LCRI LOW-CARBON RESOURCES INITIATIVE

EPRI

EXECUTIVE SUMMARY

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Cost Estimate of CO_2 Capture from Small-Scale Industrial Applications

PRIMARY AUDIENCE

Electric utilities, industrial facility operators, technology vendors, and energy sector decision-makers evaluating small-scale CO_2 capture solutions.

SECONDARY AUDIENCE

Policy analysts, regulators, investors, and researchers engaged in low-carbon technologies, industrial decarbonization, and carbon capture, utilization, and storage (CCUS).

KEY RESEARCH QUESTION

How do CO_2 capture rate and flue gas composition affect the capital cost, operating cost, and overall cost per tonne for small-scale amine-based CO_2 capture systems in industrial applications?

RESEARCH OVERVIEW

This study, conducted under the Low-Carbon Resources Initiative (LCRI), evaluates the cost and performance of amine-based carbon capture systems sized for 50,000–500,000 tonnes/year of CO_2 and flue gas streams ranging 4–40 mol% CO_2, representing common industrial sources (e.g., gas turbines, internal combustion engines, cement kilns, and steel plants).

Four representative cases (A, B, C, and D) were analyzed using vendor-provided AACE Class 5 cost estimates, scaled and normalized into consistent capital cost, operating cost, and $/tonne metrics.

ADDITIONAL MATRIX ANALYSES EXPLORED TRENDS ACROSS COMBINATIONS OF CO_2 CONCENTRATION AND CAPTURE RATE BEYOND THE FOUR BASE CASES. KEY FINDINGS

1. **Cost of capture decreases significantly with scale and CO_2 concentration**

   From 50k to 500k tonnes/yr, cost drops from $171 to $91/tonne at 4% CO_2 and from $133 to $62/tonne at 40% CO_2. Economies of scale flatten beyond ~500k tonnes/yr.

2. **Higher CO_2 concentration reduces cost**

   Across all scales, higher CO_2 concentration leads to lower capital and operating costs. The cost of capture reduces by around 20% when CO_2 concentrations increase from 4% to 21%.

3. **Oxygen concentration is a major driver of solvent cost**

   Case A (12% O_2) saw solvent makeup = 30% of variable operating costs; other cases had smaller impacts on costs at only 1–3%. O_2 accelerates solvent degradation, increasing replacement and disposal cost.

4. **Air cooling increases capital cost**

   Water cooling would reduce capital costs by 20–31% compared to air cooling, though total operating costs remain similar.

WHY THIS MATTERS

Industrial facilities face structural barriers to decarbonization due to small, distributed CO_2 sources and high process heat requirements. This research provides quantitative, vendor-grounded costs needed to:

- Assess feasibility of CCUS in “hard-to-decarbonize” sectors
- Support investment decisions for small-scale capture deployment
- Inform policy design, incentives, and regulatory frameworks based on realistic capture cost ranges
- Enable cross-industry comparisons and guide technology selection as CO_2 concentrations vary widely

HOW TO APPLY RESULTS

For industry:

- Use cost curves to screen sites for CCUS feasibility across various industries
- Evaluate whether CO_2 concentration and capture rate justify investment

For technology vendors:

- Target innovations at solvent resilience, lower-cost cooling, and optimized absorber/regenerator design
- Identify concentration ranges where non-amine technologies may outperform (e.g., >25 mol% CO_2)

For policymakers and regulators:

- Use cost ranges to calibrate incentives (e.g., 45Q) and develop realistic decarbonization strategies for smaller emitters
- Support standardization of CO_2 capture equipment at industrial scale

LEARNING AND ENGAGEMENT OPPORTUNITIES

- **Workshops/Webinars:** Deep dives into project economics for CO_2 capture from industrial sources, cost drivers, vendor assumptions, and sensitivity analyses
- **Cross-industry working groups:** Cement, steel, refining, and distributed generation sectors comparing capture integration options
- **Pilot and demonstration projects:** Partner with LCRI members to perform pilot demonstrations to validate system performance and cost evaluation

THE LOW-CARBON RESOURCES INITIATIVE

This report was published under the Low-Carbon Resources Initiative (LCRI), a joint effort of EPRI and GTI Energy addressing the need to accelerate development and deployment of low- and zero-carbon energy technologies. The LCRI is targeting advances in the production, distribution, and application of low-carbon energy carriers and the cross-cutting technologies that enable their integration at scale. These energy carriers, which include hydrogen, ammonia, synthetic fuels, and biofuels, are needed to enable affordable pathways to economy-wide decarbonization by mid-century. For more information, visit www.LowCarbonLCRI.com.

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