Appendix F

EDF NSPS LDAR Methane Cost-Effectiveness Analysis – Source Counts, Baseline Emissions, and Costs[1]

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In its 2018 NSPS Reconsideration TSD, EPA includes updated cost-effectiveness figures for LDAR at production facilities and compressor stations. EDF analyzed the cost-effectiveness of LDAR for those facility types using our analysis of source counts and model facility baseline methane emissions for production facilities[2] and published studies for compressor station methane emissions[3]. We also analyzed the impacts of reducing the costs associated with LDAR at well production facilities based on an MJB&A analysis of costs using actual data from NSPS OOOOa compliance reports[4]. Based on our updates to source counts, baseline emissions, and cost, our analysis indicates that LDAR for all facility types is universally more cost-effective than calculated by the EPA.

Baseline Emissions Results – Production Facilities

Our analysis relied on measured data, Monte Carlo statistical analytics, and other information in order to calculate emissions factors for each well type[5]. We also used DrillingInfo data to find source counts. Due to a lack of data and measurements for low-GOR, low-production oil sites, we are relying on the EPA emissions factor as a default for our analytics for those facilities.

We calculated cost-effectiveness at low and non-low production facilities with and without gas savings for the frequencies analyzed by the EPA. We include results for three scenarios: (1) updates to the baseline methane emissions factors and source counts only, (2) updates to the costs only, and (3) updates to source counts, emissions factors, and costs. As is illustrated, the cost-effectiveness as calculated by EDF is consistently far lower than the EPA figures.

The table below outlines the differences in source counts and baseline emissions for the mean EDF emissions analysis. The updated emissions factors and source counts are utilized in scenarios 1 and 3, below. Scenario 2, the cost only scenario, relies on the EPA emissions factors and source counts to gauge the effect of updates only to cost assumptions. We included calculations for cost-effectiveness using the 2014 source counts as calculated by EDF, as well as the 2017 source counts, which are more representative of the facilities currently subject to the NSPS.

[1] This analysis focuses on updates in source counts and baseline emissions, and cost assumptions. It does not consider the social cost of methane.
[2] Omara, Mark. *A technical analysis of the forgone methane emissions reductions as a result of EPA's proposed reconsideration of the 2016 NSPS standards for oil and gas production sites.*
[3] T&S: Zimmerle et al (assumes 75% total station emissions are fugitive); G/B: Marchese et al/EPA GHGI EF (assumes 50% of station emissions are fugitive)
[4] MJB&A. *Analysis of OOOOa Annual Air Emission Reports*.
[5] *See supra* note 2.

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Facility Type	Non-Low Production					Low Production				
	Baseline (tons/facility)		Source Count			Baseline (tons/facility)		Source Count		
	EPA	EDF	EPA (2014)	EDF (2014)	EDF (2017)	EPA	EDF	EPA (2014)	EDF (2014)	EDF (2017)
Gas	5.91	15.50	2,001	1,019	1,246	4.8	6.11	409	251	740
Oil GOR >300	3.0	11.81	9,190	9,736	5,266	2.63	4.68	2,171	1,309	624
Oil GOR <300	2.06	10.37	1,848	2,492	1,156	1.83	1.83	2,241	2,241	1,347

Scenario 1: Source Count and Baseline Emissions Factors

The table below includes a comparison of single pollutant OGI cost-effectiveness[6] for production facilities per EPA's 2018 Reconsideration NSPS TSD versus EDF's mean baseline emissions analysis, including the percentage difference in calculated cost-effectiveness. As noted, these results only reflect the changes in cost-effectiveness when the source counts and baseline emissions factors are updated to reflect EDF's analysis. In this scenario, facility costs for each facility type and frequency were held the same as EPA's costs.[7]

As is illustrated, EDF finds that LDAR is between 22%- 91% more cost-effective for methane reductions than the values presented in the 2018 EPA TSD, depending on the facility type, frequency, and other parameters presented in the table.

Production	Frequency	Without Savings ($/ton)					With Savings ($/ton)				
		EPA (2014)	EDF (2014)	EDF (2017)	EDF vs. EPA (2014)	EDF vs. EPA (2017)	EPA (2014)	EDF (2014)	EDF (2017)	EDF vs. EPA (2014)	EDF vs. EPA (2017)
Non-Low Producing Sites	Annual	$979	$277	$268	-72%	-73%	$781	$198	$70	-75%	-91%
	Stepped	$1,041	$294	$285			$842	$198	$87	-76%	-90%
	Semi-annual	$1,164	$329	$319			$965	$264	$121	-73%	-88%
Low Producing Sites	Biennial	$1,104	$859	$727	-22%	-34%	$906	$767	$529	-15%	-42%
	Annual	$1,360	$1,058	$895			$1,140	$767	$697	-33%	-39%
	Stepped	$1,445	$1,124	$952			$1,247	$767	$753	-38%	-40%
	Semi-annual	$1,616	$1,257	$1,064			$1,396	$767	$866	-45%	-38%

Note: Assumed same cost per facility as EPA in "1-Proposed Rule OOOOa TSD Section 2 OGI Well Pad Model Plant Costs" workbook.

Scenario 2: Cost Assumptions

The table below includes a comparison of single pollutant OGI cost-effectiveness for production facilities per EPA's 2018 Reconsideration NSPS TSD versus MJB&A's cost analysis, including the percentage difference in calculated cost-effectiveness. As noted, these results only reflect the changes in cost-effectiveness when the facility costs are updated to reflect MJB&A's analysis, which is based on actual data reported in compliance reports under OOOOa. The source counts and baseline methane emissions factors reflect EPA figures. The MJB&A analysis found that EPA overestimated costs by 15% - 32%, so we assumed a decrease in facility costs of 23.5% (the averaged value) for the analysis shown below.

As is illustrated, EDF finds that LDAR is between 23.5%- 37% more cost effective than the values presented in the 2018 EPA TSD when the facility costs are adjusted downward by 23.5% based on data in OOOOa compliance reports.

[6] We present single pollutant cost effectiveness here for ease of comparison with EPA estimates, though as we note in our comments, sole reliance on these single pollutant values is flawed because it ascribes the full cost of reductions to both methane and VOCs, essentially double counting those costs.

[7] Facility costs from EPA workbook: *1-Proposed Rule OOOOa TSD Section 2 OGI Well Pad Model Plant Costs*

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Production	Frequency	Without Savings ($/ton)			With Savings ($/ton)		
		EPA	EDF - Cost Adjusted	EDF vs. EPA	EPA	EDF - Cost Adjusted	EDF vs. EPA
Non-Low Producing Sites	Annual	$979	$749	-24%	$781	$557	-29%
	Stepped	$1,041	$796		$842	$605	-28%
	Semi-annual	$1,164	$890		$965	$700	-28%
Low Producing Sites	Biennial	$1,104	$845	-24%	$906	$634	-30%
	Annual	$1,360	$1,040		$1,140	$827	-27%
	Stepped	$1,445	$1,105		$1,247	$782	-37%
	Semi-annual	$1,616	$1,236		$1,396	$1,020	-27%

Note: Sources and baseline emissions reflect EPA values to illustrate effect of change in cost.

Scenario 3: Source Counts, Baseline EFs, and Cost Assumptions

The table below includes a comparison of single pollutant OGI cost-effectiveness for production facilities per EPA's 2018 Reconsideration NSPS TSD versus EDF's mean baseline methane emissions analysis in addition to MJB&A's cost analysis, including the percentage difference in calculated cost-effectiveness. As noted, these results reflect the changes in cost-effectiveness when the source counts, baseline methane emissions factors, and facility costs are updated to reflect EDF and MJB&A analysis.

As is illustrated, our analysis finds that LDAR is between 40%- 99% more cost effective than the values presented in the 2018 EPA TSD when recent data on source counts, baseline emissions factors, and facility costs are incorporated. The variability is dependent on the facility type, frequency, and other parameters presented in the table.

Production	Frequency	Without Savings ($/ton)					With Savings ($/ton)				
		EPA (2014)	EDF (2014)	EDF (2017)	EDF vs. EPA (2014)	EDF vs. EPA (2017)	EPA (2014)	EDF (2014)	EDF (2017)	EDF vs. EPA (2014)	EDF vs. EPA (2017)
Non-Low Producing Sites	Annual	$979	$212	$205	-78%	-79%	$781	$13	$7	-98%	-99%
	Stepped	$1,041	$225	$218			$842	$27	$20	-97%	-98%
	Semi-annual	$1,164	$252	$244			$965	$53	$46	-94%	-95%
Low Producing Sites	Biennial	$1,104	$657	$556	-40%	-50%	$906	$459	$358	-49%	-60%
	Annual	$1,360	$809	$685			$1,140	$611	$487	-46%	-57%
	Stepped	$1,445	$860	$728			$1,247	$662	$530	-47%	-58%
	Semi-annual	$1,616	$961	$814			$1,396	$763	$616	-45%	-56%

Note: Assumed same cost per facility as EPA in "1-Proposed Rule OOOOa TSD Section 2 OGI Well Pad Model Plant Costs" workbook.

Compressor Stations Cost-effectiveness

The table below outlines the differences in baseline methane emissions for the EDF emissions analysis. EDF used study data to recalculate the baseline emissions factors at compressor stations.[8] Zimmerle et al (2015) estimates 2012 methane emissions of from the U.S. transmission and storage sector based on a model incorporating site- and component-level measurements from 45 Transportation and Storage compressor stations and reported data from over 900 facilities. Marchese et al (2015) estimates methane emissions from the U.S. gathering and processing sector based a site-level measurement data from 130 facilities.

[8] T&S: Zimmerle et al (2015), assumes 75% total station emissions are fugitive, *available at* https://pubs.acs.org/doi/abs/10.1021/acs.est.5b01669; G/B: Marchese et al/EPA GHGI EF, assumes 50% of station emissions are fugitive, *available at* https://pubs.acs.org/doi/abs/10.1021/acs.est.5b02275

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Facility Type	Compressor Stations		
	Baseline (tons/facility)		Source Count
	EPA	EDF	EPA/EDF
G/B	35.1	189.0	212
Transmission	40.4	502.5	36
Storage	142.4	635.3	2

The table below includes a comparison of single pollutant OGI cost-effectiveness for compressor stations per EPA's 2018 Reconsideration NSPS TSD versus EDF's baseline emissions analysis, including the percentage difference in calculated cost-effectiveness. As is illustrated, the cost-effectiveness based on this recent data is consistently lower than the EPA figures, ranging from 85% - 116% more cost-effective than the values presented by EPA in the 2018 TSD.

Production	Frequency	Without Savings ($/ton)			With Savings ($/ton)		
		EPA	EDF	EDF vs. EPA	EPA	EDF	EDF vs. EPA
Compressor Stations	Annual	$557	$86	-85%	$396	-$62	-116%
	Semi-annual	$652	$101	-85%	$491	-$49	-110%
	Quarterly	$910	$141	-85%	$749	-$15	-102%

Note: Reflects updates to the baseline emissions only.

As for well production facilities, MJB&A conducted a review of compliance reports for compressor stations. The reports are for gathering and boosting compressor stations, for which MJB&A concluded the data show that EPA costs are overestimated by 7% -24%. The table below illustrates the impacts to cost-effectiveness if baseline emissions are updated to reflect EDF analysis and gathering and boosting station costs are scaled down by 15.5% (the average value) to reflect MJB&A analysis based on compliance data.

As is illustrated in the table below, making these updates based on recent data result in LDAR at compressor stations being 87% - 118% more cost-effective than the values presented by EPA in the 2018 TSD.

Production	Frequency	Without Savings ($/ton)			With Savings ($/ton)		
		EPA	EDF	EDF vs. EPA	EPA	EDF	EDF vs. EPA
Compressor Stations	Annual	$557	$75	-87%	$396	-$73	-118%
	Semi-annual	$652	$88	-87%	$491	-$62	-113%
	Quarterly	$910	$122	-87%	$749	-$34	-104%

Note: Reflects updates to the baseline emissions and G/B faciltity costs.