Methane Abatement Costs in the Oil and Gas Industry: Survey and Synthesis

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This paper critically reviews and synthesizes methodologies and findings related to the cost of reducing methane emissions from the oil and gas (O&G) sector. Given methane's extremely high global warming potential, recent estimates attribute about 30% of warming to anthropogenic methane emissions. The sector thus provides a major opportunity for "bending the curve" of near-term climate change by implementing cost-effective methane abatement measures as a bridge to longer-term strategies.

The literature identifies three principal methodologies for estimating methane abatement potential and costs. The first is the bottom-up engineering approach, which models the costs of implementing specific abatement technologies and processes. This method underlies analyses by the International Energy Agency (IEA) and the U.S. Environmental Protection Agency (EPA), which use it to generate marginal abatement cost curves and regulatory impact analyses. The second is an econometric, or retrospective, approach, which analyzes real-world market behavior and regulatory compliance to infer actual costs incurred by regulated entities. Recent studies, such as those by Marks (2022) and Lade and Rudik (2020), use variations in market conditions and regulation to derive these estimates. A third method involves examining the revealed costs of public policies—such as subsidies or emissions fees—by assessing firm participation.

A precise understanding of methane abatement costs is vital for effective policy design, regulatory standard development, anticipation of firm responses, and assessment of related trade measures, such as lifecycle emissions standards for liquefied natural gas (LNG) exports. This synthesis draws on a comprehensive review of published studies, reports, public comments, and expert communications.

Engineering cost models consistently indicate substantial potential for low-cost methane abatement. For example, the IEA (2024) estimates that over half of the 77 million metric tons of global O&G methane emissions in 2023 could be cut at no net cost, reflecting the value of captured methane. In North America, 25 percent of emissions could be eliminated at no net cost and roughly 74 percent at under $10 per ton of CO_2-equivalent (tCO_2e). EPA analysis for its 2023 O&G methane rule suggests nearly 80 percent reductions are feasible at an average cost of about $12/$tCO_2e$, after accounting for recovered methane. Canadian analyses yield similar results.

However, these engineering estimates have important limitations. They generally assume the ability to monetize all captured methane, which is not always realistic for every operator. They may also omit leak detection costs, ignore the wide variance in implementation costs across operators, and exclude management and administrative costs.

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In contrast, retrospective analyses—by looking directly at observed behavior and compliance—implicitly incorporate many real-world costs overlooked by engineering models. Some studies indicate that, at lower levels of ambition, actual abatement can be achieved at even lower costs than engineering models project. For instance, Marks (2022) finds that a marginal price of about \$6.20/tCO_2e could motivate a 60 percent emissions cut for just \$60 million per year—far below engineering-based policy cost estimates. Lade and Rudik (2020) demonstrate significant cost differences among firms, and for flaring-focused emissions, the average abatement cost of a 60 percent reduction is \$2.40/tCO_2e, rising to \$6.75/tCO_2e for an 80 percent reduction.

Overall, the synthesis finds substantial potential for low-cost methane abatement, typically at net costs much lower than those modeled for CO_2 reductions in the U.S. power sector under recent legislation. Yet, claims of widespread negative abatement costs should be treated cautiously. Notably, marginal costs rise steeply as abatement levels approach or exceed 70–80 percent. For example, adding just 6 percentage points beyond a 74 percent reduction in North America more than triples the incremental cost in engineering models, and similarly, costs for reducing flaring-related emissions escalate sharply beyond the initial gains.

Two additional findings have major policy implications. First, methane abatement costs vary significantly across firms, suggesting that market-based approaches could deliver substantial reductions more cost-effectively than uniform regulations. Second, technological innovation—especially in methane monitoring and remote sensing—has significant potential to lower detection and abatement costs further, improve cost estimates, and facilitate the extension of these methods to other methane sources.