



Innovations and Markets

IN CARBON EMISSIONS MANAGEMENT

October 2019

REPORT SUMMARY

This report was prepared by AJW, Inc. for the Institute of Clean Air Companies (ICAC).



OVERVIEW

Leading climate science highlights why the buildup of greenhouse gas (GHG) emissions is unlikely to reverse without significant contributions from carbon emissions management (CEM) technologies. This report highlights a surprisingly diverse range of viable CEM technologies currently under development. The report also proposes policy improvements that will be necessary to provide a competitive and stable market where these technologies have the ability to scale-up to meet the challenge and thrive globally.

FACT – CARBON EMISSIONS MANAGEMENT TECHNOLOGIES ARE NECESSARY

Pollution reduction and cleanup technologies have been an important part of every environmental protection effort. For GHG emissions, technologies that mitigate, (i.e. industrial capture), reduce (i.e. fugitive emissions capture), and cleanup (i.e. atmospheric capture) can complement renewable energy strategies and accelerate decarbonization.

OPPORTUNITY – VASTLY MORE TECHNOLOGY OPTIONS EXIST THAN ARE COMMONLY DISCUSSED

The range of prospective commercial-scale CEM technologies is more varied than many may realize. Some are ready now and only need policies that support deployment. Others are in earlier development stages, ranging from lab-scale to pre-commercial demonstrations. Commercial success with any of them is likely to increase investment interest for other promising CEM technologies.

PROBLEM – POLICY AND COMMERCIAL BARRIERS IMPEDE INVESTMENT IN CEM

Until recently, most climate policies excluded CEM technologies as viable decarbonization tools. Previous private sector investments in CEM were undermined by policy barring them as compliance options. Even as policymakers and stakeholders are increasingly open to CEM, new programs too narrowly target favored technologies or otherwise inhibit interest in private sector CEM investment.

SOLUTION – DESIGN POLICIES TO MAXIMIZE PRIVATE SECTOR INVESTMENT

Commercializing CEM technologies in a relevant timeframe requires policies that maximize the application of private sector capital and human resources. Policies need to be as innovative as the technologies they aim to support. Policy dialogue with a wider range of CEM developers and investors will shed light on how policies can be fashioned for optimal results and maximum private investment.

Better Collaboration and Smarter Investments Will Unlock CEM's Market Potential

SUMMARY FOR POLICYMAKERS

Deploying CEM technologies will:

- **Reduce costs** CEM will make decarbonization **138% less expensive**
- **Accelerate the pace** CEM can support net-zero goals as renewable energy use increases
- **Complement renewable energy** Only CEM technologies can address certain hard-to-decarbonize industry sectors (e.g. steel and cement) and cleanup past emissions (e.g. direct air capture).

Climate policies should **be clear about the goal** (maximizing decarbonization as rapidly and efficiently as possible). Policy should be **technology-neutral** to let the best options come forward – even if that produces surprising outcomes. And they should **offer dependable and generous rewards to maximize commercial interest**.

Key Takeaways

THE MARKET AND ENVIRONMENT OPPORTUNITY FOR CEM

CEM technologies can follow the path of the emissions control industry's long, successful history of inventing, refining, and deploying emissions management technologies. **Policymakers should seek to put private sector expertise to work** and, once again, outperform environmental and economic performance expectations.

CEM TECHNOLOGY ASSESSMENT

CEM can support decarbonization with a **diverse range of applications** across industrial sectors, but CEM systems are at varying stages of technology readiness. An unbiased assessment of these technology innovations is needed in order to help them reach commercial viability.

DESIGNING POLICY TO ATTRACT CEM INVESTMENT

Policy innovation is as necessary as technology innovation to address climate challenges. Policymakers need to understand how to attract investment throughout the technology development process. This report suggests policy approaches that will **ensure larger private sector investments while also reducing the risks to taxpayers** from project failures.

CEM TECHNOLOGY R&D, DEMONSTRATION, AND THEN COMMERCIALIZATION

Optimism regarding CEM development is warranted, however, climate stakeholders should incorporate realistic development timeframes and understand commercial challenges for CEM applications. **Commercialization timeframes will vary by technology and sector**. Some less developed CEM applications may have far greater impacts when deployed than some more ready applications.

TECHNOLOGY-NEUTRALITY IS VITAL

Asking the government to pick winners and losers among unproven technologies is a recipe for failure. **Policy should remain technology-neutral** to enable investment in and discovery of the most successful technologies and commercial pathways – which will remain unknown until proven in the market.

SUMMARY FOR BUSINESS EXECUTIVES

Carbon Emissions Management (CEM) is rapidly emerging and could become the largest commercial opportunity the emissions management industry has ever seen.

Increasing numbers of policymakers and climate stakeholders agree that the most rapid and cost-effective path to addressing climate change depends on achieving substantial emissions reductions through diverse CEM technologies. Bipartisan legislation and policies that support this continue to take shape.

Current CEM Support

\$35 - \$200 per ton

- \$35-\$50/ton currently available through section 45Q of the federal tax code
- >\$200/ton for DAC projects registered under California's Low Carbon Fuel Standard

More than \$4 billion

Total DOE investment in CEM from 2012-2018

Proposed CEM

More than \$5.5 billion

In proposed funding for CEM activities through FY2024 in introduced legislation

\$6.3 trillion

Average climate policy funding proposed by top ten 2020 Democratic presidential candidates

Proposed financial incentives for CEM include technology development grants, tax credits, private activity bonds, and master-limited partnerships.

Key Takeaways

THE MARKET AND ENVIRONMENTAL OPPORTUNITY

CEM could become a multi-billion dollar technology market. ICAC intends to support policymakers and stakeholders by sharing ideas about how best to promote and reward private sector investment across the full spectrum of CEM technologies.

CEM TECHNOLOGY ASSESSMENT

CEM technologies are at various stages of development that require technical and commercial expertise to bring these innovations to market. **Many of these technologies also require adapting existing air pollution control equipment or components** as part of their processes.

DESIGNING POLICY TO ATTRACT INVESTMENT

The market for CEM – if pursued with sound policy and disciplined technology development, scale-up, and demonstration efforts – could dwarf all previous emissions control market opportunities combined. Industry should continue to share their expertise with policymakers and stakeholders on effective policies that support CEM technology development and deployment. **Absent industry engagement, policies are more likely to repeat old mistakes rather than reward renewed CEM investment and new market development opportunities.**

COMPENDIUM OF TECHNOLOGIES AND PROJECTS

DISCOVER THE GROWING OPPORTUNITY

<p>\$800 BILLION POTENTIAL MARKET</p> 	<p>450+ PROJECTS in 40 countries & 42 U.S. States</p>	<p>300+ TECHNOLOGIES from 23 countries (🇺🇸) & 36 U.S. States</p>
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GLOBAL CO₂ CAPTURE



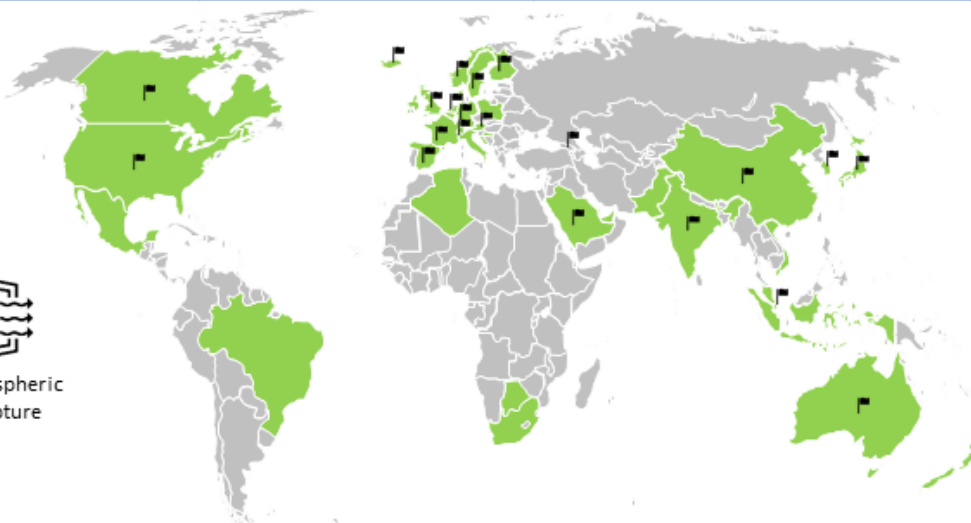
Industrial Capture



Fugitive Emissions



Atmospheric Capture



CO₂ UTILIZATION PROJECTS

35%



Building materials

25%



Geologic storage

20%



Enhanced oil recovery

10%



Syngas/biofuels

7%



Commodity chemicals

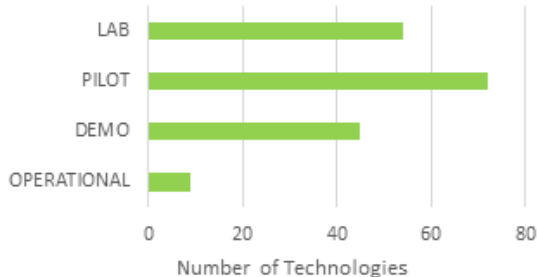
3%



Food & beverage

DEVELOPMENT DIVERSITY

Stage of Development



“Research and development efforts will continue to be important in refining and improving CCS technologies, but major breakthroughs and cost reductions will likely only be achieved through actual development at scale.”

- International Energy Agency (IEA)

For more information, please visit: ICAC.com/CEMInnovations



About AJW

AJW is the leading government affairs and business consulting firm serving technology innovators. They analyze regulatory risks and opportunities for avenues to expand market demand for advanced technology solutions. AJW then works to affect the public policy process to support clients' strategic business planning goals.



About ICAC

For nearly 60 years, the Institute of Clean Air Companies has been *the* trusted voice in the clean air technology industry. ICAC provides members with unique opportunities to sharpen market awareness and enhance business planning through valuable engagement with market influencers and policymakers.