ORAL ARGUMENT NOT YET SCHEDULED

IN THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

No. 24-1054 and consolidated cases

STATE OF TEXAS, ET AL.,
Petitioners,

v.

U.S. ENVIRONMENTAL PROTECTION AGENCY, ET AL.,
Respondents.

OPPOSITION OF ENVIRONMENTAL AND HEALTH RESPONDENT-INTERVENORS TO INDUSTRY PETITIONERS' MOTION FOR STAY

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Rule	Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review, 89 Fed. Reg. 16,820 (Mar. 8, 2024)
Section 111	42 U.S.C. § 7411
Section 136	42 U.S.C. § 7436
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INTRODUCTION

Although Industry Movants seek a sweeping stay of the Rule, their arguments focus on faulty claims about impacts to marginal wells—low producing wells that generate less than 15 barrels of oil equivalent per day. While they account for only 7% of the Nation's oil and gas production, marginal wells are collectively responsible for half of methane emissions from oil and gas well sites. 89 Fed. Reg. 16,820, 16,926 (Mar. 8, 2024). Long past their higher producing days, marginal wells tend to be old, leaky, and in disrepair (for example, nearly all of movant Miller Energy's wells are over 40 years old, Attachment A, Muehlenbachs Decl. ¶20), contributing to their disproportionately large pollution.

Over 92% of marginal wells are owned by larger companies that also own many higher producing wells and generate millions in revenue. Muehlenbachs Decl. ¶18. Oftentimes, companies decline to properly close these wells in order to avoid plugging and remediation costs or to maintain lease rights, leaving the wells to continue releasing potent climate-disrupting and health-harming gas. *Id.* ¶26; Attachment B, Alexander Decl. ¶10. Congress recently acknowledged this problem,

providing millions of dollars to support methane mitigation and plugging efforts at marginal wells. 42 U.S.C § 7436(b).

Recognizing marginal wells' significant pollution and their above-mentioned characteristics, EPA took a tailored approach when setting standards in the Rule. The Agency subcategorized well sites based on factors including the site's complexity and equipment while also examining the financial impacts of the standards on marginal wells specifically. The Rule provides, among other things, greater flexibility with lower compliance costs for small sites and those producing minimal associated gas. Because nearly all marginal wells are considered existing sources under the Rule, they are subject to a longer compliance timeline with potential for additional flexibilities through state-granted variances. And all new wells—including any marginal new wells—have been subject to leak monitoring and other requirements since 2016 under 40 C.F.R. part 60, subpart OOOOa ("2016 Rule") and face only incremental changes in compliance costs under this Rule.

Movants are unlikely to succeed on the merits. EPA determined costs were reasonable based on multiple, detailed analyses and

extensively supported its approach to subcategorization, adhering to the requirements of Section 111 and this Court's longstanding precedents. Nor can Movants show that any irreparable harm is imminent and certain for owners of marginal wells. In contrast, a stay of the Rule would impose severe harm to Respondent-Intervenors' members and the public by allowing millions of additional tons of climate- and health-harming pollution from oil and gas sources—harms that, by their nature, cannot be remedied. Movants thus fail to meet the standard for the extraordinary remedy of a stay, *see Nken v. Holder*, 556 U.S. 418, 434 (2009), and the Court should deny the motion.

BACKGROUND

The statutory and regulatory background are set forth in our and EPA's initial stay opposition briefs. Environmental and Health Respondent-Intervenors Opp'n, 2-6 (filed May 6, 2024) (Doc. 2053103); EPA Opp'n, 2-7 (filed May 6, 2024) (Doc. 2053091).

ARGUMENT

I. Industry Movants Are Not Likely to Succeed on the Merits.

a. EPA's Analysis of Cost Comports with the Requirements of Section 111.

1. EPA Properly Analyzed Cost as Required by the Statutory Text and This Court's Precedent.

Movants are not likely to succeed on the merits because they make cost arguments previously rejected by this Court. Section 111(a)(1) directs EPA to "tak[e] into account the cost of achieving such [emission] reduction" in setting standards, 42 U.S.C. § 7411(a)(1), leaving EPA considerable "discretion" in *how* it accounts for cost and identifies "an achievable emission level which represents the best balance of economic, environmental, and energy considerations." *Sierra Club v. Costle*, 657 F.2d 298, 330 (D.C. Cir. 1981). For more than fifty years, this Court has held that EPA must consider costs under Section 111, ensuring they are not "unreasonable," *id.* at 385, or "exorbitant[]," *Essex Chem. Corp. v. Ruckelshaus*, 486 F.2d 427, 433 (D.C. Cir. 1973). *See also Lignite Energy Council v. EPA*, 198 F.3d 930, 933 (D.C. Cir. 1999). That is exactly what EPA did in the Rule.

For decades, EPA has ensured standards are cost-reasonable by evaluating the cost-per-ton of emissions reduced by a given standard ("cost-effectiveness"). *See, e.g.*, 37 Fed. Reg. 5767, 5771, Table III (Mar. 21, 1972) (evaluating costs on a dollar-per ton-basis); *see also* 86 Fed. Reg. 63,110, 63,154 (Nov. 15, 2021) (discussing EPA's past practice for evaluating cost-effectiveness). EPA again followed this approach in the Rule by comparing methane (and, for new source requirements, volatile organic compound) reductions associated with each standard against the cost of compliance with that standard. Separately, for each requirement of the Rule, and also collectively, EPA determined the standards were cost-effective, reasonable, and within the historic range used by the Agency. *See* 89 Fed. Reg. at 16,864-65.

EPA also analyzed expected compliance costs in the context of industry revenues and capital expenditures, finding that compliance costs would represent 0.5-3.2% of each. *Id.* at 16,864-66. This Court has upheld Section 111 rules with far larger impacts. *See, e.g.*, *Essex Chem.*, 486 F. 2d at 440 (upholding rule that would increase industry's capital costs by 15.8%, 86 Fed. Reg. at 63,156); *Portland Cement Ass'n v. Ruckelshaus*, 486 F.2d 375, 387–88 (D.C. Cir. 1973) (upholding as

reasonable compliance costs representing 12% of facilities' capital costs). EPA reasonably concluded that these modest compliance costs could be readily absorbed by the industry. 89 Fed. Reg. at 16,866.

Moreover, Movants' reliance on *Michigan v. EPA*, 576 U.S. 743 (2015), is entirely misplaced. There, the Supreme Court held that the phrase "appropriate and necessary," in a Clean Air Act provision specific to air toxics, 42 U.S.C. § 7412(n)(1)(A), "requir[ed] at least some attention to cost." 576 U.S. at 752. But EPA has always considered cost under Section 111, which explicitly requires EPA to "tak[e] into account the cost" when setting standards. 42 U.S.C. § 7411(a)(1). Furthermore, the Supreme Court expressly declined to hold that 42 U.S.C. § 7412(n)(1)(A) required EPA "to conduct a formal cost-benefit analysis," instead explaining that "[i]t will be up to the Agency to decide (as always, within the limits of reasonable interpretation) how to account for cost." 576 U.S. at 759. In the Rule, EPA paid substantial "attention to cost" by deploying numerous different cost metrics and finding each one to be reasonable. Moreover, as it has long done, EPA weighed compliance-related expenditures against the emission-reduction benefits those dollars would provide.

2. EPA Thoroughly Evaluated Financial Impacts to Marginal Wells.

Although Movants assert that EPA ignored the Rule's cost impacts on marginal wells (Mot. 15-16), the agency carefully evaluated them in an entire section of its Technical Support Document ("TSD") titled "Financial Analysis of Marginal Wells." TSD at 6-1 to 6-15. There, EPA analyzed the number of marginal wells, their production levels and emissions, and their operating costs and revenues in relation to compliance costs. *Id.* EPA also analyzed the many factors that influence if and when an operator may stop production (shut-in) or close (plug) an end-of-life marginal well. *Id.* at 6-11 to 6-15.

EPA provided a thorough analysis of how the Rule could affect marginal wells, acknowledging the many types and sizes of companies that own them. The Agency estimated many of these wells, which have average profits up to $42,000 each year, would be subject to annual monitoring costs of just $336-$660, TSD at 6-7 to 6-8, while those with leak-prone equipment would be subject to annual monitoring costs of around $3,000. 87 Fed. Reg. 74,702, 74,732, Table 11 (Dec. 6, 2022). And, as existing sources, marginal oil wells would receive greater leeway to flare associated gas, qualifying for exemptions based on low

gas volumes or technical infeasibility. 89 Fed. Reg. at 16,833. EPA thus reasonably analyzed costs for marginal wells and is not required to (nor could it) evaluate the profitability of individual companies as Movants contend.

b. EPA Reasonably Subcategorized Well Sites Based on the Amount of Leak Prone Equipment.

Movants claim that EPA's well site subcategories are arbitrary, but their arguments fail to acknowledge EPA's well-reasoned explanation for its evidence-based approach. The Rule subcategorizes well sites into four different groupings subject to distinct leak monitoring requirements. Sites with more leak-prone equipment must monitor more often and with infrared cameras, while simpler and smaller sites need only undertake quarterly visual inspections. 89 Fed. Reg. at 17,026-27.

Movants' assertions that EPA's approach to subcategorization is arbitrary fall far short of what is necessary to justify a stay of this Rule. While "EPA is not required by [Section 111] to subcategorize," *Lignite Energy Council*, 198 F.3d at 933, the Agency's choice of subcategories in this case reasonably bases monitoring frequency and stringency on sites' relative risk of fugitive emissions. EPA's "scientific judgment" on

characteristics relevant to categorization merits a "high degree of deference." *Id.* Here, EPA's thorough explanation of each subcategory and its monitoring requirements, which Movants ignore, reveals wholly rational decision making.

Contrary to Movants' contentions, *see* Mot. 15, EPA's subcategories *are* based on emissions, sensibly using the presence of leak-prone equipment as a proxy for leaks themselves. 87 Fed. Reg. at 74,725. Additionally, EPA *did* consider the use of "throughput" (the amount of oil and gas produced from the site), *see* Mot. 15, but determined that it was poorly predictive of emissions and thus inappropriate as a subcategorization metric. As the Agency explained at length in both its supplemental proposal and final Rule, a robust body of science supports its determination to base subcategories on a site's equipment rather than throughput. 89 Fed. Reg. 16,905-06; 87 Fed. Reg. at 74,725-27.[1] Far from being "one-size-fits-all," Mot. 14, EPA's

[1] This is likewise consistent with EPA's approach in the 2016 Rule. 81 Fed. Reg. 35,824, 35,856. There, in declining to finalize an exemption for low-producing marginal wells, EPA explained "well site fugitive emissions are not correlated with levels of production, but rather based on the number of pieces of equipment and components." *Id.*

approach is carefully tailored and reflects a substantial evidentiary record.[2]

Well sites that are properly designed and maintained with minimal leak-prone equipment will typically have lower fugitive emissions than well sites with leaky and poorly maintained equipment, regardless of production levels. 87 Fed. Reg. at 74,731. Indeed, record evidence shows that low producing, marginal wells emit about 50% of the sector's methane pollution despite producing only about 7% of its oil and gas. TSD at 6-2, 6-3; 87 Fed. Reg. at 74,730, n. 70.

EPA also concluded that its final, equipment-based approach was more workable for operators than the modeling-based approach in its initial proposal. *See* 87 Fed. Reg. at 74,724-25. Operators can readily

[2] 89 Fed. Reg. at 16,990, n. 661 (describing the Department of Energy's marginal well study that found strong correlations between site equipment counts and magnitude of emissions, Richard L. Bowers, *Quantification of Methane Emissions from Marginal (Low Production Rate) Oil and Natural Gas Wells, United States*, https://doi.org/10.2172/1865859); *see also* 87 Fed. Reg. at 74,731 ("While the EPA does not find that production rates correlate to the amount of fugitive emissions and therefore should not be used as a basis for establishing different fugitive emissions monitoring requirements among well sites, we do find that the empirical data described supports distinguishing among well sites based on equipment and component counts.").

determine their compliance obligations based on the equipment present at the site rather than needing to conduct data analysis or emissions modeling. And while a limited subset of marginal well sites with leak-prone equipment may be subject to more extensive monitoring requirements, EPA estimates that 50-60% of all well sites nationwide (a majority of which are marginal) will be subject only to low-cost visual inspections. TSD at 6-3, 6-4, 6-8. EPA considered all of this in developing subcategories and ultimately finalized a reasonable framework for all types of wells—including marginal wells—based on the best available data. Movants have failed to identify any defect in EPA's decision making and are unlikely to succeed on the merits of their claims.

II. Industry Movants Have Not Demonstrated That They Will Suffer Irreparable Harm in the Absence of a Stay.

It is Movants' burden to demonstrate irreparable harm that is "imminen[t]," *Chaplaincy of Full Gospel Churches v. England*, 454 F.3d 290, 297 (D.C. Cir. 2006), "certain and great," and "directly result[ing]" from the Rule, *Wis. Gas Co. v. FERC*, 758 F.2d 669, 674 (D.C. Cir. 1985). "Where the injuries alleged are purely financial …, the barrier to proving irreparable injury is higher still." *Mexichem Specialty Resins,*

Inc. v. EPA, 787 F.3d 544, 555 (D.C. Cir. 2015). Movants do not meet this high bar.

a. The *New Source* Standards Will Not Cause Closure of *Existing* Marginal Wells.

Movants claim that "hundreds of thousands of marginal wells will likely be closed as a result of the Methane Rule," Mot. 5. But at the same time, they acknowledge that very few marginal wells face any near-term impacts. *E.g.*, Mot. Ex. A ¶24 (identifying only one well potentially subject to subpart OOOOb ("New Source Standards")). This is not surprising: marginal wells are overwhelmingly *existing* sources, Muehlenbachs Decl. ¶20, which will only face compliance obligations after a multi-year state planning and implementation process under subpart OOOOc ("Existing Source Guidelines"). 89 Fed. Reg. at 17,010. And even then, states have flexibility to provide such wells with up to three additional years of phased-in compliance, along with the option to grant variances for sources that exhibit fundamental differences. *See id.* at 17,002-03, 17,011. For instance, through the implementation process a well could receive an extended compliance timeline or variance from the flaring standards that Movants claim pose an immediate threat.

By contrast, newly drilled wells subject to the New Source Standards are overwhelmingly high-producing wells that generate substantial revenues. Muehlenbachs Decl. ¶17. In fact, there are only around 400 well sites nationwide (less than 15% of total new well sites) drilled or modified since December 6, 2022 (and therefore subject to the New Source Rule) that are marginal. *Id.*; *contra* Mot. 5 ("hundreds of thousands of marginal wells will likely be closed"). This is primarily because drilling a new well is capital intensive, costing millions of dollars and entailing extensive planning. Muehlenbachs Decl. ¶14; Alexander Decl. ¶¶8. Companies must recoup these upfront expenses through high levels of production and associated profits and thus try to avoid drilling wells that would be low producing at the outset. Alexander Decl. ¶9. The illogical contention found throughout Movants' motion that thousands of marginal wells are imminently threatened is fatal to their case for a stay: the New Source Standards do not affect the vast majority of marginal wells that are existing sources. Any harm allegations resulting from the Existing Source Guidelines are too distant and speculative to pass muster.

Especially given these extended timelines, Movants have not explained why the Rule's compliance costs, as opposed to independent factors like production decline, would cause them to stop production (shut-in) and close (plug) their marginal wells, or when that would occur. As EPA explained, numerous factors influence an operator's decision to shut-in or plug a marginal well, including market prices and each companies' unique financial circumstances. TSD 6-11 to 6-15; *see also* Alexander Decl. ¶10.

Movants' claims that reasonable and cost-effective methane regulation will cause widespread well closures (Mot. 5) is also not supported by real world experience. Alexander Decl. ¶¶6, 10. Available data from New Mexico, which recently adopted standards (including for flaring and well monitoring) similar to the Rule, show a continued increase in both production and well-count despite those regulations. Muehlenbachs Decl. ¶¶28-29. Likewise, comprehensive EPA methane standards for new sources have been in place for nearly a decade under the 2016 Rule, and U.S. oil and gas production has since continued to grow. Muehlenbachs Decl. ¶¶5-6.

b. Possible Changes to Planned Future Projects Do Not Constitute Irreparable Harm.

Movants' alleged injuries relating to planned *future* projects that (they claim) could be rendered uneconomical as a result of EPA's standards are theoretical and distant. *See, e.g.*, Mot. Ex. A ¶25 (pointing to "one well planned for drilling in the immediate future that will now either be subject to the Subpart OOOOb requirements or canceled"). The need to adjust future plans based on new regulatory developments is a routine feature of doing business and does not constitute irreparable harm sufficient to secure a stay.

Movants also mischaracterize the New Source Standard's compliance costs as "exorbitant." Mot. 21. Not only does EPA demonstrate through numerous metrics that the costs are reasonable, but Movants simply ignore the 2016 Rule's requirements that would otherwise apply to any planned development up through the New Source Standard's effective date of May 7, 2024. The 2016 Rule contains many standards similar to the New Source Standards, establishing leak monitoring requirements and broadly prohibiting sources from venting gas. 81 Fed. Reg. at 35,826-27. Movants' future projects and modifications should all have been planned with the similar

requirements of the 2016 Rule in mind. The incremental increase in cost from the 2016 Rule to the specific standards Movants take issue with is even more manageable than the baseline cost of the standards themselves. This only underscores the wide gap between the significant capital expenditures required to construct or modify a well site in the first place (on the one hand) and (on the other) the modest additional expenditures needed to comply with the New Source Standards.

In fact, some of the standards Movants object to are actually less costly than those that would otherwise apply under the 2016 Rule. For example, the 2016 Rule requires all new and modified well sites with equipment, including marginal wells, to conduct semiannual monitoring with infrared cameras. Under the New Source Standards, small well sites (which EPA estimates represent 50-60% of all sites nationwide and include a significant portion of marginal wells, TSD at 6-8) are subject to less costly visual inspections—which Movants claim they already conduct regularly. Mot. Ex. A ¶15; Mot. Ex. B ¶12. The effect of the New Source Standards will therefore be to *lessen* monitoring-related compliance costs for any new and modified small well sites. Movants fail to acknowledge the existence of the 2016 Rule, which undermines

their claims that the New Source Standards' incrementally greater (and sometimes lesser) costs are "exorbitant" and threaten their operations.

With regard to the flaring standards, Movants fail to explain why irreparable harm would result from sending gas to a sales line or choosing one of the three other EPA-provided mitigation options. For new wells (which are generally not marginal), the two-year phase-in gives Movants sufficient time to plan new drilling operations using one of the four approved methods. Alexander Decl. ¶13. In fact, using these methods is already the industry norm. *Id.* ¶¶9, 14. As noted above, *supra* pp. 7, 12, existing wells will have even more planning time and greater compliance flexibility under the Existing Source Guidelines' flaring standards, and those that produce minimal amounts of associated gas will be fully exempt from routine flaring restrictions. These regulatory features recognize unique characteristics of different operations and belie Movants' claims of irreparable harm.

III. A Stay Would Harm Respondent-Intervenors and Is Not in the Public Interest.

A stay of the Rule would substantially harm Respondent-Intervenors' members and would cause irreversible emissions of climate-disrupting methane and other health-harming pollution.

Environmental and Health Respondent-Intervenors Opp'n, 23-27 (filed May 6, 2024) (Doc. 2053103). Because methane is a highly potent greenhouse gas, reducing these emissions—particularly from the oil and gas sector, the largest industrial source in the U.S.—is one of the most important steps to mitigating the immediate impacts of climate change, including extreme heat, drought, and wildfires. Numerous studies estimate that half of all oil and gas production emissions are caused by marginal wells. *See* 89 Fed. Reg. at 16,926 (describing studies).

By avoiding over 58 million tons of methane pollution through 2035, the Rule is expected to provide societal climate benefits amounting to $110 billion alongside significant improvements to local air quality. Attachment C, Howard Decl. ¶6. Respondent-Intervenors' members, as well as the general public, would suffer severe injury if these benefits were delayed or lost due to a stay. And while Movants claim harm based on standards applicable to a small subset of wells they own, they seek a disproportionate stay of the entire Rule, Mot. 22.

Congress recently recognized the importance of mitigating emissions from marginal wells, *see* 42 U.S.C. § 7436(b), providing $700 million specifically for methane mitigation and plugging of those wells.

It likewise emphasized the urgency of methane reductions from oil and gas facilities through a 2021 Congressional Review Act Resolution, Pub. L. No. 117-23 (2021), which immediately restored the 2016 Rule's methane standards after a 2019 administrative action rescinding them. Both pieces of recent legislation reinforce that timely implementation of the Rule is in the public interest.

CONCLUSION

The motion to stay should be denied.

DATED: June 11, 2024

Respectfully submitted,

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CERTIFICATE OF COMPLIANCE WITH TYPE-VOLUME LIMIT

I hereby certify that the foregoing Opposition of Environmental and Health Respondent-Intervenors to Petitioners' Motion for Stay contains 3,477 words and was composed in Century Schoolbook font, 14-point. The motion complies with applicable type-volume and typeface requirements.

DATED: June 11, 2024

/s/ Edwin LaMair
Edwin LaMair

CERTIFICATE OF SERVICE

I hereby certify that I filed the foregoing Opposition of Environmental and Health Respondent-Intervenors to Petitioners' Motion for Stay via the Court's electronic filing system, which will provide electronic copies to counsel of record.

DATED: June 11, 2024

/s/ Edwin LaMair
Edwin LaMair

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IN THE UNITED STATES COURT OF APPEALS
FOR THE DISTRICT OF COLUMBIA CIRCUIT

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v.

U.S. ENVIRONMENTAL PROTECTION AGENCY, ET AL.,
Respondents.

APPENDIX TO OPPOSITION OF ENVIRONMENTAL AND HEALTH RESPONDENT-INTERVENORS TO INDUSTRY PETITIONERS' MOTION FOR STAY

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Attachment A

Declaration of Lucija Muehlenbachs, Lauren Beatty, and Maureen Lackner

DECLARATION OF LUCIJA MUEHLENBACHS, LAUREN BEATTY, AND MAUREEN LACKNER

We, Lucija Muehlenbachs, Lauren Beatty, and Maureen Lackner declare as follows:

1. I, Dr. Lucija Muehlenbachs, am a Professor of Economics at the University of Calgary. I am also a University Fellow at Resources for the Future, a visiting faculty member at Columbia University's Center on Global Energy Policy, and an affiliate researcher at the Swiss Federal Institute of Technology. I hold a Doctor of Philosophy from the University of Maryland. My curriculum vitae is attached as Exhibit A.

2. I, Dr. Lauren Beatty, am a High Meadows Postdoctoral Economics Fellow at Environmental Defense Fund (EDF). I hold a Doctor of Philosophy from the University of Maryland. My curriculum vitae is attached as Exhibit B.

3. I, Maureen Lackner, am a Senior Manager of Economics and Policy Analysis at EDF. I hold a Bachelor of Arts in Political Science and Statistics from Columbia University, and a Master of Public Policy from University of Michigan. My curriculum vitae is attached as Exhibit C.

EPA's Methane Rule

4. We understand that the U.S. Environmental Protection Agency (EPA) recently finalized *Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and*

Natural Gas Sector Climate Review, 89 Fed. Reg. 16,820 (March 8, 2024) (Methane Rule). We have reviewed the Methane Rule, as well as EPA's Technical Support Document[1] and Regulatory Impact Analysis,[2] which summarize EPA's cost analyses. We believe EPA's analyses and conclusions are reasonable and well supported, as discussed further below.

The U.S. Oil and Gas Industry is Producing and Profiting at Record Levels

5. In recent years, the United States has become the world's largest oil and gas producer[3] and the world's largest gas exporter.[4] The vast majority of this production comes from newer, non-marginal wells, meaning those producing more than 15 barrels of oil equivalent per day (BOE/d) on average. While marginal wells represent a large number of the total well count, their low production levels mean they do not significantly contribute

[1] EPA, Background Technical Support Document (TSD) for the Final New Source Performance Standards (NSPS) and Emissions Guidelines (EG): 40 CFR Part 60, subpart OOOOb (NSPS) 40 CFR Part 60, subpart OOOOc (EG) (November 2023) ("TSD").
[2] EPA, Regulatory Impact Analysis of the Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review (Dec. 2023) ("RIA").
[3] In 2023, U.S. onshore oil production in the lower 48 states reached a record of 10.8 million barrels per day. John Kemp, *US oil output hits record as producers boost drilling efficiency*, Reuters (Nov. 1, 2023), https://www.reuters.com/markets/commodities/us-oil-output-hits-record-producers-boost-drilling-efficiency-kemp-2023-11-01/.
[4] Curtis Williams, *US was top LNG exporter in 2023 as hit record levels*, Reuters (Jan. 3, 2024), https://www.reuters.com/business/energy/us-was-top-lng-exporter-2023-hit-record-levels-2024-01-02/#:~:text=Natural%20gas%20flows%20to%20the,in%20November%2C%20LSEG%20data%20showed.

to production, representing just 7% of U.S. oil production and 7.5% of U.S. gas production.[5]

6. Alongside record production levels have come record profits for U.S. oil and gas companies. The six largest oil and gas companies operating in the U.S. reported net income of $90 billion in 2021 and $167 billion in 2022.[6] In 2023 alone, fifteen of the largest oil and gas companies operating in the U.S. reported net income of $173 billion.[7] And now with the U.S. exporting about half of its natural gas production, companies are selling for higher prices to foreign buyers. Companies operating marginal wells are no exception, generating an average revenue of $53 million per year.[8]

The Methane Rule's Total Compliance Costs Are Small

7. The Methane Rule's total annualized compliance costs are estimated to represent just 0.5% of industry revenue.[9] This percentage represents EPA's projections of annualized total compliance costs for new and existing sources between 2024 and 2038 ($1.7 billion) as a share of current U.S.

[5] TSD at 6-2 to 6-3; EDF, *By the numbers: Marginal oil and gas wells*, https://www.edf.org/sites/default/files/documents/MarginalWellFactsheet2021_0.pdf.
[6] Josh Axelrod, *Amid Record Profits, Big Oil Ignores Consumers, Climate*, NRDC (Feb. 9, 2023), https://www.nrdc.org/bio/josh-axelrod/amidst-record-profits-big-oil-ignores-consumers-climate.
[7] Zanagee Artis, *Big Oil Made Billions Amidst the Hottest Year on Record*, NRDC (Feb 29, 2024), https://www.nrdc.org/bio/zanagee-artis/big-oil-made-billions-amidst-hottest-year-record.
[8] Comments of EDF et al., Attachment H, Docket ID EPA-HQ-OAR-2021-0317-2433.
[9] 89 Fed. Reg. at 16,866.

onshore oil and gas industry revenues ($357 billion estimated in 2017).[10] Similarly, the Methane Rule's total capital costs are expected to represent just 1.6% of industry capital expenditures. This percentage is calculated using annualized capital costs (i.e., excluding operations and maintenance costs and revenues from recovered gas), which are projected to be $2.5 billion between 2024 and 2038.[11] Total industry capital expenditures have ranged from $156 billion in 2019 to $75 billion in 2021.[12] These figures indicate that compliance costs from the Methane Rule are minimal, and we would expect compliance costs to have little or no impact on the industry's operations and production.

8. From 2024 to 2027—when only new sources have compliance obligations—compliance costs are an even smaller fraction of total industry capital expenditures and revenues. That is because only a subset of sources will be regulated—newly built or modified sources—which also tend to involve significant capital expenditures and generate significant revenue. For example, in 2025, the annual compliance costs represent 0.02% of industry

[10] *Id.* at 16,865. Both $1.7 billion in annual compliance costs and $357 billion in revenue were taken from the Final Rule, which we divided to obtain the 0.5%. EPA obtained the revenue from industry receipts in the U.S. Census' 2017 County Business Patterns and Economic Census.
[11] *Id.*
[12] *Id.* Both $2.5 billion in capital costs and $156 billion in total industry capital expenditures are taken from the Final Rule, which we divided to obtain the 1.6%. The final rule obtained the capital expenditures from the US Census' Annual Capital Expenditures Survey.

revenue, and compliance-related capital expenditures represent 0.2% of total industry capital expenditures.[13] In 2028 and beyond, these figures rise to 0.7% of industry revenue and 1.3% of industry capital expenditure.[14] These are modest costs that can be easily absorbed by the industry.

9. EPA's compliance cost projections are derived from reasonable cost estimates associated with each standard multiplied by the estimated number of sources that will be subject to those standards. In determining the costs of each standard, EPA relied on numerous data sources, including data from past federal and state rulemakings and, in many cases, industry supplied data. Further, EPA's analysis relies on 2017 data to determine industry revenues.[15] Comparing EPA's estimated compliance costs to more recent data on industry revenues demonstrates how conservative EPA's analysis is.

[13] RIA at 2-60, Table 2-11. The 0.02% estimate is calculated using annualized costs with product revenue in 2025 ($78 million) from Table 2-11, divided by $357 billion, EPA's estimate of industry receipts. 89 Fed. Reg. 16,865. The 0.2% estimate is calculated using 2025 annualized costs ($370 million), less operations and maintenance ($57 million), from Table 2-11, to obtain annualized capital costs and then dividing by $156 billion, the estimated of industry capital expenditures. *Id.*

[14] RIA at 2-60, Table 2-11. The 0.7% estimate is calculated using annualized costs with product revenue in 2028 ($2.5 billion) from Table 2-11, divided by $357 billion, EPA's estimate of industry receipts. 89 Fed. Reg. at 16,865. The 1.3% estimate is calculated using 2028 annualized costs ($3.6 billion), less operations and maintenance ($1.5 billion), from Table 2-11, to obtain annualized capital costs and then dividing by $156 billion (Final Rule estimate of industry capital expenditures). *Id.*

[15] *See* 89 Fed. Reg. at 16,865.

For example, Rystad Energy[16] estimates that industry revenue was $550 billion in 2021 and $859 billion in 2022. Using Rystad's estimates, EPA's annualized compliance costs would represent 0.3% and 0.2% of revenue respectively. Our estimates using data from Enverus[17] show slightly lower industry revenues of $380 billion in 2021 and $608 billion in 2022. Using Enverus's estimates EPA's annualized compliance costs would represent 0.4% and 0.3% of revenue respectively.

Compliance Costs for Leak Monitoring and Flaring Standards are Modest

10. We examined EPA's cost assumptions for various standards and compared them to those used by state environmental agencies in similar rulemakings, as well as other publicly available cost data. Our assessment is that EPA's analyses of the costs associated with individual standards are reasonable and are based on reliable data from state regulators and industry. Given that cost data is often proprietary, and service and equipment providers may offer

[16] Rystad Energy is an independent research and energy intelligence company (https://www.rystadenergy.com/aboutus). Our analysis is based on data from Rystad's UCube Database.

[17] Throughout this declaration we reference data from the Enverus database. Enverus is an oil and gas data and market analytics firm provider (www.enverus.com). For this analysis, EDF obtained well data from Enverus Prism (formerly known as DrillingInfo), a proprietary database that compiles a wide range of drilling- and production-related information from state oil and gas commissions. In late November 2023, we obtained data for all wells in the U.S., filtering to include only onshore wells with active production during 2021 and 2022.

variable rates, we expect that costs may be lower in reality than assumed by EPA.

11. Leak Detection and Repair (LDAR) requirements vary by method (e.g., audible, visual, and olfactory (AVO) or optical gas imaging (OGI)), site (e.g., single-well head site or compressor station), and frequency (e.g., monthly or quarterly), but are a cost-effective way to reduce fugitive methane emissions. Quarterly AVO inspections are estimated at $660/year or less,[18] and quarterly OGI surveys are approximately $3,000/year.[19] EPA estimates that 50-60% of all well sites nationwide, a majority of which are marginal wells, would be subject to the lower cost AVO inspections.[20]

12. The standards for flaring and capture of associated gas from oil wells likewise vary by site type and between new and existing sources. For new wells, EPA found that routing gas to a sales line could be done cost-effectively, at costs as low as $158 per ton of methane reduced even before considering savings (additional revenue) from captured gas. EPA, likewise, in response to comments, evaluated costs for oil wells producing low levels of associated gas. EPA determined that such wells would generally be

[18] TSD at 6-8.
[19] 87 Fed. Reg. at 74,732, Table 11.
[20] TSD at 6-8.

existing sources and, in the Methane Rule, provided an exemption for wells producing 40 tons per year or less of methane.

13. Compliance costs are likely to decline over time as operators learn how to comply at lower costs and as manufacturers ramp up production of equipment and devices.[21] Marginal wells, the vast majority of which will not have to comply for up to five years, will benefit from these declining costs.

Compliance Costs for New Sources Are Minimal

14. Drilling and completing a new well typically costs multiple millions of dollars, before even considering the associated equipment needed to continue operating and producing from that well.[22] For example, the President and CEO of Tall City Exploration, a Texas-based company, recently testified to Congress that each new well his company drilled "required an investment of approximately $10,000,000 per well[.]"[23] Once

[21] *See, e.g.*, Harrington et al., *On the accuracy of regulatory cost estimates*, 19 J. of Policy Analysis & Mgmt. 297-322 (2000); Chestnut & Mills, *A fresh look at the benefits and costs of the US acid rain program*, 77 J. of Env. Mgmt. 252-266 (2005). These studies conclude that realized post-innovation costs are generally lower than ex ante cost forecasts, and specifically point to unanticipated technological innovation as one of the driving factors for this phenomenon.

[22] John Merva, *Oil Economics - How Much Does An Oil And Gas Well Cost?* (Jan. 3, 2017), https://seekingalpha.com/article/4034075-oil-economics-how-much-oil-and-gas-well-cost; Trey Cowan, *Costs for Drilling The Eagle Ford*, Rigzone (June 20, 2011), https://www.rigzone.com/news/oil_gas/a/108179/costs_for_drilling_the_eagle_ford/.

[23] Testimony of Michael A. Oestmann, President and CEO, Tall City Exploration Before the House Energy and Commerce Committee's Subcommittee on Environment, Manufacturing, and Critical Materials (January 10, 2024), https://d1dth6e84htgma.cloudfront.net/01_10_24_ENV_Testimony_Oestmann_9022607f4a.pdf.

producing, new wells can generate hundreds of thousands of barrels per day, worth millions of dollars based on current market prices.[24] In comparison to the costs of drilling and operating a new well, and the amount of revenue generated from the produced oil and gas, the compliance costs of EPA's standards are negligible. We do not expect that the added compliance costs will have any impact on companies' decisions to drill or not drill new wells.

15. Using the Enverus database, we examined available production data over the first six months of 2023 from the well sites drilled, spudded, or completed as of December 6, 2022—well sites with sources that will likely be categorized as "new, modified, or reconstructed" under the Methane Rule.[25] In the available data, there are 2,797 new and modified well sites nationwide. Notably, according to multiple sources, there is no active drilling occurring in Michigan at this time and very few drill rigs have operated there in the last decade.[26]

[24] The cost of 100,000 bbl of production at 2023 average market prices for oil (at $78/barrel) and gas ($2.626/Mcf): 100,000 bbl oil * $78 per bbl = $7.8M of oil and $1.6M of gas.

[25] Data was pulled from Enverus Prism in November 2023. We only analyzed Enverus Prism production data for the first six months of 2023. Wells that were drilled or modified after December 6, 2022 are "new" or "modified" wells are subject to the NSPS OOOOb. Remaining wells are considered "existing" and would be regulated under EPA's OOOOc standards for existing sources. We present our results at the well site level (i.e., by pad). We define sites as "new" or "modified" if any single well at the site is classified as such.

[26] Baker Hughes, *North America Rig Cout: Rigs by State* (Jan. 2000-Mar. 2024), https://rigcount.bakerhughes.com/na-rig-count; Enverus, *Enverus U.S. Daily Rig Count*, https://www.enverus.com/dailyrigcount/.

16. Total revenue from these new or modified sites is $38 billion in the first half of 2023, equating to over $13 million per site in just those six months. EPA's projected annual compliance costs for various standards (which we believe are conservative, as discussed above) are in the thousands of dollars range, with some as low as a few hundred dollars. We therefore do not expect that new and modified sites will face financial hardship in complying with the standards, given their significant revenues.

17. In the Enverus dataset, 86% (2,397 well sites) of the sites we categorize as "new, modified, or reconstructed" are higher producing, while only 14% (400 well sites), are considered marginally producing—meaning they produce 15 BOE/d. The average production among the marginal well sites is 5.2 BOE/d, which, using 2023 oil and gas prices, equates to around $60,000 of gross revenue from product recovery at each site for just the first six months of 2023. Even in just six months of production, these lower producing new well sites generate adequate revenue to absorb compliance costs.

18. Using Enverus data and 2020-2022 oil and gas prices, we analyzed revenues for companies owning these new well sites and marginal well owners more

broadly.[27] We found that the new well sites are overwhelmingly owned by companies generating substantial profits. Even new sources owned by smaller companies, meaning those owning fewer than 25 well sites, generate average company revenues of $25 million per year. Likewise, the 400 marginal new well sites are owned by operators that make over $6 million per year on average. Similarly, the vast majority of both new and existing marginal well sites across the country (92%) are owned by large companies with average revenues of over $100 million per year.

19. Additionally, all 2,797 of the sites we identify as new or modified under the Methane Rule would be subject to requirements under EPA's 2016 Rule, Subpart OOOOa. Under the 2016 Rule, EPA's cut-off date for establishing new and modified sources was September 18, 2015. The difference in compliance costs between the 2016 Rule and the Methane Rule requirements for new and modified sources is incremental.

Compliance Costs for Existing Sources Are Minimal

20. Marginal wells, which are likely to be classified as existing sources under EPA's regulations, vary significantly in their production levels and site characteristics. For example, the Enverus dataset shows the vast majority of

[27] More information and the methods underlying this analysis are available here: Comments of EDF et al., Attachment H, Docket ID EPA-HQ-OAR-2021-0317-2433.

Movant Miller Energy's wells are 40 or more years old.[28] And since existing sites will not face compliance obligations for at least three and up to five years (2029), it is difficult to draw any conclusions about the impact of compliance costs on their operations. There is further uncertainty given that in many cases state agencies will develop the actual standards for existing sources and may provide additional flexibilities—so, the compliance costs projected by EPA may not ultimately be borne by existing sources.

21. Additionally, as production from these sites declines over time, many may be shut in before they even face regulatory obligations under the Methane Rule. This is because, as discussed below, many may have already exceeded their productive lives. In recognition of the need to plug end-of-life wells when they are no longer producing at viable levels, the federal government has provided significant funding to states to help facilitate proper closure. Most recently, EPA and the Department of Energy announced grants of $350 million to fourteen states to reduce emissions and facilitate closure of

[28] Data are from the November 2023 Enverus Prism dataset described above. Note that in this case we are counting all wells, not wells lumped into well sites.

marginal wells,[29] and the Bipartisan Infrastructure Law provides $4.7 billion for orphan well clean up.[30]

22. Nonetheless, we analyzed the revenue and ownership profiles of these well sites to evaluate their ability to absorb compliance costs. Based on Enverus data for 2022, operators generated $608 billion from well sites likely to be classified as existing under the Methane Rule, with a per operator average revenue of $53 million. In 2019 and 2021, the average per operator revenue for operators of existing sources was $24 million and $32 million, respectively.

Market Forces Drive Operational Decisions and Well Closures

23. Market forces are the most important driver of oil and gas production and operator behavior. Economic indicators, such as market prices for oil and gas and production levels, along with industry trends, like consolidation, are of much greater importance than regulatory considerations when evaluating a well site or company's profitability.

[29] EPA, *Biden-Harris Administration Announces $350 Million to 14 States to Reduce Methane Emissions from Oil and Gas Sector as Part of Investing in America Agenda* (Dec. 15, 2023), https://www.epa.gov/newsreleases/biden-harris-administration-announces-350-million-14-states-reduce-methane-emissions.

[30] U.S. Department of the Interior, *Biden-Harris Administration Releases Final Guidance on New Orphaned Well Program* (April 12, 2022), https://www.doi.gov/pressreleases/biden-harris-administration-releases-final-guidance-new-orphaned-well-program.

24. Operators tend to shut in oil and gas wells when oil or gas prices are low, or when their revenue isn't covering their operating expenses. Shut-ins can be temporary or permanent. For example, when oil prices went negative in 2020, operators announced widespread shut-ins, cutting 341,000 barrels per day of production.[31] Oil and gas wells have operating costs well above the projected increased costs from regulations, meaning additional regulatory costs would play a de minimus role compared to the market prices of oil and gas.

25. Wells are permanently shut in at the end of their productive lives and the current retirement rate of marginal wells is high. Each year, wells producing less than 3 BOE/d have a 4.4% to 6.7% probability of retiring.[32] Because marginal wells have naturally declining production and limited profitability, they will retire over time, regardless of the regulatory landscape. It is difficult or impossible to predict when an operator will shut in a particular well, but it depends primarily on the market prices of oil and gas, the well's production and remaining recoverable reserves, and the total operating costs.

26. Many oil and gas wells in the U.S. are inactive, reporting zero production. These wells are likely at the end of their productive lives and should be

[31] Wood Mackenzie, *Negative prices reveal the crisis for US oil* (April 2020), https://www.woodmac.com/news/opinion/negative-prices-reveal-the-crisis-for-us-oil/.
[32] RIA at 2-33, Table 2-3.

permanently closed, by plugging and abandoning and site reclamation. Yet many wells remain in this inactive or idle state because permanent closure costs are high,[33] and many jurisdictions do not have time limits on how long wells can remain inactive.

27. Research in Alberta, Canada shows that inactive wells have a low probability of returning to production but are left inactive to avoid cleanup costs.[34] Research in California shows that most inactive and marginal wells are owned by productive companies; only 7% of the inactive and marginal wells are likely orphan or at high risk of becoming orphan.[35] What this means is that the Methane Rule will not cause the shut in of production from inactive wells, because many have already reached the end of their productive lives. In fact, the Methane Rule includes measures to incentivize timelier cleanup of inactive wells. Specifically, it provides an off-ramp from compliance obligations and monitoring requirements when an operator submits records showing a well was properly closed in accordance with applicable state or federal standards.

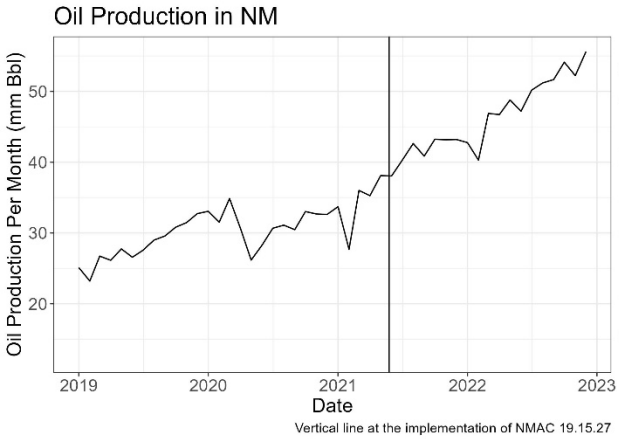
[33] TSD at 6-11 to 6-15.
[34] Muehlenbachs, *A dynamic model of cleanup: Estimating sunk costs in oil and gas production*, 56 International Economic Review 155-185 (2015), https://onlinelibrary.wiley.com/doi/abs/10.1111/iere.12098.
[35] Boomhower et al., *Orphan Wells in California: An Initial Assessment of the State's Potential Liabilities to Plug and Decommission Orphan Oil and Gas Wells*, Technical report, California Council on Science and Technology (2018), https://ccst.us/wp-content/uploads/CCST-Orphan-Wells-in-California-An-Initial-Assessment.pdf.

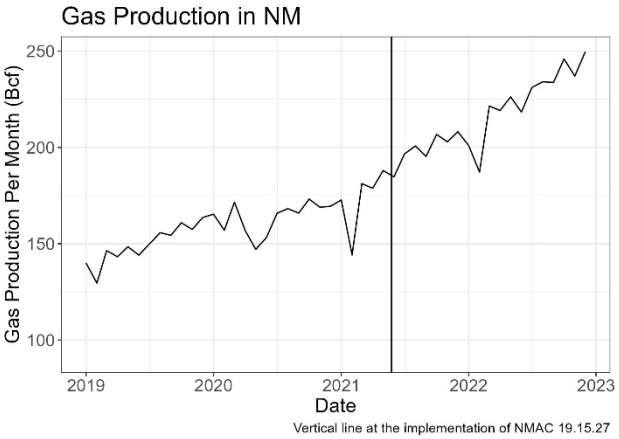
Impact of Regulations on Production

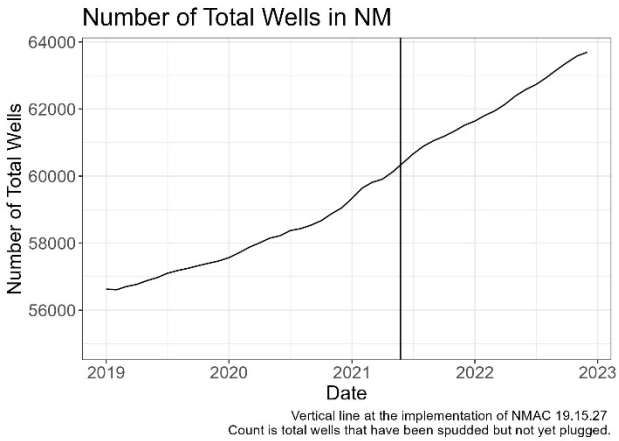
28. Available data from states with regulations similar to EPA's shows that the onset of regulations does not negatively impact production levels.[36] For example, New Mexico instituted NMAC 19.15.27 on May 25, 2021 and 20.2.50 NMAC, which took effect in August of 2022. These rules are similar to EPA's regulations and include, among other things, flaring and venting performance standards, and requirements for wellsite inspections. New Mexico has also instituted a prohibition on routine flaring of associated gas.

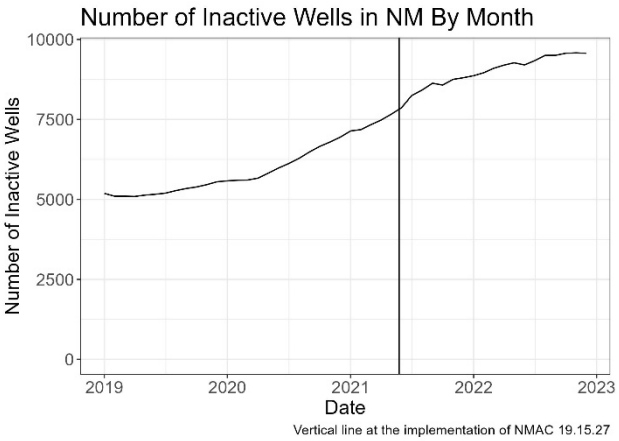
29. Based on our analysis, we do not find evidence that New Mexico's regulations have had any effect on oil and gas production in the state. Below we've plotted state-level gas production, oil production, and the total number of wells and inactive wells. In each plot, we've also added a vertical line beginning at the implementation date of the regulations. As shown, production levels have continued to climb at similar rates after regulations were imposed. The number of total wells and inactive wells have likewise continued to grow at similar rates before and after the regulations became effective.

[36] New Mexico Energy, Minerals and Natural Resources Department, *Publicly available OCD Documents and Files*, https://www.emnrd.nm.gov/ocd/ocd-data/ftp-server/.


Oil Production in NM
Oil Production Per Month (mm Bbl)
50
40
30
20
2019
2020
2021
2022
2023
Date
Vertical line at the implementation of NMAC 19.15.27

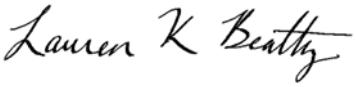

Gas Production in NM
Gas Production Per Month (Bcf)
250
200
150
100
2019
2020
2021
2022
2023
Date
Vertical line at the implementation of NMAC 19.15.27


Number of Total Wells in NM
Number of Total Wells
64000
62000
60000
58000
56000
2019
2020
2021
2022
2023
Date
Vertical line at the implementation of NMAC 19.15.27
Count is total wells that have been spudded but not yet plugged.


Number of Inactive Wells in NM By Month
Number of Inactive Wells
10000
7500
5000
2500
0
2019
2020
2021
2022
2023
Date
Vertical line at the implementation of NMAC 19.15.27

We declare that the foregoing is true and correct.

/s/ Lucija Muehlenbachs



/s/ Lauren Beatty

/s/ Maureen Lackner

Executed on June 10, 2024.

Exhibit A

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Professor, University of Calgary, Department of Economics, July 2024-
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University Fellow, Resources for the Future, Washington, D.C., 2017-present
Visiting Faculty Member, Columbia University, Center on Global Energy Policy, 2024
Research Fellow, University of Calgary, School of Public Policy, 2018-present
Affiliate Researcher, Swiss Federal Institute of Technology (ETH Zurich), 2014-present
Visiting Fellow, London School of Economics, Grantham Research Institute, 2017
Visiting Fellow, Resources for the Future, Washington, D.C., 2014-2017
Editor, Tribune Media Services, Glens Falls, NY, 2002-2004

EDITORIAL POSITIONS

Editorial Council, *Journal of the Association of Environmental and Resource Economists*, 2024-present
Editorial Board, *Review of Environmental Economics and Policy*, 2021-present
Editorial Council, *Land Economics*, 2021-present
Co-Editor, *Journal of Environmental Economics and Management*, 2019-2023
Editorial Advisor, *Canadian Journal of Economics*, 2018-2023
Co-Editor, *Resource and Energy Economics*, 2019-2022
Editorial Council, *Journal of Environmental Economics and Management*, 2016-2019

PUBLICATIONS

Bakkensen, L., L. Ma, L. Muehlenbachs, and L. Benitez, "Cumulative Impacts in Environmental Justice: Insights from Economics and Policy," *Regional Science and Urban Economics*, Special Issue on Urban Economics and the Environment, 2024.

Campa, P., and L. Muehlenbachs, 2024, "Addressing Environmental Justice through In-Kind Court Settlements," *American Economic Journal: Economic Policy*, 16(1).

Muehlenbachs, L., S. Staubli and, Z. Chu, 2021. "The Accident Externality from Trucking: Evidence from Shale Gas Development," *Regional Science and Urban Economics*, 88.

Swiedler, E., L. Muehlenbachs, Z. Chu, J. Shih, A. Krupnick, 2019, "Should Solid Waste from Shale Gas Development be Regulated as Hazardous Waste?" *Energy Policy*, 129:1020-1033

Hausman, C. and L. Muehlenbachs, 2019, "Price Regulation and Environmental Externalities: Evidence from Methane Leaks," *Journal of the Association of Environmental and Resource Economists*, 6(1): 73-109.

Linn, J. and L. Muehlenbachs, 2018, "The Heterogeneous Impacts of Low Natural Gas Prices on Consumers and the Environment," *Journal of Environmental Economics and Management*, 89: 1-28.

Ho, J, J. Shih, L. Muehlenbachs, C. Munnings, and A., Krupnick, 2018, "Managing Environmental Liability: An Evaluation of Bonding Requirements for Oil and Gas Wells in the United States," *Environmental Science & Technology*, 52(7): 3908-3916.

Muehlenbachs, L., Staubli, S., and M.A. Cohen. 2016. "The Impact of Team Inspections on Enforcement and Deterrence," *Journal of the Association of Environmental and Resource Economists*, 3(1): 159-204.

Muehlenbachs, L., E. Spiller, and C. Timmins. 2015. "The Housing Market Impacts of Shale Gas Development," *American Economic Review*, 105(12): 3633-59.

Shih, J., J.E. Saiers, S.C. Anisfeld, Z. Chu, L. Muehlenbachs, and S. Olmstead. 2015. "Characterization and analysis of liquid waste from Marcellus Shale gas development," *Environmental Science & Technology*, 49(16): 9557–9565.

Muehlenbachs, L. 2015. "A Dynamic Model of Cleanup: Estimating Sunk Costs in Oil and Gas Production," *International Economic Review*, 56(1): 155-185.

Mason, C., L. Muehlenbachs, and Olmstead, S. 2015. "The Economics of Shale Gas Development," *Annual Review of Resource Economics*, 7(1).

Graham, J., X. Tang, J. Irving, S. Sellers, J. Crisp, D. Horwitz, D. Carey, L. Muehlenbachs, A. Krupnick. 2015. "Increased Traffic Accident Rates Associated with Shale Gas Drilling in Pennsylvania," *Accident Analysis & Prevention*, 74: 203-209.

Olmstead, S., L. Muehlenbachs, J. Shih, J. Chu, and A. Krupnick. 2013. "Shale Gas Development Impacts on Surface Water Quality in Pennsylvania," *Proceedings of the National Academy of Sciences,* 110 (13):4962−4967.

Muehlenbachs, L. M.A., Cohen, and T. Gerarden. 2013. "The Impact of Water Depth on Safety and Environmental Performance in Offshore Oil and Gas Production," *Energy Policy*, 55: 699-705.

Alberini, A., A. Chiabai, and L. Muehlenbachs. 2006. "Using Expert Judgement to Assess Adaptive Capacity to Climate Change: Evidence from a Conjoint Choice Survey," *Global Environmental Change,* 16: 123–144.

WORK IN PROGRESS

Brown, D., and L. Muehlenbachs, "The Value of Electricity Reliability: Evidence from Battery Adoption" revisions requested at *Journal of Public Economics*

Wheeler, L., and L. Muehlenbachs, "Drained Away: Oil Lost from First Nations Reserves"

OTHER PUBLICATIONS

L. Muehlenbachs "What I Wish I had Known before Starting as a PhD Student," Thriving in Economics: PhD Student Edition, crowdsourced e-book, Deryugina, T, Ed.

Hallak, A., Jensen, A., Lybbert, G. and Muehlenbachs, L., 2021. "The Oil Production Response to Alberta's Government-Mandated Quota," University of Calgary, School of Public Policy Publications.

Muehlenbachs, L. "80,000 Inactive Oil Wells: A Blessing or a Curse?" University of Calgary School of Public Policy SPP Briefing Paper, 10(3), 2017.

Muehlenbachs, L. and S. Olmstead, "Hydraulic Fracturing and Water Resources," 2014, *Choices*

PERMANENT WORKING PAPERS

Muehlenbachs, L., E. Spiller, and C. Timmins, "Shale Gas Development and Property Values: Differences across Drinking Water Sources," NBER Working Paper No. 18390, September 2012.

Muehlenbachs, L., E. Newcomb-Sinha and N. Sinha, "Politics and the Strategic Release of News at the EPA," RFF Discussion Paper 11-45, October 2011.

Muehlenbachs, L., E. Newcomb-Sinha and N. Sinha, "Hitting the violators where it hurts? Stock market reaction to USEPA press releases"

RESEARCH GRANTS

Principal Investigator, "Inequities in oil production," SSHRC Insight Grant, $67,971 (2023-2026) Co-Applicant: Laurel Wheeler.

Principal Investigator, "NOx Budget Trading Program on ozone formation," RFF's Retrospective Analysis of Federal Environmental Regulation, $20,000 (2023-2024), Co-Applicant: Lala Ma.

Co-Applicant, "Pathways to mitigating methane emissions from inactive oil and gas wells," NSERC Alliance Missions Grant, $746,000 (2023-2026) PI: Mary Kang.

Co-Applicant, "Closing the Gap: The Impact of Oil and Gas Regulations on Producing First Nations," Future Energy Systems, $67,000 (2021-2022) PI: Laurel Wheeler.

Principal Investigator, "Costs and Benefits of In-kind Settlements: Evidence from Environmental Enforcement Cases," SSHRC Insight Grant, $54,607 (2020-2023) Collaborator: Pamela Campa.

Co-Applicant, "Penalties in Cash or In-kind?" FORMAS, 2.1 million SEK (2019-2022) PI: Pamela Campa.

Co-Applicant, "Impact of residential proximity to hydraulic fracturing sites on human reproduction and child development," New Frontiers in Research Fund – Exploration, $250,000 (2019-2021) PI: Amy Metcalf.

Co-Principal Investigator, "Rate of Return Regulation and Environmental Externalities: Evidence from Natural Gas," NBER/Sloan Foundation: The Future of Energy Distribution, (2016-2018) Co-PI: Catherine Hausman.

Principal Investigator, "Rate of Return Regulation and Environmental Externalities: Evidence from Natural Gas," SSHRC Insight Development Grant, $30,870 (2016-2018). Collaborator: Catherine Hausman.

Co-Investigator, "Understanding the Impacts of Shale Gas and Oil Development on Local Communities," $308,088 (2015-2016), Smith Richardson Foundation, PI: Alan Krupnick.

Co-Investigator, "Subsurface impacts of hydraulic fracturing (including contamination, seismic sensitivity, and groundwater use and demand management)," Canadian Water Network, $120,000 (2014-2015). PI: Cathy Ryan. Co-Investigators: Daniel Alessi, David Eaton, Bernhard Mayer, Uli Mayer, John Molson, Beth Parker.

Principal Investigator, "Inspection Group Dynamics and Deterrence," National Science Foundation, SES-1251916, $77,994 (2013-2015). Co-PI: Mark Cohen.

Co-Investigator, "Regulating Risks from Shale Gas Development," Sloan Foundation, $1,171,667 (2011- 2012). PI: Alan Krupnick; Co-Investigators: Sheila Olmstead, Juha Siikamaki, Jhih-Shyang Shih.

Co-Principal Investigator, "Analysis of BOEMRE Enforcement and Compliance Data," National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling, $50,000 (2010-2011). Co-PI: Mark A. Cohen.

RESEARCH IN THE MEDIA

Ph.D. Dissertation: *Alberta Views*

Politics and the Strategic Release of News at the EPA: *E&E News PM, The Hill, Oil and Gas Journal, Washington Post, USA today*

Shale Gas Development and Property Values: Differences across Drinking Water Sources: *Chicago Policy Review, EnergyWire, McClatchy Natural Gas Daily, Washington Post, WCPN-Cleveland Public Radio*

Shale Gas Development Impacts on Surface Water Quality in Pennsylvania: *Circle of Blue, Huffington Post, NGT News, IHS The Energy Daily, Wall Street Journal*

The Housing Market Impacts of Shale Gas Development: *Bloomberg, EnergyWire, Forbes, Reuters, SNL Financial, The Economist, BBC radio.*

Price Regulation and Environmental Externalities: Evidence from Methane Leaks: *the Conversation, E&E News, NBER digest, SNL News, Michigan Public Radio.*

80,000 Inactive Oil Wells: A Blessing or a Curse?: *CBC, CTV News, Calgary Herald, Daily Oil Bulletin, Globe and Mail, the Tyee, News Talk 770, 630 CHED.*

The Value of Electricity Reliability: Evidence from Battery Adoption: *Ergs and Equilibrium Podcast; Resources Radio Podcast*

HONORS AND AWARDS

Killam Emerging Research Leader Award, 2019
Canadian Women Economists Committee, CWEC Young Researcher Award, 2019
GREAT Supervisor Award, University of Calgary, 2018
New Scholar Research Award, Faculty of Arts, University of Calgary, 2018
Outstanding Reviewer, *Journal of Environmental Economics and Management*, 2015
Outstanding Reviewer, *Energy Policy*, 2015
Dr. and Mrs. Bill V. Lessley Dissertation Excellence Award, University of Maryland, 2010
Student Travel Award, European Economics Association Congress, Barcelona, 2009
Dennis J. O'Brien Best Student Paper Award, 32nd International Association for Energy Economics International Conference, 2009
National Capital Area Chapter, U.S. Association for Energy Economics Student Scholarship for the IAEE International Conference, 2009
Institute on Computational Economics Fellow, University of Chicago and Argonne National Laboratory, 2008
Distinguished Teaching Assistant Award, University of Maryland, 2007-2008
Canadian Economics Association Travel Grant, Vancouver, 2008

Jacob K. Goldhaber Travel Award, University of Maryland, 2007

SERVICE

Committee Member, CWEC Early Career Research Award, 2023
Committee Member, Wallace E. Oates Outstanding Doctoral Dissertation Award, 2020-2022
Equity and Diversity Committee, Faculty of Arts, 2019-2020
Vice President, Canadian Association of Energy Economics 2015-2019
Scholarship Committee, Faculty of Graduate Studies, University of Calgary, 2016
Board Member, Van Horne Institute, 2016-2018
Hiring Committee, Haskayne School of Business, 2018; Economics Department, 2014, 2015
Co-organizer of University of Calgary's Empirical Microeconomics Workshop 2014, 2015, 2016

REVIEWING

Editorial boards: *Canadian Journal of Economics*; *Journal of Environmental Economics and Management; Land Economics; Resource and Energy Economics*; *Review of Environmental Economics and Policy.*

Refereeing: *Agricultural and Resource Economics Review; American Economic Journal: Economic Policy; American Economic Review; American Journal of Agricultural Economics; American Journal of Health Economics; Applied Economics Teaching Resources; Bulletin of Economic Research; Canadian Journal of Economics; C.D. Howe Institute Commentary; Conservation Letters; Economic Inquiry; Economic Journal; Economics of Energy and Environmental Policy; Energy Economics; Energy Journal; Energy Policy; Environmental Management; Environmental Monitoring and Assessment; Environmental and Resource Economics; Environmental Politics; Environmental Science & Technology; Health Economics; International Economic Review; Journal of Applied Econometrics; Journal of the Association of Environmental and Resource Economists; Journal of Economic Dynamics and Control; Journal of Environmental Economics and Management; Journal of Housing Economics; Journal of Policy Analysis and Management; Journal of Political Economy; Journal of Political Economy: Microeconomics; Journal of Public Economics; Journal of Regulatory Economics; Journal of Rural and Community Development; Land Economics; Nature Energy; Nature Sustainability; Oxford Encyclopedia of Environmental Economics; Regional Science and Urban Economics; Resource and Energy Economics; Review of Economics and Statistics; Review of Industrial Organization; Science; Science of the Total Environment.*

Conference Selection Committees: NBER Distributional Consequences of New Energy Policies 2023; IIPF 2021; IAEE 2019; EMEE 2020, 2024; WCERE 2018; AERE 2016, 2017; CEA 2016; CREE 2016; Calgary's Empirical Microeconomics Workshop 2014, 2015, 2016; AAEA Annual Meeting 2014.

Granting Agencies: Alfred P. Sloan Foundation Proposal; Czech Science Foundation; Michigan Sea Grant Proposal; Mitacs; Swiss National Science Foundation, US National Science Foundation.

Peer Reviewer: U.S. Environmental Protection Agency; California Council on Science and Technology.

PRESENTATIONS

2024 UT Austin (expected); Western University; Louisiana State University; ifo Institute; Mannheim Conference on Energy and the Environment (Keynote); Columbia University-Center for Global Energy Policy

2023 University of Queensland; University of Sydney; University of British Columbia; University of Alaska Anchorage Workshop

2022 Thompson Rivers University Cluster Workshop (keynote), Occasional Workshop (discussant); HEC Montreal; University of Kentucky

2021 Appalachian State University, University of California San Diego, Florence School of Regulation (panel), CERE-Umeå, University of Basel.

2020 ASSA disucssant, University of Alberta, University of Manchester

2019 Carleton University.

2018 University of Pennsylvania; Stockholm School of Economics in Riga; University of British Columbia; WCERE; University of Waterloo's Current Challenges in Environmental and Resource Economics Workshop; University of Alberta's Conference on Renewable Energy and Electricity Markets (discussant); ASSAs (discussant).

2017 PERC Energy Workshop (discussant); University of Verona; London School of Economics-Grantham Institute; University of Tennessee; POWER Conference; University of Melbourne; ASSAs (discussant).

2016 HEC Montreal; Environmental Defense Fund; Carnegie Mellon University; Cornell University; ASSAs (discussant).

2015 Arizona State University; University of Alberta; University of Michigan; Colorado School of Mines; University of British Columbia; ASSAs (discussant); University of Oklahoma's Energy Finance Research Conference (discussant).

2014 Duke University (Arctic Drilling Workshop); UC Berkeley (Guest Lecture); Georgia Institute of Technology; Environmental Protection Agency (National Center for Environmental Economics); International Industrial Organization Conference; World Congress of Environmental and Resource Economists; American Society of Civil Engineers Shale Conference (panelist).

2013 AERE Conference Sponsored Session; ETH Zurich; Triangle Resource and Environmental Economics Seminar (Duke University, North Carolina State University, and RTI); University of Calgary.

2012 MIT CEEPR workshop; APPAM Conference; CREE Study Group; Pembina Shale Gas Thought Leaders Forum; World Bank Sustainable Development Forum; 1st NE workshop on Energy Policy and Environmental Economics; Empirical Methods in Energy Economics.

2011 2nd Annual Energy Policy Symposium, Washington DC; University of Basel, Department of Economics; Resources for the Future.

2010 University of Aberdeen; Resources for the Future; University of Alaska-Anchorage; University of Alberta; University of Calgary; Bank of Canada; Congressional Budget Office; Stockholm Institute of Transition Economics, Stockholm School of Economics; International Association for Energy Economics Conference.

2009 European Economics Association Congress; Department of Civil and Environmental Engineering, University of Alberta; International Association for Energy Economics Conference; ETH Zurich.

TEACHING
World Oil Markets ECON527; Natural Gas Markets ECON323; Natural Resource Economics ECON475 Energy Economics ECON627; Environmental Economics ECON377; PhD Research Workshop II, ECON 793; Research Methods I, ECON 693.

SUPERVISORY COMMITTEE MEMBER
Wojciech Fulmyk* (PhD, ongoing); Sagbo Anicet Hounton* (PhD, ongoing); Abena Darkwah* (PhD, ongoing); Arthur Novaes de Amorim (PhD, 2023), Daniel Ma (PhD, 2021); Sakib Rahman (PhD, 2023); Longzhou Wang (PhD, 2022); Mokhtar Tabari (PhD, 2020); Elham Adibnia (PhD, 2021); Chi Man Yip (PhD, 2020); Alaz Munzur (PhD, 2019); Jingchi Yan* (MA, 2020); Reinaldo Viccini* (MA, 2019); Hossein Hosseini (PhD, 2018); Blake Shaffer (PhD, 2018); Xiaoli Zheng (PhD, 2018); Naima Farah (PhD, 2017); Yuan Wen (PhD, 2015); Grant Freudenthaler (MA, 2016); Younes Ahmadi (PhD Candidacy Committee, 2014).
*Supervisor
External examiner: Eric Adebayo (SFU PhD, 2020)

PERSONAL INFORMATION
Citizenships: Canada, Latvia, United States

Languages: English (Native); Spanish (Proficient); Japanese (Proficient); French (Proficient); Latvian (Proficient); Swiss German (Rudimentary)

Married to economist Stefan Staubli

Exhibit B

Lauren Beatty

Phone: (207) 216-3007 | Email: lbeatty@edf.org | Homepage: https://lbeatty1.github.io

Current Position

2023-Present Highmeadows Postdoctoral Economics Fellow, **Environmental Defense Fund**

Education

2023 PhD, Agricultural and Resource Economics, **University of Maryland**
2016 BA, Math and Economics, **Macalester College**

Dissertation Committee Josh Linn (chair), James Archsmith, Louis Preonas
Rob Williams, Andrew Sweeting

Research

"How Do Natural Gas Pipeline Networks Affect Emissions From Drilling and Flaring?" (Job Market Paper)

> *Most oil wells co-produce natural gas. Producers can choose to burn this valuable co-product on site (known as flaring) if the cost of connecting to the existing natural gas pipeline network is sufficiently high. While flaring is damaging to the climate, there exists surprisingly little research on the economics of flaring. I construct and estimate a dynamic model of producer drilling and flaring decisions which depend on the current state of the pipeline network and expectations over its evolution. My model also allows producers to internalize spillover effects for their neighbors – any pipeline they build will extend the network and weakly decrease their neighbors' future pipeline connection costs. Using my model estimates, I simulate pipeline development and flaring outcomes under counterfactual policies: a flaring tax, a flaring ban, and a gas subsidy. My counterfactual simulations show that flaring abatement costs are higher than previous studies but suggest that a flaring tax could substantially reduce flaring. A* $5/*Mcf tax reduces flaring by* 39%.

"Policy Options to Reduce State Liabilities from Orphaned Gas Wells"

> *There are hundreds of thousands of aging oil and gas wells scattered throughout the United States that pose serious environmental and safety risks. These well sites will require billions of dollars of investment in remediation. When producers go bankrupt before remediation is complete, the responsibility to clean up the site often lands with either the state or federal government. These wells are known as orphan wells, and have received increasing attention in the scientific and policy literature. In this paper, I estimate a model of well-level status transitions, then use my model to simulate how a policy requiring producers to either bring wells back into production or plug them after two years of inactivity would affect well orphan rates. I find that since many wells are left inactive for years at a time, this simple policy would be an effective way to decrease government plugging responsibilities and prevent environmental damage without dramatically reducing oil and gas production.*

Fellowships and Awards

2021-2023 NBER Pre-Doctoral Fellowship in Energy Economics
2020 Bessie H. DeVault Award for Best Paper by a Third-Year Student
2018 Rhona Lantin Memorial Scholarship for Best Paper by a First-Year Student
2017-2022 University of Maryland Flagship Fellowship
2016 Phi Beta Kappa
2016 3M Scholar Award
2015 John M. Dozier Prize in Economics

Employment

Graduate Research Assistant for James Archsmith	Aug. 2022 - Present
Graduate Research Assistant for Louis Preonas	Aug. 2019 - Aug. 2021
Graduate Teaching Assistant for AREC 610 (Applied Microeconomics)	Jan. 2019-May 2019
Graduate Teaching Assistant for AREC 623 (Econometrics I)	Sep. 2018-Jan. 2019
Graduate Research Assistant for Anna Alberini	Jan. 2018-Sep. 2018
Graduate Research Assistant for Roberton Williams III	Sep. 2017-Dec. 2017
Abstract Algebra Preceptor	Jan. 2016 - Jun. 2016
Multivariable Calculus Preceptor	Sep. 2014 - Dec. 2014
Discrete Mathematics Preceptor	Sep. 2013 - Jun. 2014

Presentations

2023: AERE Summer Conference; Wesleyan University, Department of Economics; U.S. Environmental Protection Agency, National Center for Environmental Economics; New England ISO; Federal Trade Commission; Department of Justice; Government Accountability Office

References

Josh Linn:	`linn@umd.edu`
Rob Williams:	`roberton@umd.edu`
Louis Preonas:	`lpreonas@umd.edu`
James Archsmith:	`archsmit@umd.edu`

Skills

R, SQL, Git, Stata, LaTeX

Last updated: January 10, 2024
`https://lbeatty1.github.io/cv/`

Exhibit C

Maureen Lackner

www.linkedin.com/in/mklackner • maureen.lackner@gmail.com • 914-434-1233

Education

University of Michigan, Gerald R. Ford School of Public Policy, Ann Arbor, MI — May 2017
Master of Public Policy

Columbia University, New York, NY — May 2013
Bachelor of Arts, Political Science and Statistics

Experience

Environmental Defense Fund, Boulder, CO

Senior Manager, Economics and Policy Analysis — April 2021-Present

- Oversee and support economic analyses across EDF's North American oil and gas methane portfolio; this includes assessing policy options, providing oversight on internal and consultant-led data analysis, and building EDF's external network of oil and gas methane experts
- Developed an R model to identify existing oil and gas wells at high-risk of becoming improperly abandoned, and assess policy solutions to mitigate that risk; economic analysis informs advocacy campaigns in six key states
- Manage a full-time analyst's work in support of these workstreams

Senior Economics and Policy Analyst — June 2017-April 2021

- Researched market-based policies to address issues such as methane abatement in the oil and gas sector, economywide emissions in the United States, and scaling new technologies to target power sector emissions
- Developed a global oil and gas methane tracker in R that relies on best available data and a Monte Carlo analysis to simulate ranges of emissions and potential reductions
- Analyzed the economic viability of proposed policies to reduce greenhouse gas emissions across multiple industries; provided analyses to national and state policymakers as part of EDF's advocacy

U.S. Government Accountability Office, Washington, D.C. — May 2016-July 2016
Applied Research and Methods Intern

- Conducted research and stakeholder interviews regarding U.S. preparedness for Zika outbreak; presented findings to internal executives to inform development of audit plan and contributed to published blog post
- Contributed to written and visual analyses and prepared descriptive data analysis that will be used in an audit of the Department of Defense pertaining to pathogens in high-containment labs

Dow Sustainability Fellows Program, Ann Arbor, MI — January 2016-December 2016
Dow Sustainability Masters Fellow

- Developed project to assess transportation needs for HOPE Village, a community-based initiative of the non-profit foundation Focus:Hope
- Conducted focus groups for residents living in HOPE Village to identify gaps in access and transportation
- Engaged with stakeholders from auto-industry, city government, and non-profit sector to inform analysis
- Used focus group results, GIS and census data to contribute to needs assessment and constraints analysis regarding potential for shared use mobility

The Commonwealth Fund, New York, NY — October 2013-July 2015
Grants Associate

- Developed business intelligence solutions, including a real-time budget tool used across program areas
- Coordinated development of budgets, subcontracts, and data use agreements for quarterly grant approvals

Awards

Clean Energy Leadership Institute – 2021 Fellow

Maureen Lackner

www.linkedin.com/in/mklackner • maureen.lackner@gmail.com • 914-434-1233

Programming and Software Skills

R (tidyverse), Python, Git, Excel, Stata

Publications and Presentations

Certification of Natural Gas With Low Methane Emissions: Criteria for Credible Certification Programs. *EDF white paper.* (2022) [With K. Mohlin]

Policy Instrument Options for Addressing Methane Emissions from the Oil and Gas Sector. *Environmental Defense Fund Economics Discussion Paper Series, EDF EDP 22-01,* (2022) [With K. Mohlin, H. Nguyen, and A. Wolfe.]

Early Deployment of Direct Air Capture with Dedicated Geologic Storage: Federal Policy Options. *EDF working paper.* (2021) [With S. Capanna and J. Higdon]

Pricing Methane Emissions from Oil and Gas Production. *Environmental Defense Fund Economics Discussion Paper Series, EDF EDP 21-04.* (2021) [With J.R. Camuzeaux, S. Kerr, and K. Mohlin]

What do we know about methane emissions from the global oil and gas sector? *25th EAERE Annual Conference.* (2020) Virtual Session. Policy Session Conference Presentation.

Reverse Auctions: Lessons learned from renewables and storage procurement. *24th EAERE Annual Conference.* (2019) The University of Manchester, Manchester, UK. Policy Session Conference Presentation.

Policy Brief—Using Lessons from Reverse Auctions for Renewables to Deliver Energy Storage Capacity: Guidance for Policymakers. *Review of Envir. Econ. and Policy.* (2019) [With J. R. Camuzeaux and S. Koller]

Instruments of Political Control: National Oil Companies, Oil Prices, and Petroleum Subsidies. *Comparative Political Studies.* (2014) [With J. Urpelainen and A. Cheon]

Why Do Governments Subsidize Gasoline Consumption? An Empirical Analysis of Global Gasoline Prices, 2002-2009. *Energy Policy.* Volume 56. (2013) [With J. Urpelainen and A. Cheon]

Attachment B

Declaration of Thomas M. Alexander

DECLARATION OF THOMAS M. ALEXANDER

I, Thomas M. Alexander, declare as follows:

1. I earned a Bachelor of Arts in Psychology from Wake Forest University (1973) followed by post-graduate work in chemistry and genetics at Duke University (1973). I earned a Master of Science, Mining Engineering (1981) and a Bachelor of Science, Mining Engineering (1981) from South Dakota School of Mines and Technology and completed the course work for Master of Arts, Environmental Policy and Management at the University of Denver (1994).

   Throughout my work experience in oil and gas I have taken several industry-related courses focused on and not limited to oil and gas well production, drilling, completion techniques, rock mechanics, economics, health, safety and environmental engineering, artificial lift, gas reservoir engineering, risk management, nodal analysis and well cementing.

2. I have been a consultant to Environmental Defense Fund (EDF) for over 7 years by providing technical expertise on issues such as

underground gas storage, flaring, venting, and conventional and unconventional regulations. I have testified as an expert for EDF during hearings for proposed rules to prohibit routine venting and flaring in New Mexico and Colorado. I have also assisted EDF in its contributions to the Interstate Oil and Gas Compact Commission and Energy Resources, Research and Technology committee and on two American Petroleum Institute work groups focused on updating two recommended practices for underground gas storage. My primary work there focused on risk management, health, safety and environment, security and training.

3. Prior to working with EDF, I worked for Southwestern Energy (SWN) for 18 years (1998 – 2016). I first served as a consultant and then as a staff oil and gas well production and completion engineer, the team leader for the Fayetteville Shale discovery team, and as a Completion Manager where I was responsible for the completion[1] of close to 2,000 of 4,500 wells in north central Arkansas in the Arkoma Basin. From late 2012 to 2015, I served as Vice President

[1] A completion is the process of bringing an oil or gas well into production after initial drilling has been completed.

of Health, Safety & Environment for SWN where I led a team of over 60 professionals that were responsible for maintaining operational standards for health, safety and the environment. I also worked for SWN's Canadian subsidiary, SWN Resources Canada in New Brunswick, Canada as the General Manager from mid-2010 through most of 2012 where I managed exploration efforts, public relations and government relations. Prior to SWN, I worked for several companies as an engineer to facilitate the planning, design, and execution of drilling, completion and production operations of oil and gas wells. My curriculum vitae is attached as Exhibit A.

4. I have reviewed EPA's recently finalized rule to reduce methane emissions from the oil and gas sector, *Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review*, 89 Fed. Reg. 16,820 (March 8, 2024) ("the Rule"), including requirements for monitoring and repairing leaks and standards to capture associated gas instead of flare. Based on my extensive experience in the oil and gas industry, I concur with EPA's final rules. They are feasible, cost-effective, and reasonable for large and small

producers alike.

Leak Detection and Repair Standard Compliance Costs

5. EPA outlines compliance costs for its final LDAR standards in its Technical Support Document (TSD).[2] In my opinion, the compliance costs per well cited in EPA's TSD should not drive business decisions; they are reasonable and in line with typical leak detection and repair regulatory costs associated with new drilling operations. Further, at SWN, we factored regulatory costs into the economic evaluation of a new well, and I am not aware of our ever declining to develop a new well based on regulatory compliance costs along the lines of those projected by EPA.

6. EPA's cited costs are also reasonable for existing wells. Though LDAR standards for existing wells didn't exist prior to the Rule, while working for SWN in the Fayetteville Shale, we voluntarily conducted an internal initiative to find and repair any fugitive emissions as part of a program to increase gas recovery and reduce fugitive emissions. Our costs for this endeavor were in line with

[2] EPA, Supplemental Background Technical Support Document for the Proposed New Source Performance Standards and Emissions Guidelines (October 2022), EPA-HQ-OAR-2021-0317-1578 at 5-16 to 5-25.

EPA's estimates for existing wells. In fact, we found that conducting LDAR surveys resulted in enough additional gas to send to sales to pay for the cost associated with the surveys for the first two years.

Associated Gas Standard Compliance Costs and Deciding to Drill or Shut-In Wells

7. I have reviewed EPA's discussion and supporting data for its determination that routing gas to a sales line (for different pipe sizes and distances to a sales line) is frequently a cost-effective solution to flaring. EPA contracted and relied upon data from the INGAA Foundation and ICF study and used the Chemical Engineering Cost Index to help determine costs. These data sources are well known and respected as a source of information for the oil and gas industry.

8. In comparison to the overall costs of drilling and operating a new well and the amount of revenue generated from the produced oil and gas, the compliance costs for EPA's associated gas standards are negligible and I do not expect that the added compliance costs will have any impact on companies' decisions to drill wells. When SWN developed

the Fayetteville Shale, we drilled, completed and produced thousands of wells, many of which cost upwards of $3,000,000 each. The midstream infrastructure SWN built to connect each well to the nearest sales line only represented about 1% to 2% of the costs of the overall well.

9. Because of the substantial investment in drilling a well overall, the decision to drill was never taken lightly. But the decision typically was dependent upon a variety of feasibility and non- regulatory cost considerations. These include: the technical difficulties associated with developing the shale reservoir because of its geological and reservoir properties; the price of the product, which sometimes can cause an operator to alter – or even cancel – drilling plans; the non-regulatory cost of operations which can vary depending on the shale's properties, supply chain, the availability of qualified personnel, the ability to economically maintain a safe operation, and changes in supply and demand. Additionally, because operators economically benefit from recovering their gas and sending

it to sales, they tend to seek out wells in locations where there is infrastructure nearby or infrastructure that could economically be built. I submit that it would not be prudent for an operator to drill or modify a well without a complete consideration of these economic and technical feasibility factors.

10. Similarly, the decision to shut-in (stop production) and plug a well is typically dependent upon non-regulatory compliance factors. Generally, new oil and gas wells begin production with a "normal" reservoir pressure. It's this pressure that provides the driving mechanism to produce the oil and gas. Over time, the reservoir pressure declines and with that decline, production declines while at the same time, the cost to produce the well may stay the same or actually increase with the need for artificial lift systems or a change in product price. All in all, the primary driver in declining profits at a marginal well is typically extraction of the resource that results in the well's declining production. Declining production and profits

usually result in an operator deciding to shut-in a well as it makes no sense to operate a well at a loss. Unfortunately, the cost of plugging is high and operators often do not choose to plug because it isn't profitable. As a result, all too often these uneconomic wells wind up continuously emitting and being the responsibility of the public and taxpayers for final disposition.

Proper Planning and Accessing Sales Lines for Stranded Gas

11. Operators typically engage in extensive planning prior to drilling a new well in order to set up the operation, enhance gas recovery, turn a reasonable profit, and comply with regulatory obligations. SWN's pre-drilling planning included: (1) securing technically attractive land; (2) spending months and even years to understand the technical nature of the geology and reservoir in order to maximize gas sales; (3) securing permission to connect to pipelines nearby upon completing a well; (4) contacting vendors that provide oilfield services such as drilling, logging, cementing, and fracing to encourage them to establish services in the region for our use;

(5) exploring ways to drill, complete and produce at a low cost; (6) exploiting the resource in an environmentally favorable way; and (7) setting up operations in order to accommodate regulatory obligations.

12. At SWN, our planning efforts allowed us to enhance gas recovery at well sites with "stranded gas," i.e., oil and gas wells that are not near sales lines. We did this, for example, in the Fayetteville Shale in Arkansas where I helped manage completions for SWN. The only takeaway infrastructure available near the Fayetteville Shale was two interstate pipelines, but there were no access points to those potential points of sale. Additionally, we had no oil and/or condensate to sell to help fund our operation. As a result, developing the ability for our operation to offtake natural gas and avoid the waste of gas through venting and flaring was imperative to our success. We therefore developed a drilling and completion plan sequence where we first drilled immediately adjacent to the two interstate pipelines (even though some of the wells might not be the very best reservoir quality) and then

developed inwardly into our acreage with our own midstream infrastructure. Over the course of approximately 15 years, SWN drilled approximately 4,500 wells in this manner. SWN also developed completion strategies that absolutely minimized emissions from gas wells, cut costs and thus extended the economic viability of the resource, and created thousands of very good paying jobs in an otherwise fairly depressed area.

Associated Gas Standard Feasibility

13. Overall, I agree with EPA's approach to reducing associated gas flaring emissions. New Mexico's and Colorado's associated gas provisions, which are more stringent than EPA's, are being implemented by operators in those states. Under the Rule, in situations that render all mitigation options technically infeasible in the first two years, operators can document this to EPA to justify exemptions that would allow flaring with combustion percentages at or in excess of 95% for certain categories of wells. Meanwhile, operators have plenty of time – two years

– to plan their new well operations such that they can comply with one of the mitigation options provided by EPA after the two-year exemption period ends.

14. Aside from routing gas to a sales line, there are a number of alternative technologies that operators can use to avoid flaring and enhance the beneficial use of produced associated natural gas and which are permitted under the Rule. Operators can use the natural gas to power onsite equipment (such as pumping units, compressors, control valves, and controllers). Additionally, under the Rule operators are permitted to use their gas for "another useful purpose" which could include, but is not limited to, onsite or regional power generation or conversion to various useful fuels (CNG/LNG) for nearby use. Finally, the associated natural gas could be injected to maintain reservoir pressure and/or enhance oil recovery.

I declare the foregoing is true and correct.

Thomas M. Alexander

DATED: June 10, 2024

Exhibit A

THOMAS MICHAEL ALEXANDER

(910)256-7814
(479)409-6495

EDUCATION.

***University of Denver, Denver, Colorado**

Master of Arts, Environmental Policy and Management, completed all coursework, 1994

* **South Dakota School of Mines and Technology, Rapid City, South Dakota**
Master of Science, Mining Engineering, 1981
Bachelor of Science, Mining Engineering, 1981

* **Duke University, Durham, North Carolina**
Post-graduate work in chemistry and genetics, 1973

* **Wake Forest University, Winston-Salem, North Carolina**
Bachelor of Arts, Psychology, 1973
Athletic Scholarship (golf), 1969-1973

* **Oil & Gas Industry Courses,** including but not limited to reservoir, economics, production, drilling, safety, cementing, directional wells, hydraulic stimulation, conformance, facilities, pressure analysis.

RELEVANT WORK EXPERIENCE

Over 39 years of comprehensive technical, operational and HSE experience in the oil and gas industry; recognized as an industry expert in unconventional resource development.
Assisted in development of leading edge regulatory frameworks within Southwestern Energy, New Brunswick and North Carolina.
Exceptional understanding of varying social, economic, regulatory, and political interests.
Excellent experienced communicator with multiple levels of understanding.
Very comfortable with all forms of media, live and otherwise.
Demonstrated composure in the most difficult public relations situations.
Adept at building consensus amongst multiple stakeholders.

EMPLOYMENT HISTORY

July 2016-present **Environmental Defense Fund - Technical/Regulatory Consultant**

Assisting with several Key projects involving underground natural gas storage, flaring/venting, conventional regulation reviews, underground gas storage in China, IOGCC regulatory project, Illinois and Oklahoma gas storage regulation comment, white paper covering HSE Management Systems, Risk Management, Emergency Response Planning, policy, process, procedure, corporate culture and water management. Additional projects include methane emission reduction in related regulatory updates in Colorado and New Mexico with EDF and several partner organizations.

I participated in a nearly 2 year long project representing EDF to update (American Petroleum Institute Recommended Practice) API RP 1170 (cavern storage of natural gas) and API 1170 (depleted reservoir and aquifer storage of natural gas) in 2 work groups focusing on risk management and HSE (health, safety and environment). The work accomplished a great deal toward better organization, flow, utilization of key HSE management system principles, KPI's, goals and objectives, audit functions, and the use of ALARP or a related system of quantifying and ranking risk assessment and management thereof.

Current projects (2024) include review and comment on upcoming PHMSA safe transport of CO2 via pipeline regulations, a new API RP on pipeline transport of CO2

and continued defense of the recent EPA rules related to methane emission reduction and management.

Jan 2017-Mar 2018 **Independent Energy Standards Corporation - Consultant**
Assisted in the development of rubrics to evaluate companies' HSE management systems, risk management programs, corporate culture, emergency response plans, upstream engineering and operations. Assisted as well in developing an HSE management system for IES itself. Helped evaluate IES clients in underground natural gas storage operations and upstream independent oil and gas operations in the mid-continent.

Oct. 2012-Apr. 2016 **Southwestern Energy Company - Vice President Health Safety & Environment**
Managed staff of over 60 HSE professionals assisting full breadth of company operations. Worked closely with federal and state government and regulatory agencies to insure safe and responsible development of company's oil and natural gas assets. Led team efforts that reduced company and contractor injury rates by over 50%. Managed all aspects of the cultural conversion to behavior based safety. Retired April 1, 2016.

May 2010-Sep. 2012 **SWN Resources Canada -General Manager, New Brunswick, Canada**
Managed company's initial international exploration project covering 2.5 million acres. Worked closely with provincial government, regulators, First Nations, and the public on a daily basis. Delivered well over 100 presentations and consultations, including numerous media events (live television, radio, scrums, and print). Served on Board of Directors of the Canadian Society of Unconventional Resources. Served on Board of Atlantica Centre for Energy, and was Treasurer for newly-formed New Brunswick Oil and Natural Gas Association.

Mar. 2007-Apr. 2010 **Southwestern Energy Company, Houston, Texas - Fayetteville Shale Completion Manager**
Managed a team of up to 75 professionals and was responsible for the completion of over 1200 horizontal wells. Annual completion budgets were in excess of $500,000,000. Team coordinated activity with drilling, geology, geophysics, land, and production. Shared technical and operational expertise at numerous industry conferences. Served on initial committee that ultimately developed our Model Regulatory Framework.

Apr. 2004-Feb. 2007 **Southwestern Energy Company - Team Lead Fayetteville Shale Project**
Promoted to Team Lead for Fayetteville Shale Project and managed multidisciplinary staff. Responsible for drilling, completion, and production of some 50 vertical and 90 horizontal wells during the initial phases of the project.

Jan. 2001-Mar. 2004 **Southwestern Energy Company, Fayetteville, Arkansas - Staff and Senior Staff Production Engineer**
Reviewed well performance of over 200 wells. Prepared commingling of 90 to 100 wells and identified 40-50 candidates for artificial lift. Directed the field work to accomplish these installations and commminglings. Identified over 30 stimulation candidates, designed the refracs and supervised their execution. Responsible for the completion design and execution of over 20 new wells each year.

Dec. 1997-Nov. 2000 **New Prospect Company, Fort Smith, Arkansas - Production/Reservoir Engineer**
Responsible for all production and reservoir aspects of over 200 wells, Consulted to Southwestern Energy 12/1998 - 12/2000 regarding production, operations, and artificial lift.

Nov. 1996-Nov. 1997 **Oil and Gas Consulting Engineer, Fort Smith, Arkansas**

June 1994-Nov. 1996 **Revere Corporation, Fort Smith, Arkansas - Operations/Engineering Manager**
Designed and executed all drilling, completion, and production, including artificial lift, recompletions, workovers, and safety and environmental concerns. Supervised and trained field and office personnel, provided expert testimony at state and local levels.

Sep. 1989-Jun. 1994 **Habersham Energy Company, Englewood, Colorado-Vice President Operations**
Managed all phases of an independent operating oil and gas company. Supervised 8 employees, served on board of directors, executed the annual budget.

Jul. 1998-Sept. 1989 **Southwest Operating, Incorporated, Tyler, Texas - President**
Acquired and invested in producing oil and gas properties.

Aug.1984-Jul. 1988 **Altair Energy Corporation, Tyler, Texas - Senior Vice President Operations**
Involved in all phases of drilling, production, property acquisition and divestiture.

Aug. 1981-Aug. 1984 **Schlumberger Offshore Services, Houston, Texas- Field and Sales Engineer**
Performed petrophysical logging services for offshore oil and gas companies. Involved personnel supervision, equipment logistics, nuclear sources and explosives control, log interpretation, electronic equipment maintenance, calibration, trouble-shooting and repairs. Sold logging products, petrophysical evaluations, and new technologies.

Mar. 1975-Jun. 1981 **United States Air Force- B-52H Navigator and Radar Navigator**
SAC B-52H crew member. Consistently rated top in class and operations in all phases of performance and training. Honorably discharged with the rank of Captain.

Attachment C

Declaration of Peter H. Howard

DECLARATION OF PETER H. HOWARD, PH.D.

I, Peter H. Howard, declare as follows:

1. I received a Ph.D. in Agricultural and Resource Economics from the University of California, Davis, in 2012. Since 2015, I have served as the Economics Director at the Institute for Policy Integrity at New York University School of Law, a nonpartisan think tank dedicated to improving the quality of government decision-making through advocacy and scholarship in the fields of administrative law, economics, and public policy.[1]

2. My fields of expertise include environmental and natural resource economics, with a primary focus on climate economics. Much of my research focuses on valuing the damages from greenhouse gas emissions, more commonly known as the "social cost of greenhouse gases." I have published numerous reports and articles on this topic in peer-reviewed economics and science journals including *Science*, *Nature*, *Environmental and Resource Economics*, and *Climatic Change*. I have also published articles on valuing climate impacts in legal journals such as the *Yale Journal on Regulation*, *Harvard Environmental Law Review*, and *Columbia Journal*

[1] This declaration does not purport to represent the views, if any, of New York University School of Law.

of Environmental Law. My curriculum vitae is attached as Exhibit A.

3. Government bodies that have worked on valuing the social cost of greenhouse gases have widely cited my work. Of particular note, the Interagency Working Group on the Social Cost of Greenhouse Gases, the National Academy of Sciences' Committee on the Social Cost of Carbon, and the Environmental Protection Agency (EPA) have cited my articles. *E.g.*, Interagency Working Grp. on Soc. Cost of Greenhouse Gases, *Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide* 12 n.14, 16, 20 (2021) (Working Group 2021 TSD); Nat'l Acads. of Scis., Eng'g & Med., *Valuing Climate Damages: Updating Estimation of the Social Cost of Carbon Dioxide* 53, 149, 155 (2017) (National Academies Report); EPA, *EPA Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances* 2, 15, 17, 47, 53 & n.91, 55 tbl.2.3.2, 56, 57–59 & nn.97–104, 63, 66, 69, 76, 83, 86, 100, 101 n.154, 148, 151, 153, 170 tbl.A.8.1 (2023) (EPA Report). My *Columbia Journal of Environmental Law* article on the justifications for estimating global damages, for example, was cited by all three of those government reports.

4. As noted further below, EPA uses my damage function in its new social cost of greenhouse gas estimates. Nobel Laureate Dr. William Nordhaus also uses my work valuing climate change's harms as one way to calibrate his

climate-economic model, the Dynamic Integrated Climate-Economy (DICE) model. William Nordhaus, *Climate Change: The Ultimate Challenge for Economics*, 109 Am. Econ. Rev. 1991, 2000 (2019).

5. I am deeply familiar with the economic methodologies for estimating the social cost of greenhouse gases and the federal government's application of those values.

Updated Social Cost of Greenhouse Gas Valuations from EPA's National Center for Environmental Economics

6. I understand that EPA recently finalized requirements for oil and gas operators to reduce their methane emissions, 89 Fed. Reg. 16,820 (Mar. 8 2024) (the Rule); that EPA released a peer-reviewed report updating valuations of the social cost of greenhouse gases; and that in EPA's Regulatory Impact Analysis (the RIA) for the Rule, EPA utilized its updated valuations of the social cost of methane to monetize the Rule's climate benefits (and also applied the updated social cost of carbon dioxide estimates in an illustrative analysis of the Rule's small potential climate disbenefits due to minor increases in carbon dioxide). EPA estimated, using its updated social cost of methane valuations, that the Rule will result in a present value of $110 billion in climate benefits (using its central social cost of methane estimate corresponding to a 2% social discount rate). 89 Fed. Reg. at 16,836, tbl. 6. I understand EPA did not rely on the RIA's climate benefits or the

social cost of methane to create or justify the standards. I nonetheless provide an explanation as to why EPA's updated social cost of greenhouse gas estimates used in the RIA are economically sound.

7. The social cost of a greenhouse gas represents the monetized harms to society associated with one additional metric ton of emissions of that greenhouse gas. Stated differently, it represents the monetized marginal external benefits of avoiding one additional ton of emissions of that greenhouse gas. These estimates exist for numerous greenhouse gases, including carbon dioxide, nitrous oxide, and methane.

8. A federal Interagency Working Group last produced a substantive update to its estimates of the social cost of carbon in 2013 and added new estimates of the social cost of methane and nitrous oxide in 2016; all those estimates were adjusted for inflation in 2021, but not otherwise updated. Working Group 2021 TSD, *supra*. In 2017, the National Academies of Sciences called for regular updates of the social cost of greenhouse gas estimates and provided recommendations for future updates. National Academies Report, *supra*.

9. Since the Working Group last updated its climate-damage estimates, there have been many developments in the economic and scientific literature on the proper valuation of climate damages. *See, e.g.*, EPA Report, *supra*, at 46

fig.2.3.1 (showing a surge in recent research that was not incorporated into the Working Group's 2016 estimates). The National Center for Environmental Economics (NCEE), a division of EPA, sought to fill this analytical gap by developing updated estimates of the social cost of greenhouse gases. That update further reflects the recommendations of the National Academies, along with other recent updates in science and economics.

10. EPA released draft estimates in December 2022 through a technical report from NCEE. *See* EPA, *EPA External Review Draft of Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances* (2022). Following publication, those draft estimates underwent public comment and expert peer review. EPA finalized these estimates in December 2023, when it released an updated NCEE technical report and applied the valuations in the final methane rule's RIA. EPA Report, *supra*.

11. The expert peer reviewers who reviewed EPA's valuations were independently chosen and eminently qualified. An independent contractor managed EPA's peer review process to help insulate the process from bias. Request for Nominations of Experts for the Review of Technical Support Document for the Social Cost of Greenhouse Gases, 87 Fed. Reg. 3801, 3802 (Jan. 25, 2022). The peer reviewers included, as representative

credentials, a former and the current President of the Association of Environmental and Resource Economists (Dr. Maureen Cropper and Dr. Karen Fisher-Vanden, respectively), a contributing author of reports from the Intergovernmental Panel on Climate Change (Dr. Chris E. Forest), and four economics professors at top universities (Dr. Catherine Louise Kling, Cornell University; Dr. Michael Oppenheimer, Princeton University; and Drs. Wolfram Schlenker and Gernot Wagner, Columbia University). EPA, *Details of External Peer Review Panel Process for the Review of EPA's "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances"* 2–4 (2023).

12. These expert peer reviewers offered extensive praise for EPA's estimates. EPA, *Final Comments Summary Report, External Letter Peer Review of Technical Support Document: Social Cost of Greenhouse Gases* (2023) (Peer Review *Report*). These experts lauded EPA's methodological improvements as a "huge advance," *id.* at 7 (comments of Dr. Cropper), a "significant step," *id.* at 9 (comments of Dr. Forest), and a "much-needed improvement," *id.* at 10 (comments of Dr. Kling), that "advanc[e] our state of knowledge," *id.* at 14 (comments of Dr. Schlenker), and "represent[] well the emerging consensus in the literature," *id.* at 15 (comments of Dr. Wagner).

13. EPA values climate impacts using state-of-the-art damage functions from leading climate economists and research laboratories: one from the University of Chicago's Climate Impact Lab; one from Resources for the Future and the University of California, Berkeley; and one that I and Dr. Thomas Sterner developed that integrates and combines many other published estimates through a meta-analysis. EPA Report, *supra*, at 47. The choice to combine three independently constructed damage functions helps ensure rigor by incorporating a range of expert analyses and thereby guarding against overreliance on any one methodology.

14. EPA presents its estimates for each greenhouse gas (carbon, methane, and nitrous oxide) in ranges, which it developed by using three different discount rates (1.5%, 2%, and 2.5%). *Id.* at 101 tbl.4.1.1. The estimates that use a 2% discount rate represent EPA's central estimates. *Id.* at 69 (citing National Academies Report, *supra*). Each estimate calculates total climate damages regardless of where they occur in the world. *Id.* at 12–19. Some of EPA's updates to the Working Group's methodology tend to increase its climate-damage estimates, while other updates tend to decrease them.

15. In December 2023, the Working Group recognized the many pertinent "developments in the scientific literature" since its latest estimates from 2016. Interagency Working Grp., Memorandum from the Interagency

Working Group on Social Cost of Greenhouse Gases (Dec. 22, 2023). It therefore encouraged federal agencies to use climate-damage values that "reflect the best available evidence, are most appropriate for particular analytical contexts, and best facilitate sound decision-making." *Id.* In my opinion, EPA's climate-damage values are consistent with all three of these recommendations from the Working Group.

16. I have reviewed EPA's social cost of greenhouse gas estimates and the underlying methodology and, like the expert peer reviewers, find these estimates to be robust and well supported. More specifically, EPA's updated climate-damage values are the best federal estimates available.

EPA Appropriately Uses Global Climate-Damage Estimates

17. Economics literature and theory strongly support EPA's decision to value the total climate impacts associated with U.S. emissions, regardless of where those impacts occur in the world. This is a longstanding position. EPA first explained in 2008, during the George W. Bush Administration, the arguments in favor a global estimate of the social cost of greenhouse gases. EPA, *Technical Support Document on Benefits of Reducing GHG Emissions* 10-11 (2008), *available at* https://costofcarbon.org/files/document_gw_04.pdf ("EPA recommends consideration of estimates of the global marginal benefit of a reduction in

GHGs," because, for example, of spillover impacts to U.S. economic and national security impacts, among other reasons). The Interagency Working Group consistently adopted a global valuation since its earliest estimates. Working Group 2021 TSD, *supra*, at 16 ("This [global] approach is the same as that taken in regulatory analyses [since] 2009."). And in 2017, the National Academies stressed the need to "consider," when estimating the social cost of greenhouse gases, "the potential implications of climate impacts on, and actions by, other countries, which also have impacts on the United States." National Academies Report, *supra*, at 53.

18. Numerous reasons underlie this decision, as discussed in this section. For one, climate change effects that initially occur abroad will have both direct and indirect effects on U.S. citizens and residents and on U.S. physical and financial assets.

19. The United States is particularly vulnerable to effects that will spill over from other regions of the world given its economic and strategic interests around the world. As EPA recognizes, around nine million U.S. citizens live overseas, including many in the military. EPA Report, *supra*, at 14. Among other foreign interests, U.S. taxpayers report hundreds of billions of dollars in income from abroad, U.S. companies earn about a fifth of their profits from activities abroad, and U.S. citizens own trillions of dollars in foreign

equity and debt. *Id.* & n.21. Americans also benefit substantially from exports, imports, and foreign innovation. *E.g.*, The World Bank, *Imports of Goods and Services (% of GDP) - United States*, https://data.worldbank.org/indicator/NE.IMP.GNFS.ZS?locations=US (last accessed Feb. 29, 2024) (finding the value of imported goods in 2022 were worth 15.6% of U.S. gross domestic product); Francisco J. Buera & Ezra Oberfield, *The Global Diffusion of Ideas*, 88 Econometrica 83 (finding substantial economic benefits of global innovation from international trade).

20. Climate change can also threaten national security in numerous ways. EPA Report, *supra*, at 14; Peter Howard & Jason Schwartz, *Think Global: International Reciprocity as Justification for a Global Social Cost of Carbon*, 42 Colum. J. Env't L. 203, 240–41 (2017). Aside from its effect on the more than 500 American military installations abroad, EPA Report, *supra*, at 14 (citing Dep't of Def., *Base Structure Report – Fiscal Year 2018 Baseline* 7 fig.1 (2018)), the Department of Defense views climate change as an "existential threat" that "transcend[s] political boundaries" and "will continue to have worsening implications for U.S. national security" by "increasing the risk that crises cascade beyond any one country or region," Dep't of Def., *Climate Risk Analysis* 4–5 (2021). The same report describes how climate change will affect migration patterns, global supply chains,

food availability, political instability, and the spread of vector-borne diseases, each of which could pose grave challenges to the United States. *Id.* at 9. EPA recognizes that these and other direct effects on U.S. citizens, residents, assets, and national security interests counsel in favor of using global climate-damage estimates. EPA Report, *supra*, at 14–16.

21. Another compelling justification for using global climate-damage estimates is international reciprocity. Specifically, if the United States reduces its greenhouse gas emissions, foreign nations are more likely to reduce their own emissions, which in turn will benefit U.S. citizens and residents. *See id.* at 17 (citing, *inter alia*, Howard & Schwartz, *supra*; Robert E. Kopp & Bryan K. Mignone, *Circumspection, Reciprocity, and Optimal Carbon Prices*, 120 Climatic Change 831 (2013)).

22. These benefits from international reciprocity can be substantial. For example, one analysis finds that every ton of U.S. emissions reduced using emerging climate technologies will result in 2.4–2.9 tons of emissions reductions in other countries. Kate Larsen et al., Rhodium Grp., *Global Emerging Climate Technology Diffusion and the Inflation Reduction Act* (2023). Another analysis, which I co-authored, estimates that the United States stands to gain over $10 trillion in benefits over the next three decades from other nations reducing their greenhouse gas emissions. Peter Howard &

Jason Schwartz, Inst. for Pol'y Integrity, *Foreign Action, Domestic Windfall* 2 (2015). Highlighting these reciprocity benefits, a peer-reviewed paper by Yale University economics professor Matthew J. Kotchen developed a framework showing how it can be rational for countries to fully value global climate damages when analyzing domestic policies. Matthew J. Kotchen, *Which Social Cost of Carbon? A Theoretical Perspective*, 5 J. Ass'n Env't & Res. Economists 673, 675, 678 (2018) (providing formulas for the "efficiency argument in support of all countries internalizing the GSCC [global social cost of carbon] for domestic policy").

23. Experience shows that U.S. adoption of global valuations leads to reciprocal global valuations abroad. Numerous countries adopted the Working Group's climate-damage valuation methodology, accounting for global climate impacts. Jason Schwartz, Inst. for Pol'y Integrity, *Strategically Estimating Climate Pollution Costs in a Global Environment* 10–11 (2021). And Canada has already adopted EPA's updated estimates, further demonstrating the power of U.S. leadership in spurring reciprocal foreign actions. Gov't of Can., *Social Cost of Greenhouse Gas Estimates – Interim Updated Guidance for the Government of Canada* (2023). As noted above, these reciprocal actions benefit the United States.

24. A partial accounting that disregards climate damages that occur outside U.S.

borders would omit these direct effects on Americans and their foreign-held assets, spillover climate impacts, and reciprocity effects. As I argued in a letter co-authored with other experts including Nobel Laureate Kenneth Arrow, "To solve the unprecedented global commons problem posed by climate change, all nations must internalize the global externalities of their emissions; otherwise, collective abatement efforts will never achieve an efficient, stable climate outcome." Richard L. Revesz et al., *The Social Cost of Carbon: A Global Imperative*, 11 Rev. Env't Econ. & Pol'y 172, 172 (2017) (citation omitted). EPA's approach follows this expert consensus.

25. Finally, the global approach to valuing climate damages is correct from the perspective of consistency. As a reminder, in this Rule, EPA did not weigh climate benefits using the social cost of methane against costs to industry to justify its standards. Rather, it laid out the monetary climate benefits of the Rule in the RIA for informational purposes to comply with Executive Order 12,866; separately, under its statutory factors, EPA determined the standards' cost-reasonableness using a cost-effectiveness approach and weighed compliance costs against emissions reductions occurring within the United States. 89 Fed. Reg. at 16,864 (comparing industry compliance costs to domestic emissions reductions); *see also id.* at 16,866 (noting that while EPA is not required under the statute to conduct a formal cost-benefit

analysis, it did weigh advantages of the Rule against disadvantages). Within the RIA, a global perspective for valuing climate damages was appropriate to be consistent with a global perspective for valuing the RIA's compliance costs. As the Office of Management and Budget's updated guidance on regulatory analysis reminds, agencies "should be *consistent* and transparent in whether and how important impacts to noncitizens residing abroad are included" in their RIAs. OMB, *Circular A-4*, 9 (2023) (emphasis added). For this same reason, even though EPA did not consider monetized climate benefits in setting the standards under the statute, had EPA weighed the social cost of methane against industry costs, a global valuation of benefits would have been appropriate to match the global valuation of costs.

26. All industry compliance costs ultimately fall on the owners, employees, or customers of regulated and affected firms. Companies affected by the Rule include subsidiaries of major corporations that are headquartered abroad or that are publicly traded with investors across the globe. In general, about 29% of U.S. corporate debt and 14% of equities are foreign-owned, according to Department of Treasury records of foreign portfolio holdings, and adding foreign direct investment to portfolio stock ownership suggests that foreigners own up to 40% of U.S. corporate equity. *See* Steve Rosenthal

& Theo Burke, Who's Left to Tax? U.S. Taxation of Corporations and Their Shareholders at 2 (Urban-Brookings Tax Policy Center Working Paper, 2020), https://perma.cc/YMR2-XREM. These general patterns largely hold true for the oil and gas industry, according to Energy Information Administration data. *See e.g.*, Energy Info. Admin., Foreign Investors Play Large Role in U.S. Shale Industry, https://www.eia.gov/todayinenergy/detail.php?id=10711.

27. EPA's RIA for the Rule does not distinguish between compliance costs that may ultimately fall to the foreign investors, employees, or customers of affected entities versus costs accruing only to U.S. citizens and entities. Since EPA's RIA assesses the Rule's global costs without distinguishing between U.S. and foreign effects, it would be inconsistent and arbitrary for the agency to attempt to separate and disregard climate benefits that occur abroad.

EPA's Valuations Greatly Improve upon Prior Federal Estimates and Represent the Best Available Federal Climate-Damage Values

28. The federal government has advanced three climate-damage estimates since 2010: the Working Group's estimates (first advanced in 2010, with the social cost of methane added in 2016, and reinstated in 2021), the Trump administration's estimates (used from 2017 to 2021), and EPA's recent estimates. In my view, EPA's estimates are by far the best of the three.

29. The Trump administration's estimates were premised upon unjustifiable analytical decisions, including the decision to prioritize an attempt to estimate domestic-only climate damages, undercutting the longstanding global approach.

30. The Trump administration's estimates attempted to consider only the harms of climate change that accrue within U.S. borders. *E.g.*, EPA, *Regulatory Impact Analysis for the Proposed Emission Guidelines for Greenhouse Gas Emissions from Existing Electric Utility Generating Units* 4-3 (2018). As explained above, that approach is inconsistent with economic theory and expert consensus, for several reasons. First, the Trump administration's approach ignored the fact that climate change effects that initially occur abroad ultimately affect U.S. citizens and residents, U.S. physical and financial assets, and national security. Second, the Trump administration's approach ignored the reciprocity benefits that the United States experiences from emissions reductions in foreign countries. And third, because climate change is a global externality, collective abatement requires all nations to internalize the global externalities of their emissions.

31. The Trump administration's purported domestic-only estimates ignored all of these critical considerations. For this reason, they incompletely account for climate damages. As the Government Accountability Office put it in its

critique of the Trump administration's estimates, "accurately estimating the damages from carbon dioxide emissions for the United States would involve more than examining the direct impacts of climate change that occur within U.S. physical borders. [It] would need to consider how climate change and emissions reductions in other parts of the world could also affect the United States—for example, through (1) increased migration because of economic or political destabilization and (2) reciprocal actions by other countries in response to U.S. emission reductions." U.S. Gov't Accountability Off., *Social Cost of Carbon: Identifying a Federal Entity to Address the National Academies' Recommendations Could Strengthen Regulatory Analysis* 26 (2020).

32. The Trump administration's estimates did not attempt to model the spillover and reciprocity impacts of climate change. Combined with other unsupported methodological choices (such as on the choice of discount rates), this approach left the Trump administration's estimates irredeemably unjustifiable. EPA's current approach, as updated in 2023, is unquestionably superior to the Trump administration's.

33. While the Working Group's 2016 estimates were based on sound methodological choices, including their focus on global damages, they have not been substantively updated since the addition of social cost of methane

estimates in 2016, and the underlying methodology has not been updated since 2013. For reasons explained above, their underlying data is now largely outdated and their valuations are widely recognized to understate the true costs of climate change.

34. EPA's updated 2023 estimates represent a marked improvement over any prior set of estimates and are therefore the best available values for agencies to use in their regulatory impact analyses and other policy assessments.

I declare that the foregoing is true and correct.

Peter H. Howard, Ph.D.

Executed on June 10, 2024.

Exhibit A

Peter H. Howard
Institute for Policy Integrity
New York University School of Law
Wilf Hall
139 MacDougal Street, Third Floor
New York, NY 10012
(551)208-1863
HowardP@mercury.law.nyu.edu

Fields of Interest

Environmental Economics and Policy, Climate Economics and Policy, Natural Resource Economics, Land Economics and Policy

Education

Doctor of Philosophy June 2012
Department of Agricultural and Resource Economics
University of California, Davis, CA

Dissertation
The Economics of Climate Change at the Local Level: The Case of Shifting Oak Habitat Range in the Tulare Lake Basin

Bachelor of Arts 2003
Economics
Bard College, Annandale-on-Hudson, NY

Current Position

Economics Director February 2015-Present

Institute for Policy Integrity, New York University School of Law
Research, mathematical programming, econometric analysis, reviewing literature, writing, hiring, and managing economic fellows, research assistants and interns, and grant writing
Projects: Conduct research, write policy briefs, and develop and submit legal comments on climate change, resource extraction, automobile emissions, and other environmental and regulatory topics
Supervisor: Richard Revesz

PROFESSIONAL EXPERIENCE

Economic Fellow August 2012-February 2015

Institute for Policy Integrity, New York University School of Law
Research, mathematical programming, econometric analysis, reviewing literature, writing, and hiring and managing research assistants and interns

Projects: Develop an interactive website on the social cost of carbon (SCC); write policy briefs; co-write comments on the SCC; develop research projects that address potential shortcomings in the current SCC estimates
Supervisors: Michael Livermore, Richard Revesz
Work in Conjunction with: Environmental Defense Fund and Natural Resource Defense Council

Research Assistant April 2006-August 2012

Department of Agricultural and Resource Economics, University of California, Davis
Mathematical programming, data collection and cleaning, reviewing literature, econometric analysis, writing, and managing graduate student research assistants
Projects: Estimate the economic cost to California agriculture of a proposed state-wide ban on chloropicrin; estimate the economic cost to California agriculture of California Department of Pesticide Regulation's proposed surface water regulations; estimate the economic cost of fumigant and emulsifiable concentrate regulations in Fresno County, California; estimate the economic cost to California agriculture of the non-registration of methyl iodide; estimate the economic cost of fumigant regulations in Ventura County, California; estimate the economic cost to California agriculture of California Department of Pesticide Regulation's VOC regulations
Supervisors: Rachael Goodhue, Richard Howitt
Work in Conjunction with: California Department of Food and Agriculture

Research Assistant January 2006-April 2006

Department of Agricultural and Resource Economics, University of California, Davis
Write a summary explaining the Statewide Agricultural Production Model (a mathematical programming model for California agriculture), and data collection and cleaning
Supervisor: Richard Howitt

Teaching Assistant September 2005-December 2005

Department of Agricultural and Resource Economics, University of California, Davis
Design lesson plans, teach, and grade
Undergraduate Course: Econometrics
Supervisor: Sandeep Mohapatra

Conference Coordinator January 2004-May 2004

Association for Geo-classical Studies, NY
Create contact list, plan conference, and contact potential attendees
Supervisor: Kris Feder

reports

Best Practices for Energy Substitution Analysis
Peter Howard and Max Sarinsky, December 2022. Available at https://policyintegrity.org/publications/detail/best-practices-for-energy-substitution-analysis.

Enacting the "Polluter Pays" Principle: New York's Climate Change Superfund Act and Its Impact on Gasoline Prices
Peter Howard and Minhong Xu, November 2022. Available at https://policyintegrity.org/publications/detail/enacting-the-polluter-pays-principle

The Real Costs of Offshore Oil and Gas Leasing

Peter Howard, Max Sarinsky, and Minhong Xu, September 2022. Available at https://policyintegrity.org/publications/detail/the-real-costs-of-offshore-oil-and-gas-leasing.

Expert Elicitation and the Social Cost of Greenhouse Gases
Peter Howard and Derek Sylvan, June 2021. Available at https://policyintegrity.org/publications/detail/expert-elicitation-and-the-social-cost-of-greenhouse-gases.

About Time: Recalibrating the Discount Rate for the Social Cost of Greenhouse Gases
Peter Howard and Jason Schwartz, June 2021. Available at https://policyintegrity.org/publications/detail/about-time.

Gauging Economic Consensus on Climate Change
Peter Howard and Derek Sylvan, March 2021. Available at https://policyintegrity.org/publications/detail/gauging-economic-consensus-on-climate-change.

Turbocharged: How One Revision in the SAFE Rule Economic Analysis Obscures Billions of Dollars in Social Harms
Peter Howard and Max Sarinsky, November 2020. Available at https://policyintegrity.org/publications/detail/turbocharged.

Shortchanged: The Concealed Costs of the Clean Water Rule Rollback
Bethany Davis Noll, Peter Howard, Jason Schwartz, and Avi Zevin, June 2020. Available at https://policyintegrity.org/publications/detail/shortchanged-the-trump-administrations-rollback-of-the-clean-car-standards.

Beneath the Surface: The Concealed Costs of the Clean Water Rule Rollback
Bethany Davis Noll, Peter Howard, Max Sarinsky, Jason Schwartz, and Jeffrey Shrader, April 2020. Available at https://policyintegrity.org/publications/detail/beneath-the-surface.

Expert Report: An Evaluation of the Revised Definition of "Waters of the United States"
Peter Howard and Jeffrey Shrader, April 2019

Analyzing EPA's Vehicle-Emissions Decisions
Bethany Davis Noll, Peter Howard, and Jeffrey Shrader, May 2018. Available at https://policyintegrity.org/publications/detail/analyzing-epas-fuel-efficiency-decisions1.

Social Cost of Greenhouse Gases and State Policy
Iliana Paul, Peter Howard and Jason Schwartz, October 2017. Available at https://policyintegrity.org/publications/detail/social-cost-of-ghgs-and-state-policy.

The Bureau of Land Management's Modeling Choice for the Federal Coal Programmatic Review
Peter Howard, June 2016. Available at http://policyintegrity.org/publications/detail/BLM-model-choice.

Illuminating the Hidden Costs of Coal
Jayni Hein and Peter Howard, December 2015. Available at http://policyintegrity.org/publications/detail/hidden-costs-of-coal.

Expert Consensus on the Economics of Climate Change
Peter Howard and Derek Sylvan, December 2015. Available at http://policyintegrity.org/publications/detail/expert-climate-consensus.

Foreign Action, Domestic Windfall: The U.S. Economy Stands to Gain Trillions from Foreign Climate Action
Peter Howard and Jason Schwartz, November 2015. Available at http://policyintegrity.org/publications/detail/foreign-action-domestic-windfall.

Reconsidering Coal's Fair Market Value: The Social Costs of Coal Production and the Need for Fiscal Reform
Jayni Hein and Peter Howard, October 2015. Available at http://policyintegrity.org/publications/detail/reconsidering-coals-fair-market-value.

Flammable Planet: Wildfires and the Social Cost of Carbon
Peter Howard, September 2014. Available at http://costofcarbon.org/files/Flammable_Planet__Wildfires_and_Social_Cost_of_Carbon.pdf.

Omitted Damages: What's Missing From the Social Cost of Carbon
Peter Howard, March 2014. Available at http://costofcarbon.org/files/Omitted_Damages_Whats_Missing_From_the_Social_Cost_of_Carbon.pdf

Economic Implications of a Statewide Chloropicrin Ban on California Agriculture
Rachael Goodhue, Peter Howard, Karen Klonsky, Matthew MacLachlan, Pierre Mérel, and Kaitlyn Smoot. Final report submitted to the California Department of Food and Agriculture. October 2012.

Potential Economic Impacts of the February 1, 2010 Department of Pesticide Regulation Draft Restrictions to Address Pesticide Drift and Runoff to Protect Surface Water: Case Study Analysis
Rachael Goodhue, Peter Howard, Karen Klonsky, and Kaitlyn Smoot. Final report submitted to the California Department of Food and Agriculture. September 2011.

Costs of Methyl Iodide Non-Registration: Economic Analysis
Rachael Goodhue, Peter Howard, and Richard Howitt. Final report submitted to the California Department of Food and Agriculture. May 2010.

Effects of the January, 2008 CDPR Field Fumigation Regulations: Ventura County Case Study
Rachael Goodhue, Richard Howitt, Peter Howard, and Henry An. Final report submitted to the California Department of Food and Agriculture. April 2009. Available at www.cdfa.ca.gov/files/pdf/GoodhueHowitt042309.pdf.

Effects of Proposed VOC Emission Reduction Rule on California Agriculture: A Statewide Industry Analysis
Rachael Goodhue, Peter Howard, and Richard Howitt. Interim report submitted to the California Department of Food and Agriculture. June 2007.

selected Comments

Comments to NHTSA on New Corporate Average Fuel Economy Standards
Peter Howard et al., October 2023

Comments on the Consideration of Climate Benefits in Proposed Rule to Limit Methane Leakage from Gas Pipelines
Peter Howard and Max Sarinsky, August 2023

Comments to EPA on GHG Regulations for Fossil Fuel-Fired Power Plants
Dean Adler et al., July 2023

Comments to EPA on Proposed Emissions Standards for New Motor Vehicles
Peter Howard et al., July 2023

Comments to OMB on Draft Update of Circular A-4
Dean Adler et al., June 2023

Economic Comments on the EPA External Review Draft of Report on the Social Cost of Greenhouse Gases (Docket No. EPA-HQ-OAR-2021-0317)
Peter Howard, February 2023

Comments on the EPA External Review Draft of Report on the Social Cost of Greenhouse Gases (Docket No. EPA-HQ-OAR-2021-0317)
Brunstein et al., February 2023

Comments to EPA Science Advisory Board on Economic Analysis Guidelines
Jason A. Schwartz, Matt Butner, Peter Howard, and Max Sarinsky, May 2020.

Second Supplemental Comments on NHTSA's Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2016 Passenger Cars and Light Trucks
Bethany Davis Noll, Peter H. Howard, Jason Schwartz, and Avi Zevin, May 2019.

Comments on the Replacement of the Clean Water Rule
Ian David, Bethany Davis Noll, Peter H. Howard, James Meresman, and Jason Schwartz, April 2019.

Supplemental Comments on NHTHA's Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2016 Passenger Cars and Light Trucks
Bethany Davis Noll, Peter H. Howard, Jason Schwartz, and Avi Zevin, Zevin December 2018.

Comments on NHTSA's Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021-2016 Passenger Cars and Light Trucks
Bethany Davis Noll, Peter H. Howard, Jason Schwartz, and Avi Zevin, Zevin October 2018.

Comments on Interior's Offshore Oil and Gas Leasing 2019-2024 Draft Proposed Program,
Jayni Hein, Peter H. Howard, Alexander Leicht, Kelly Lester, March 2018.

Comments on Use of the Social Cost of Greenhouse Gases in Environmental Impact Statements,
Elly Benson et al., March 2018.

Comments on Arctic Drilling to the Bureau of Ocean Energy Management
Rachel Cleetus, Denise Grab, Jayni Hein, Peter H. Howard, Benjamin Longstreth, Richard L. Revesz, Jason A. Schwartz, December 2017.

Comments on EPA Methane Rule Stay
Susanne Brooks et al., December 2017.

Comments to Minnesota on the Social Cost of Carbon
Denise Grab, Peter H. Howard, Iliana Paul, Jason A. Schwartz, July 2017

Comments on U.S. Army Corps of Engineers Environmental Impact Statement
Susanne Brooks et al., April 2017.

California Air Resources Board – Comments on the 2017 Scoping Plan Update
Denise A. Grab, Peter H. Howard, Iliana Paul, Jason A. Schwartz, April 2017.

Comments to California Air Resources Board on 2030 Target Scoping Plan Draft
Denise A. Grab, Jayni Foley Hein, Peter H. Howard, Iliana Paul, Jason A. Schwartz, and Burcin Unel, December 2016.

Comments on the Department of Energy's Use of the Social Cost of Carbon
Tomás Carbonell et al., December 2016.

Comments on the U.S. Department of Interior's Regulatory Impact Analysis and Environmental Impact Statement for the Proposed Stream Protection Rule,

Peter Howard and Jayni Hein, August 2016.

Comments on the Draft Proposed 2017-2022 Outer Continental Shelf (OCS) Oil and Gas Leasing Program, BOEM-2014-0059
Jayni Hein and Peter Howard, June 2016.

Comments to the National Academy of Sciences on the Social Cost of Carbon
Peter Howard and Jason Schwartz, April 2016, Available at http://policyintegrity.org/what-we-do/update/national-academy-of-sciences-reviews-social-cost-of-carbon.

Comments on the Energy Conservation Standards for Walk-In Coolers and Freezers
Laurie Johnson, Peter Howard, Megan Ceronsky, Rachel Cleetus, Richard Revesz, and Gernot Wagner. November 12, 2013. Available at http://policyintegrity.org/documents/Comments_on_use_of_SCC_in_Walk-in_Coolers_and_Commercial_Refrigeration_Rules.pdf

Comments on Petition for Correction: Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866 (February 2010) and Technical Support Document: Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866 (May 2013)
Laurie Johnson, Peter Howard, Megan Ceronsky, Rachel Cleetus, Richard Revesz, and Gernot Wagner. October 21, 2013.

Comments on the Energy Conservation Program: Energy Conservation Standards for Metal Halide Lamp Fixtures; Proposed Rule, 78 Fed. Reg. 51,464 (August 20, 2013)
Laurie Johnson, Peter Howard, Megan Ceronsky, Rachel Cleetus, Richard Revesz, and Gernot Wagner. October 21, 2013.

Published PAPERS and Chapters

Accounting for the increasing benefits from scarce ecosystems

Moritz Drupp et al. forthcoming. *Science*.

US benefit-cost analysis requires revision
Peter Howard et al. 2023. *Science*, 380, 803.

Valuing the Future: Legal and Economic Considerations for Updating Discount Rates
Peter Howard and Jason Schwartz. 2022. *Yale Journal of Regulation*, 39, 595-657.

Global Health Impacts for Economic Models of Climate Change
Kevin R Cromar, Susan C. Anenberg, John R. Balmes, Allen A. Fawcett, Marya Ghazipura, Julia M. Gohlke , Masahiro Hashizume, Peter Howard, Eric Lavigne, Karen Levy, Jaime Madrigano, Jeremy A. Martinich, Erin A. Mordecai, Mary B Rice, Shubhayu Saha, Noah C. Scovronick, Fatih Sekercioglu, Erik R. Svendsen, Benjamin F. Zaitchik, and Gary Ewart. 2022. *Annals of the American Thoracic Society.*

Climate–Society Feedback Effects: Be Wary of Unidentified Connections
Peter Howard and Michael Livermore. 2021. *International Review of Environmental and Resource Economics*, 15(1-2), 33-93.

Health impacts of climate change as contained in economic models estimating the social cost of carbon dioxide
Kevin Cromar, Peter Howard, Váleri Vásquez, and David Anthoff. 2020. *GeoHealth*, 5, 1-14.

Wisdom of the Experts: Using Economic Consensus to Address Positive and Normative Uncertainties in Climate-Economic Models
Peter Howard and Derek Sylvan. 2020. *Climatic Change*, 162, 213-232.

Funding Inclusive Green Transition through Greenhouse Gas Pricing
Thomas Sterner, Richard T. Carson, Marc Hafstead, Peter Howard, Sverker Carlsson Jagers, Gunnar Köhlin, Ian Parry, Ryan Rafaty,E. Somanatan, Jan Christoph Steckel,Dale Whittington, Francisco Alpizar, Stefan Ambec, Claudia Aravena, Jorge Bonilla, Reza Che Daniels, Jorge Garcia, Niklas Harring, Kanishka Kacker, Suzi Kerr, Haileselassie Medhin, Pham Khanh Nam, German Romero, Olof Johansson-Stenman,Mike Toman,Jintao Xu, Min Wang. 2020. Ifo DICE Report,

Sociopolitical Feedbacks and Climate Change
Michael Livermore and Peter Howard. 2019. *Harvard Environmental Law Review*

Chapter 22 - The Social Cost of Carbon: Capturing the Costs of Future Climate Impacts in US Policy
Peter H Howard. 2018. *Managing Global Warming: an interface between technology and human issues*

Few and Not So Far Between: A Meta-analysis of Climate Damage Estimates
Peter Howard and Thomas Sterner. 2017. *Environmental and Resource Economics*, 68(1), 197-225.

Best Cost Estimate of Greenhouse Gases
Ricky Revesz, R., M. Greenstone, M. Hanemann, M. Livermore, T. Sterner, D. Grab, P. Howard, and J. Schwartz. 2017.Science, 357(6352),655-655.

The social cost of carbon: A global imperative
Richard L. Revesz, Jason A. Schwartz, Peter H. Howard, Kenneth Arrow, Michael A. Livermore, Michael Oppenheimer, and Thomas Sterner. 2017. *Review of Environmental Economics and Policy*, 11(1), 172-173.

Think Global: International Reciprocity as Justification for a Global Social Cost of Carbon
Peter Howard and Jason Schwartz. 2016. Colum. J. Envtl. L. 42, 203.

Global warming: Improve economic models of climate change
Revesz, R. L., Howard, P. H., Arrow, K., Goulder, L. H., Kopp, R. E., Livermore, M. A., ... & Sterner, T. 2014. *Nature*, *508*(7495), 173-175.

Potential Economic Impacts of Draft Restrictions to Address Pesticide Drift and Runoff: Rice Case Study Analysis
Kaitlyn Smoot, Luis Espino, Rachael Goodhue, Peter Howard, Karen Klonsky, and Randall G. Mutters. *Agricultural and Resource Economics Update*, University of California, Giannini Foundation 15(3) Jan/Feb 2012.

Costs of Methyl Iodide Non-Registration
Rachael Goodhue, Peter Howard, Richard Howitt. *Agricultural and Resource Economics Update*, University of California, Giannini Foundation 13(5) May/June 2010.

Reducing Volatile Organic Compound Emissions from Pre-plant Soil Fumigation: Lessons from the 2008 Ventura County Emission Allowance System

Henry An, Rachael Goodhue, Peter Howard, Richard Howitt. *Agricultural and Resource Economics Update*, University of California, Giannini Foundation 12(5) May/June 2009.

Working papers

Between Two Worlds: Methodological and Subjective Differences in Climate Impact Meta-Analyses
Peter Howard and Thomas Sterner

Option value and the social cost of carbon: What are we waiting for?
Peter Howard, Alexander Golub, and Oleg Lugovoy

The Relative Price of Agriculture: The Effect of Food Security on the Social Cost of Carbon
Peter Howard and Thomas Sterner

Optimal Preservation of Private Open Space within a Municipality under Irreversibility and Uncertainty
Peter Howard

Measuring the Welfare Loss to Landowners of Future Geographic Shifts in the Suitable Habitat for Vegetation Due to Climate Change
Peter Howard

PresenTations and POSTERS

Between Two Worlds: Methodological and Subjective Differences in Climate Impact Meta-Analyses
Peter Howard and Thomas Sterner, 2023 EAERE Summer Conference

Refining the wisdom: eliciting climate adaptation and greenhouse gas mitigation costs
Peter Howard and Derek Sylvan, 2023 AERE Summer Conference

Do Safer Alternatives Prevent Catastrophic Chemical Accidents?
Hiroshi Matsushima and Peter Howard, 2023 AERE Summer Conference

Substituting the Future for the Past: A Decomposition Analysis Using MarketSim
Minhong Xu and Peter Howard, 2023 AERE Summer Conference

Between Two Worlds: Methodological and Subjective Differences in Climate Impact Meta-Analyses
Peter Howard and Thomas Sterner, 2020 AERE Summer Conference

Option value and the social cost of carbon: What are we waiting for?
Peter Howard, Alexander Golub, and Oleg Lugovoy, 2020 AERE Summer Conference

Between Two Worlds: Methodological and Subjective Differences in Climate Impact Meta-Analyses
Peter Howard and Thomas Sterner, 13th Annual Meeting of EfD- in Colombia

Option value and the social cost of carbon: What are we waiting for?
Peter Howard, Alexander Golub, and Oleg Lugovoy, 2019 SISC Annual Conference

Two Heads are Better than One: Using Economic Consensus to Address Positive and Normative Uncertainties in Climate-Economic Models
Peter Howard and Derek Sylvan, 2018 at 2018 World Congress of Environmental and Resource Economists

Wisdom of the Experts: Using Economic Consensus to Address Positive and Normative Uncertainties in Climate-Economic Models
Peter Howard and Derek Sylvan, 2018 at Environmental Defense Fund

The Wisdom of the Economic Crowd: Calibrating Integrate Assessment Models Using Consensus
Peter Howard and Derek Sylvan, 2016 AAEA Annual Meeting

Few and Not So Far Between: A Meta-analysis of Climate Damage Estimates
Peter Howard and Derek Sylvan, 2016 AAEA Annual Meeting

Few and Not So Far Between: A Meta-analysis of Climate Damage Estimates
Peter Howard and Derek Sylvan, 2016 EAERE Annual Meeting

Comments on the 2017-2022 Outer Continual Shelf (OCS) Oil and Gas Leasing Program
Peter Howard, Invited speaker to BOEM's Energy Supply/Demand Modeling, Market Substitutions, and Implications of Downstream GHGs/Climate Policy Change. June 2016.

The Economic Climate: Establishing Expert Consensus on the Economics of Climate Change
Peter Howard, Invited speaker to Bard College's Environmental and Urban Studies Colloquium

The Economic Climate: Establishing Expert Consensus on the Economics of Climate Change
Peter Howard and Derek Sylvan, 2015 AAEA Annual Meeting

Estimating the Option Value of Offshore Drilling in United States' OCS Regions
Peter Howard, 2015 Society for BCA Conference

The Social Cost of Carbon: How the Federal Government Values Carbon Dioxide Emissions
Peter Howard, 2015 Climate Leadership Conference sponsored by the Environmental Protection Agency

What's the Cost of Climate Change? How to Improve the Social Cost of Carbon
Peter Howard, Invited Speaker to Bard College

Raising the Temperature on Food Prices: Climate Change, Food Security, and the Social Cost of Carbon
Peter Howard and Thomas Sterner, 2014 AAEA Annual Meeting

Loaded DICE: Refining the Meta-analysis Approach to Calibrating Climate Damage Functions
Peter Howard and Thomas Sterner, 2014 AAEA Annual Meeting

The Relative Price of Agriculture: the Effect of Food Security on the Social Cost of Carbon
Peter Howard and Thomas Sterner, 2013 AAEA & CAES Joint Annual Meeting

The Relative Price of Agriculture: the Effect of Food Security on the Social Cost of Carbon
Peter Howard and Thomas Sterner, 2013 AERE Summer Conference

The Relative Price of Agriculture: the Effect of Food Security on the Social Cost of Carbon
Peter Howard, 2013 Society for BCA Conference

Climate Change, Vegetation, and Welfare: Estimating the Welfare Loss to Landowners of Marginal Shifts in Blue Oak Habitat
Peter Howard, 2012 AAEA Annual Meeting

Are Pesticide Buffers Expensive? Using Positive Mathematical Programming to Estimate the Cost of Proposed Pesticide Buffers in California
Peter Howard, Rachael Goodhue, Pierre Mérel. 2012 AAEA Annual Meeting

Optimal Preservation of Agricultural and Environmental Land within a Municipality Under Irreversibility and Uncertainty
Peter Howard, 2011 AAEA & NAREA Joint Annual Meeting

Measuring the Welfare Loss to Landowners of Future Geographic Shifts in the Suitable Habitat for Vegetation Due to Climate Change
Peter Howard, 2011 AERE Summer Conference

Optimal Preservation of Oak Woodlands within a Municipality
Peter Howard, 12th Occasional California Workshop on Environmental and Resource Economics (2010)

Optimal Preservation of Oak Woodlands within a Municipality
Peter Howard, 2010 Belpasso International Summer School on Environmental and Resource Economics, Sicily

Optimal Preservation of Oak Woodlands within a California Municipality
Peter Howard, 2010 Giannini ARE Student Conference

Optimal Preservation of Oak Woodlands within a California Municipality
Peter Howard, 2010 UCD Brown Bag Presentation

Should More California Oak Habitat Be Protected Because of Global Warming?
Peter Howard, 2009 AAEA & ACCI Joint Annual Meeting

The Economic Effects of Regulations to Reduce VOC Emissions from Pesticides: The Case of Fumigants
Peter Howard, 40th California Nematology Workshop (2008)

Expert testimony

Testifying Before the Minnesota House Climate and Energy Committee on Calculating the Social Cost of Carbon and State-level Policy
Peter H Howard, March 2022

Testimony Before the Michigan Public Service Commission
Peter H Howard, September 2021

Presentation of "Meta-Regression of Global Climate Damages" to the Interagency Working Group on the Social Cost of Greenhouse Gases
Peter H Howard and Thomas Sterner, August 2021

Report on Colorado's Zero Emission Vehicle Program Submitted to the Colorado Air Quality Control Commission
Peter H Howard and Jason A Schwartz, October 2018

Testimony Before the New Jersey Legislature: Senate Environment and Energy Committee and the Assembly Environment and Solid Waste Comm.
Peter Howard, April 2019

Testimony on Colorado's Low Emission Vehicle Program and the Social Cost of Carbon.
Peter H Howard and Jason A Schwartz, October 2018

WESTERN ORGANIZATION OF RESOURCE COUNCILS et al., Plaintiffs, vs. U.S. BUREAU OF LAND MANAGEMENT et al. Defendants.
Peter Howard, May 2018

Comments to the National Academies of Sciences' Committee on Assessing Approaches to Updating the Social Cost of Carbon
Peter Howard, 2017

Meeting with the Office of Information and Regulatory Affairs
Peter Howard, 2016

Presentation of Policy Integrity's "Comments on the 2017-2022 Outer Continental Shelf (OCS) Oil and Gas Leasing Program" to BOEM during a conversation about Energy Supply/Demand Modeling, Market Substitutions, and Related Implications of Downstream GHGs/Climate Policy Change
Peter Howard, July 2016

OP-ED and Blog

Yes, Curbing U.S. Fossil Fuel Extraction Does Reduce Climate Pollution
Max Sarinsky and Peter Howard, November 2021, The Regulatory Review.
Available at https://www.theregreview.org/2021/11/29/sarinsky-howard-curbing-fossil-fuel-extraction-reduce-climate-pollution/.

Improve the Social Cost of Carbon, Do Not Replace It
Justin Gundlach and Peter Howard, April 2021, The Regulatory Review.
Available at https://www.theregreview.org/2021/04/12/gundlach-howard-improve-social-cost-carbon-not-replace-it/.

How Much Higher? The Growing Consensus on the Federal SCC Estimate
Peter Howard, September 2014, Cost of Carbon Pollution Project
Available at http://costofcarbon.org/blog/entry/how-much-higher-the-growing-consensus-on-the-federal-scc-estimate.

Working Group Estimated, GAO Approved
Peter Howard, September 2014, Cost of Carbon Pollution Project
Available at http://costofcarbon.org/blog/entry/working-group-estimated-gao-approved.

Is the rift between Nordhaus and Stern evaporating with rising temperatures?
Peter Howard and Charles Komanoff, August 2014, Carbon Tax Center
Available at http://www.carbontax.org/blogarchives/2014/08/21/is-the-rift-between-nordhaus-and-stern-evaporating-with-rising-temperatures/.

Playing Catch Up to the IPCC
Peter Howard, April 2014, Cost of Carbon Pollution Project
Available at http://costofcarbon.org/blog/entry/playing-catch-up-to-the-ipcc.

Teaching

- Adjunct Assistant Professor of Public Service, Wagner Graduate School of Public Service, Environmental Economics: developed and taught course
- Advised on projects at Policy Integrity's Regulatory Policy Clinic (worked with New York University Law Students)
- Guest lecture at University of Cape Town
- Guest lecture for Katrina Wyman, New York University School of Law (Multiple times)
- Guest lecture for Rickey Revesz and Nathaniel Keohane, New York University School of Law
- Guest lecture for Principles of Macroeconomics at the University of North Carolina Asheville (UNCA)
- Guest lecture at Bard College (Multiple times)
- Supervised undergraduate summer interns
- Teaching Assistant in graduate school for undergraduate economics course
- Taught 7th Grade

Grants, Fellowships, and Honors

- Gamma Sigma Delta - The Honors Society of Agriculture 2010-Present
- Giannini Foundation Mini-grant with Richard Howitt 2009-2010
- Non-Resident Tuition Fellowship 2005-2006

Awards

- UCD & Humanities Graduate Research Award 2010-11
- Jastro-Shields Graduate Research Scholarship Award 2010-2011
- UCD & Humanities Graduate Research Award 2009-2010
- Jastro-Shields Graduate Research Scholarship Award 2009-2010

Professional Memberships

- Agricultural and Applied Economics Association
- Association of Environmental and Resource Economists
- European Association of Environmental and Resource Economists
- Board Member of American Journal of Economics and Sociology
- Former Board Member of the Henry George School

Computer Programs

- Programming: Julia, MATLAB, and GAMS
- Statistics: Stata
- Spatial: ArcGIS
- Microsoft office: Word, Excel, Access, PowerPoint
- Other word processing: Latex

Peer Reivew

- Ecological Economics
- Environmental and Resource Economics
- Journal of Environmental Economics and Management
- Nature Climate Change
- Nature Communications
- Nature Sustainability

- Oxford Open Climate Change
- Science Progress

Selected Media Coverage

- **Life at 3°C.** Available at https://earthlings-podcast.castos.com/episodes/life-at-3-c**.**
- **3 in 4 economists agree: something needs to be done about climate change, and fast: A recent survey found growing concern among economists.** Available at https://thehill.com/changing-america/sustainability/climate-change/545865-three-in-four-economists-agree-something-needs
- **Economists weigh in on the merits of net-zero climate goals: survey.** Available at https://www.reuters.com/article/us-climate-change-economists-idUSKBN2BM0A1
- **The U.S. Government's Price on Carbon Doesn't Value the Future Much.** Available https://qz.com/1881523/the-us-government-wont-put-a-new-price-on-carbon/
- **Material World: Global Warming Is Coming for Your Shopping Cart.** Available https://www.bloomberg.com/news/articles/2017-11-28/material-world-global-warming-is-coming-for-your-shopping-cart
- **Experts reject Bjørn Lomborg's view on 2C warming target.** Available https://www.theguardian.com/environment/2017/may/21/experts-reject-bjorn-lomborg-centres-view-that-2c-warming-target-not-worth-it
- **95% consensus of expert economists: cut carbon pollution.** Available http://www.theguardian.com/environment/climate-consensus-97-per-cent/2016/jan/04/consensus-of-economists-cut-carbon-pollution
- **Economic Impacts of Carbon Dioxide Emissions Are Grossly Underestimated, a New Stanford Study Suggests.** Available http://www.forbes.com/sites/tomzeller/2015/01/13/economic-impacts-of-carbon-dioxide-emissions-are-grossly-underestimated-a-new-stanford-study-suggests/
- **Climate change may add billions to wildfire costs, study says**. Available http://www.latimes.com/nation/la-na-wildfire-climate-change-20140917-story.html
- **Wildfire Cost May Soar With Climate Change, Report Warns**. Available http://www.huffingtonpost.com/2014/09/16/wildfires-climate-change_n_5832612.html
- **'Social Cost Of Carbon' Too Low, Report** Says. Available http://www.huffingtonpost.com/2014/03/13/social-cost-carbon_n_4953638.html