cause significant environmental harm.

Because of these same basic similarities, SMCRA, CERCLA, and the CARB Mine Methane Capture Projects Compliance Offset Protocol represent alternative regulatory mechanisms for addressing the challenge of orphaned wells. The "domestic comparative law" approach, of "apply[ing] the methods of legal precedents to policy questions by analogy to similar situations with which the law has coped successfully,"[131] illustrates the ways in which these alternative regimes may be preferable to current practices.

A. *SMCRA Historical Coal Grants*

SMCRA was designed to address environmental concerns over surface coal mining through a cooperative federalism approach.[132] First, SMCRA establishes minimum federal standards for the regulation of coal mining, but then permits states to take exclusive jurisdiction over the regulation of surface coal mining provided their regulations meet these federal standards.[133] As part of these minimum federal standards, SMCRA requires that states implement a bonding requirement sufficient to "assure the completion of the reclamation plan if the work had to be performed by the regulatory authority."[134]

Second, SMCRA establishes the Abandoned Mines Reclamation Fund to support the cleanup of lands and waters damaged by mines abandoned before the passage of the statute in 1977.[135] Money for the fund comes from a reclamation fee of 28 cents per ton of coal produced by surface coal mining and 12 cents per ton of coal produced by underground mining.[136] Thus, the overall regulatory scheme of SMCRA—a bonding requirement to cover the cost of any future abandonment and a reclamation fund to cover the cost of cleaning up previously abandoned mines—is quite similar to most existing state schemes for orphaned wells.

One unique aspect of SMCRA's Abandoned Mine Reclamation Fund is the way in which funding is collected and distributed. The reclamation fee is assessed on operators nationwide, but 50% of the reclamation fees collected annually in any state are allocated to that state's own abandoned mine reclamation program.[137] States can use these funds to remediate any abandoned coal mine, and if all the coal mines in the state have been restored, the funds can then be used to remediate hardrock mines.[138] In addition, since fiscal year 1996, 30% of the reclamation fees is distributed to states in the form of "historical coal grants" based on their pre-1977 coal production, and 20% is designated as the federal expenditure share to be used for administrative costs and various programs.[139]

129. *See*, *e.g.*, Jamison Cocklin, *Ohio Lawmaker Wants More Severance Tax Revenue Distributed to Oil/Gas Drilling Communities*, NGI's Shale Daily, June 6, 2016, http://www.naturalgasintel.com/articles/106660-ohio-lawmaker-wants-more-severance-tax-revenue-distributed-to-oilgas-drilling-communities.
130. *See* Hager & Shaw, *supra* note 19, at 8 ("Most oil producing operations, however, are on lands that have limited potential for real estate development. Plugging the wells to make way for other uses may not be cost effective.").
131. E. Donald Elliott, *Rationing Analysis of Job Losses and Gains: An Exercise in Domestic Comparative Law* (Sept. 27, 2012), *available at* https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2158324.
132. *See* Hodel v. Virginia Surface Mining & Reclamation Ass'n, 452 U.S. 264, 289, 11 ELR 20569 (1981) ("the Surface Mining Act establishes a program of cooperative federalism that allows the States, within limits established by federal minimum standards, to enact and administer their own regulatory programs, structured to meet their own particular needs"); *see also* New York v. United States, 505 U.S. 144, 167-68, 22 ELR 21082 (1992) (identifying the Clean Water Act, the Occupational Safety and Health Act of 1970, the Resource Conservation and Recovery Act of 1976, and the Alaska National Interest Lands Conservation Act as illustrative examples of statutory schemes embodying cooperative federalism).
133. 30 U.S.C. §1253; *see also* Barbara S. Weber & David J. Weber, *Promoting Economic Incentives for Environmental Protection in the Surface Mining Control and Reclamation Act of 1977: An Analysis of the Design and Implementation of Reclamation Performance Bonds*, 25 Nat. Resources J. 389 (1985) (describing and analyzing the regulatory design of SMCRA).
134. *Id.* §1259.
135. *Id.* §1231; Office of Surface Mining Reclamation and Enforcement, U.S. Department of the Interior, *OSMRE's Major Programs*, https://www.osmre.gov/programs.shtm (last modified Dec. 15, 2016).
136. *Id.* §1232.
137. *Id.* §1232(g)(2).
138. *The Earth's Open Wounds: Abandoned and Orphaned Mines*, 111 Envtl. Health Persp. A155 (2003), *available at* https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1241402/pdf/ehp0111-a00154.pdf.
139. 30 U.S.C. §1232(g)(5)(A). *See* Eric L. Dixon & Kendall Bilbrey, AML Policy Priorities Group, Abandoned Mine Land Program: A Policy Analysis for Central Appalachia and the Nation 87-95 (2015), *available at* https://appalachiancitizenslaw.files.wordpress.com/2015/07/abandoned-mine-reclamation-policy-analysis.pdf; *see also* A. Brooke Rubenstein & David Winkowski, *A Mine Is a Terrible Thing to Waste: Past, Present, and Future Reclamation Efforts to Correct the Environmentally Damaging Effects of Coal Mines*, 13 Vill. Envtl. L.J. 189, 204 (2002); Paul Stokstad, *Structuring a Reclamation Program for Abandoned Noncoal Mines*, 25 Ecology L.Q. 121, 142 (1998) (discussing the way in which funding based on historical production was instituted to replace the original, and widely criticized, allocation scheme based upon discretionary findings of state need by the Office of Surface Mining).

Thus, one-half of the funds are distributed in proportion to the current levels of coal mining in each state, and roughly one-third of the funds are distributed in proportion to each state's historic share of coal mining. The formula was designed as a compromise measure to assure the western states that their current coal production profits would not be used solely for financing cleanup projects in the East. This formula has been criticized by environmental groups for not distributing funds based on need—Wyoming, which produces 40% of the nation's coal, has relatively few unreclaimed abandoned coal mines in comparison to Pennsylvania and West Virginia, which currently produce less coal and have many more unreclaimed abandoned mines.[140]

While SMCRA's distribution formula may not be ideal, it better balances the reclamation needs of currently producing states and historical producers than the current system of state-level orphaned well reclamation funds. Like coal production, the location of oil and gas production has also varied significantly over time. A number of early producers such as Kentucky and New York have large numbers of orphaned wells, but low levels of current production.[141] On the other hand, leading oil and gas producers such as Alaska and North Dakota have few to no orphaned wells.[142] As a result, North Dakota, the site of the recent Bakken shale boom, has no orphaned wells and a $13.7 million balance in its Abandoned Oil/Gas Well Plugging and Site Reclamation Fund,[143] while New York has thousands of orphaned wells on its priority list, but only $106,566 in its Oil and Gas Account.[144] State legislatures occasionally provide additional funding to orphaned well programs through appropriations from other sources,[145] but generally the funding available to state orphaned well plugging programs is a direct function of the amount of drilling in the state.[146]

A cooperative federal program in the vein of SMCRA's historical coal grants that distributes a portion of funding based on historical oil and gas production could help ensure that states with many orphaned wells get a reasonable share of reclamation funding, even if there is little current production in the state. Additionally, by designing a distribution formula for these "historical oil/gas grants" that takes into account both (1) historic production and (2) the number of newly identified unplugged orphaned wells located in each state after the passage of the Act, state regulators would have an incentive to more actively search for unplugged abandoned wells, rather than depend on citizen volunteers.[147] Such grants may also better target the climate change impacts of fugitive emissions from orphan wells than the current system, as there is scientific evidence that methane emissions from abandoned wells are higher in states with early oil and gas plays.[148] Thus, plugging wells in eastern states may reduce methane emissions more than plugging an equal number of wells in western states.

Even if the climate change justifications for plugging orphaned wells receive some pushback at the federal level, the traditional public health and safety justifications of well plugging and the cooperative federalism aspect of the proposal may allow a federal Abandoned Well Reclamation Fund to gain some traction in Washington, D.C. Moreover, the fund could help put many unemployed oil and gas service workers back to work in states that have seen declines in oil and gas production, by supporting additional well plugging jobs in these states.[149]

B. CERCLA PRPs

CERCLA, commonly known as Superfund, was enacted to fund the cleanup of sites contaminated with hazardous waste and pollutants.[150] Two major elements of CERCLA are a broad liability scheme for current and past owners and operators of hazardous waste sites, and the establishment of the Hazardous Substance Superfund. CERCLA creates four categories of PRPs: (1) current owners and operators of a facility, (2) past owners and operators at the time the pollution occurred, (3) persons who arranged for disposal of a hazardous substance at a site, and (4) persons who transported a hazardous substance to the site.[151] EPA can order PRPs to arrange and undertake the cleanup of a site,[152] or EPA can arrange and carry out the cleanup of a

140. *See*, *e.g.*, Dixon & Bilbrey, *supra* note 139, at 133; *The Earth's Open Wounds*, *supra* note 138.
141. IOGCC, Ground Work 6 (2009), *available at* http://groundwork.iogcc.ok.gov/sites/default/files/Orphaned%20Wells%20Case%20Study_0.pdf.
142. Geoffrey Morgan, *North Dakota's Last Orphan: Why Is America So Much Better at Cleaning Up the Oil Bust?*, Fin. Post, Mar. 8, 2016, http://business.financialpost.com/news/energy/north-dakotas-last-orphan-how-canada-needs-a-lesson-on-cleaning-up-an-oil-boom-gone-bust?__lsa=2e6c-a5da ("The last time there was more than one orphan well in North Dakota was 2011, when there were two.").
143. Office of the North Dakota State Treasurer, *North Dakota Government Funds*, http://www.nd.gov/treasurer/north-dakota-government-funds/ (last updated Mar. 20, 2017).
144. New York State Department of Environmental Conservation, *supra* note 93.
145. *See* Detrow, *supra* note 114 ("Things changed in 2000, when a state bond issue called 'Growing Greener' passed. The bond money, aimed at boosting environmental efforts, added an average of $1.1 million to the program's annual surcharge revenues over the ensuing decade."); New York State Department of Environmental Conservation, *supra* note 93 ("The State's 2013-2014 FY included $2 million for the plugging of orphan and abandoned oil and gas wells . . . termed the New York Works Well Plugging Initiative (NYWWPI).").
146. *See* Detrow, *supra* note 114.
147. *See* Conti, *supra* note 110 ("At Penn State University . . . Nooreen Meghani, a research assistant in the school's Earth and Environmental Systems Institute, is using part of a $2.5 million multiyear National Science Foundation grant to train volunteers to find wells and record their locations with GPS units.").
148. *See supra* note 54 and accompanying text.
149. *See* Rachel Amann et al., IOGCC, New Energy Technologies: Regulating Change 247 (2010), *available at* https://www.netl.doe.gov/file%20library/Research/oil-gas/NT15567_FinalReport.pdf ("Federal funding assistance would be extremely helpful in boosting state plugging programs, while at the same time creating jobs and eliminating future environmental threats."); *see also* Colette Derworiz, *Alberta's Oil and Gas Wells Are Triggering a Multibillion Dollar Bill*, Nat'l Observer, Feb. 27, 2017, http://www.nationalobserver.com/2017/02/27/news/albertas-oil-and-gas-wells-are-triggering-multibillion-dollar-bill (suggesting a proposed well plugging program in Alberta would likely "put[ ] hundreds of oil and gas service workers back to work").
150. CERCLA contains an exemption for oil and gas drilling operations. 42 U.S.C. §9601.
151. *Id.* §9607.
152. *Id.* §9606.

site and then attempt to recover costs from PRPs in a subsequent lawsuit.[153] PRP liability is strict, joint and several, and retroactive. This means that PRPs can be held liable for cleanup without a finding of negligence, individual PRPs may be held liable for the entire cleanup of the site, and PRPs may be held liable for acts that happened prior to 1980. CERCLA also allows PRPs to seek contribution from other parties through civil actions.[154]

The practical result is that the government can recover all its cleanup costs in a single lawsuit against one or a few PRPs. The burden is then on these defendants to bring legal actions against any other responsible parties for their share of the cost of cleanup.[155] The Superfund serves as an alternative source of financing for cleanup operations. Funding originally came from taxes on crude oil and certain chemicals, as well as an environmental tax on corporations. But since these taxes expired in 1995, the funding now comes from general EPA appropriations and one-time allocations—most notably an injection of $582 million from the American Recovery and Reinvestment Act of 2009 ("the stimulus").[156]

Under current oil and gas abandonment regulations, when state regulators discover unplugged wells without an obvious operator or owner, they will attempt to find a responsible party before declaring a well orphaned.[157] Regulators must often sort through tangled and poorly documented ownership histories in the hope of finding a responsible party.[158] State regulations generally define responsible parties as the last owner or operator of a lease or well.[159] States that define "owner" and "operator" based on their interest in a "lease" rather than a "well" functionally impose slightly more expansive liability. This distinction is illustrated by a situation in which: "Producer A drills a well in 1934 which ceases production in 1939. The lease is surrendered. In 1988 Producer B takes a new lease and drills a new well to a deeper horizon." In states where ownership or operatorship is based on interest in a "lease," Producer B would likely be responsible for the 1934 well, while in states where owner/operatorship is based on interest in a "well," Producer A would be responsible (making it more likely the well would be considered orphaned).[160]

However, in either case, prior owners or operators who later conveyed their interest to a more recent owner or operator are not considered responsible parties. Only a few states impose broader responsibility for well plugging beyond the last owner or operator. Most significantly, in Pennsylvania, responsibility for plugging orphaned wells can be imposed on any prior owner or operator who "received economic benefit, other than economic benefit derived only as a landowner or from a royalty interest, after April 18, 1979," from the well.[161] State regulatory schemes almost never impose responsibility on landowners for well plugging costs.[162]

Adopting a variation of CERCLA's broad liability scheme for orphaned wells may enable state regulators to plug more orphaned wells while using fewer state resources. For instance, regulations could provide that all owners and operators of a lease are jointly and severally liable for the cost of plugging. A state could then recover the cost of plugging an orphaned well from any past owner or operator still in existence and not just the last responsible party. Such regulations may allow states to reach back beyond bankrupt stripper firms and collect funds from original owners and operators.[163] However, even this broadened liability may have little impact in states where orphaned wells often pre-date permitting and registration requirements, as some knowledge of a well's ownership history is still required.

States could also impose PRP liability on current oil and gas operators for any orphaned wells discovered within a set distance of their wells. This would be a logical extension of recent Pennsylvania rules that require operators to identify any "abandoned, orphan, active and inactive wells within 1,000 feet of the vertical and horizontal wellbore prior to hydraulic fracturing."[164] While operators might

153. *Id*. §9607.

154. *Id*. §9613.

155. *See* Theodore L. Garrett, *Superfund Liability*, *in* Environmental Liability and Insurance Recovery 1 (David L. Guevara & Frank J. Deveau eds., 2013), *available at* http://apps.americanbar.org/abastore/products/books/abstracts/5190479_chap1_abs.pdf.

156. *See* John M. Broder, *Without Superfund Tax, Stimulus Aids Cleanups*, N.Y. Times, Apr. 25, 2009, http://www.nytimes.com/2009/04/26/science/earth/26superfund.html.

157. *See* Conti, *supra* note 110:

> Overseen by environmental program manager Seth Pelepko, DEP staff seek to find responsible parties for old, non-producing wells by researching property records or looking into ownership or operation of nearby equipment. "If there is a responsible party, we don't want to add a well to the orphan and abandoned list," Pelepko said.

However, some states only endeavor to identify and recover funds from responsible parties once the cost of well cleanup exceeds a certain threshold amount. *See House Committee Rejects Area Lawmaker's Bill on Abandoned Oil Wells*, HoumaToday.com, May 18, 2016, http://www.houmatoday.com/news/20160518/house-committee-rejects-area-lawmakers-bill-on-abandoned-oil-wells ("Currently the [Louisiana] Department of Natural Resources can only try to recover cleanup costs from past operators once the tab exceeds $250,000.").

158. *See* Hoover, *supra* note 13.

159. *See*, *e.g.*, Kan. Stat. Ann. §55-179; N.D. Cent. Code §38-08-04.8; Ohio Department of Natural Resources, Oil & Gas Resources Management, Ohio Landowner's Guide to the Orphan Well Plugging Program, *available at* http://oilandgas.ohiodnr.gov/portals/oilgas/pdf/orphan/Orphan%20Well%20Program%20Brochure_2014.pdf.

160. R. Neal Pierce & Sharon O. Flanery, *Orphans, Foundlings, and Wards of the State: Plugging Liability for Orphan and Abandoned Wells in the Eastern States*, 14 Energy & Min. L. Inst. ch. 19 (1993), *available at* http://www.emlf.org/index.php?src=directory&view=whitepaper&srctype=detail&back=whitepaper&refno=3912.

161. 58 Pa. Cons. Stat. §3220(a); *see also* Cal. Pub. Res. Code §3237:

> The supervisor may continue to look seriatim to previous operators until an operator is found that the supervisor determines has the financial resources to cover the cost of plugging and abandoning the well. However, the supervisor may not hold an operator responsible that made a valid transfer of ownership of the well prior to January 1, 1996.

162. *See*, *e.g.*, 58 Pa. Cons. Stat. §3220(a).

163. Generally, stripper firms are among the smallest and least well-capitalized businesses in the oil and gas industry. *See* Nicole Friedman, *"Strippers" Pose Dilemma for Oil Industry*, Wall St. J., Sept. 7, 2015, https://www.wsj.com/articles/stripper-wells-are-wild-card-in-oil-rout-1441660049; Liz Hampton, *U.S. Oil "Strippers" Maneuver to Keep Pumping Amid Crude Slump*, Reuters, Jan. 4, 2016, http://www.reuters.com/article/us-oil-markets-stripperwells-idUSKBN0UI0D220160104.

164. Environmental Protection Performance Standards at Oil and Gas Well Sites, 25 Pa. Code §78a.52a.

complain about paying plugging fees for wells "drilled by someone 50 or 60 years ago,"[165] current operators would have an opportunity to track down any past owners or operators for contributions.

Another concern is that expanded liability would lead operators to actively seek out orphaned wells and then locate rigs to avoid drilling in their proximity. However, even if this were the case, as long as states implement mandatory orphaned well reporting requirements, these industry efforts would at a minimum assist the state in locating unregistered orphaned wells. States would also need to ensure that this expanded liability would not be too heavy so as to force operators to exit the industry. To limit the burden on current operators, states could consider yearly caps on the amount of orphaned well PRP liability or could limit orphaned well plugging liability to the number of new wells drilled by an operator.

C. CARB Methane Capture Offset Credits

A final alternative approach is illustrated by the CARB Mine Methane Capture Projects Compliance Offset Protocol. As part of California's greenhouse gas cap-and-trade system, covered entities can purchase carbon offset credits from emission-reduction projects in the United States to cover up to 8% of their compliance obligations.[166] Under the state's regulations, emission-reduction projects related to forestry, urban forestry, dairy digesters, destruction of ozone-depleting substances, mine methane capture, and rice cultivation are eligible to generate offset credits that can then be purchased by California entities.[167] A variety of different projects that capture and destroy methane that would otherwise be vented into the atmosphere as a result of previously existing mining operations are eligible for offset credits, including projects focused on abandoned underground mines.[168] Two abandoned mine projects have been granted offset credits: the Cambria 33 Abandoned Mine Methane Capture and Use Project in Pennsylvania[169] and the Corinth Abandoned Mine Methane Recovery Project in Illinois.[170]

The other existing cap-and-trade system in the United States, the Regional Greenhouse Gas Initiative (RGGI), which currently includes Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New York, Rhode Island, and Vermont, also allows covered electrical generation facilities to purchase offset credits from projects outside the capped sector that reduce and/or sequester emissions of greenhouse gases.[171] While landfill gas (methane) capture and combustion, as well as avoided methane emissions from agricultural manure management operations, are eligible for credits, no other types of methane reduction are currently eligible.[172] The RGGI limited the number of offset credit opportunities due to concerns about the initiative's institutional capability of "developing credible, environmentally-sound quantification protocols."[173] Because the prices of RGGI allowances have remained extremely low, no allowances derived from emissions offset projects have been sold thus far and the initiative has not developed standards for any new offset credit projects.[174]

In theory, expanding methane capture offset credits to reductions in methane emissions from the plugging of previously orphaned wells could incentivize private actors to engage in plugging. Currently, some states allow operators to adopt orphaned wells off plugging lists by posting a bond.[175] If the price of offset credits was sufficiently high, there would be a market-based incentive for operators to adopt such wells, plug them, and then sell the emission offset credit. Since the amount of offset credit would be determined by the volume of methane that would otherwise be vented into the atmosphere, operators would also have an incentive to track down and plug "super-emitting" wells to receive the most credits. This would provide a unique advantage over other regulatory approaches because it would naturally prioritize the plugging of wells that contribute most to climate change.

The offset credit regime would also have the advantage of ending dependence on oil and gas production fees for funding orphaned well programs without imposing additional costs directly on taxpayers. Under the current system, the level of funding available to state orphaned well programs often depends entirely on the level of oil and gas production in the state.[176] Even if a federal Abandoned Well Reclamation Fund came to fruition, the funding available for well plugging would still be tied to the overall level of oil

165. Conti, *supra* note 110.

166. CARB, Overview of ARB Emissions Trading Program (2015), *available at* https://www.arb.ca.gov/cc/capandtrade/guidance/cap_trade_overview.pdf.

167. CARB, *Compliance Offset Program*, https://www.arb.ca.gov/cc/capandtrade/offsets/offsets.htm (last visited Apr. 12, 2017).

168. CARB, Compliance Offset Protocol Mine Methane Capture Projects (2014), *available at* https://www.arb.ca.gov/regact/2013/capandtrade13/ctmmcprotocol.pdf.

169. Terrapass, *Cambria 33 Abandoned Coal Mine Methane Capture Project*, https://www.terrapass.com/project/cambria-33-abandoned-coal-mine-methane-capture-project (last visited Apr. 18, 2017).

170. Ruby Cannon Engineering, Verified Carbon Standards Monitoring Report, Corinth Abandoned Mine Methane Recovery Project (2013), *available at* http://www.vcsprojectdatabase.org/#/project_details/573.

171. RGGI, *Offset Categories*, https://www.rggi.org/market/offsets/categories (last visited Apr. 18, 2017).

172. RGGI, *CO_2 Offsets*, https://www.rggi.org/market/offsets (last visited Apr. 18, 2017).

173. RGGI, Summary of RGGI Stakeholder Workshop on GHG Offsets (2004), *available at* https://www.rggi.org/docs/offsets_workshopsummary.pdf ("Workshop participants emphasized the need to go slow, start with simpler examples, increase incrementally, and as much as possible, avoid making mistakes."). RGGI considered awarding offset credits for reductions in fugitive emissions from natural gas transmission and distribution systems, but held off on implementing such offsets over concerns about the lack of accurate systemwide measurements of transmission and distribution gas losses. *See* RGGI, States Solicit Comments on Draft Model Rule (2006), *available at* https://www.rggi.org/docs/cover_memo_to_public_review_draft_4.4.pdf.

174. *See* Gloria Gonzalez, *RGGI Roars Back to Life With Record Carbon Prices*, Ecosystem Marketplace, Mar. 13, 2014, http://www.ecosystemmarketplace.com/articles/rggi-roars-back-to-life-with-record-carbon-prices/; Potomac Economics, RGGI, Annual Report on the Market for RGGI CO_2 Allowances: 2015 (2016), *available at* https://www.rggi.org/docs/Market/MM_2015_Annual_Report.pdf.

175. Orphaned Well Plugging Initiative, *supra* note 25, at 8-9.

176. *See* Part III.A., *supra*.

and gas production in the United States, meaning that any reductions in drilling would reduce the money available for plugging. However, since offset credits are purchased by a wide range of greenhouse gas-producing facilities (including those outside the oil and gas industry), an offset credit regime would continue to provide an economic incentive for plugging orphaned wells even if domestic oil and gas production significantly declined.

Despite these advantages, it is unlikely that an offset credit regime would incentivize orphaned well plugging projects without a significant increase in the market price for carbon dioxide equivalent (CO_2e) allowances. In California, the most recent price for a one-ton CO_2e allowance was $12.73.[177] Based on an estimated 8,604 kilograms (kg) CO_2e per year of methane emissions from a "super-emitting" unplugged orphaned well,[178] the offset credit from plugging a well would be worth roughly $100 per year. Yet, the average cost of plugging an orphaned well is roughly $17,000.[179] Even an increase in CO_2e allowance prices to $33 (a level considered but rejected in France)[180] would likely be insufficient to make plugging orphaned wells cost-neutral.

However, even if an offset credit regime would be insufficient to fully incentivize private actors to engage in for-profit orphaned well plugging at current CO_2e allowance prices, the offset credits might still offer some advantages. The credits would allow state orphaned well reclamation funds to recoup a portion of their well plugging costs. Additionally, the presence of a potential offset credit may help spur the development of new cost-effective well plugging techniques or more specialized decommissioning infrastructure.

IV. Recommendations and Conclusion

Existing orphaned well reclamation funds are insufficient to deal with the hundreds of thousands of unplugged orphaned wells in the United States. With new research suggesting that fugitive emissions from orphaned wells may represent a significant portion of anthropogenic methane emissions, alternative approaches are needed. SMCRA historical coal grants, CERCLA PRPs, and CARB methane capture offset credits represent three different approaches to addressing orphaned pollution. For states with significant current oil and gas production, adapting a PRP scheme is the best way to ensure they have sufficient money to plug orphaned wells without raising funds directly from taxpayers. Imposing PRP liability on current operators would force those unable to locate other existing PRPs to bear the cost of plugging a well that they did not drill. Yet this is preferable to the existing scheme, in which operators pay a severance tax, but chronically understaffed and underfunded state regulators are responsible for tracking down a narrow range of responsible parties.

However, expanded liability would still have a negligible impact in states with many early-century orphaned wells but low current oil and gas production—without accurate historical ownership records or current oil and gas operators, there is no party to be held responsible for plugging costs. Since states have generally been unwilling to fund orphaned well programs though general appropriations, there is a strong need for a cooperative federal granting program, similar to SMCRA historical coal grants, to help cover the cost of plugging orphaned oil and gas wells in these states.

Through the combination of expanded PRP liability, cooperative federal granting (and perhaps granting carbon offsets in the future), it is possible to more quickly plug "super-emitting" wells and thus mitigate the climate change effects of fugitive methane emissions from orphaned oil and gas wells.

177. CARB, California Cap-and-Trade Program Summary of Joint Auction Settlement Prices and Results (2017), *available at* https://www.arb.ca.gov/cc/capandtrade/auction/results_summary.pdf.
178. Boothroyd et al., *supra* note 57.
179. Railroad Commission of Texas, *supra* note 99.
180. Geert De Clercq & Emmanuel Jarry, *France to Drop Carbon Tax Plan: Les Echos*, Reuters, Oct. 20, 2016, http://www.reuters.com/article/us-france-carbon-idUSKCN12K2OG.