

Communicating the value of CO₂

SURVEY RESULTS
SEPTEMBER 2018

An initiative of the Circular Carbon Network

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EXECUTIVE SUMMARY

There is a growing area of innovation in which waste CO₂ is captured and used to produce valuable materials and products. This space is confusing to outsiders, and even to some insiders. Understanding the perceptions and messaging in this space will make it possible to improve communications, rally support, and grow the community. To that end, The NRG COSIA Carbon XPRIZE, The Circular Carbon Network, Carbon 180, and CO₂ Value Europe launched a survey on the terminology, messaging, perceptions, challenges, and opportunities of this space.

This report summarizes the most salient results of the survey, including raw data, key takeaways, and analysis.

Below is a summary of the high-level results:

- 1. Terminology:** “Carbon Capture & Utilization (CCU),” “CO₂-based Products,” and “Carbon Utilization” were identified as the most popular terms by respondents, as measured by net favorability (favorable minus unfavorable reviews).
- 2. Perceptions:** Perceptions of this space are trending upward. Most respondents felt very positively about this space.
- 3. Messaging:** Messages that focus on either “climate change” or “economic opportunity” were both viewed positively, the latter more than the former. Many commentators argued that both messages should be emphasized simultaneously.
- 4. Promising Markets:** Markets with the clearest short-term and long-term potential are considered to be construction materials and chemicals.
- 5. Geographic Regions:** Europe is perceived to be the most active region in this space to date, with North America a close second; the U.S. and Canada are perceived to have the most activity on a country-by-country basis.
- 6. Unlocking Innovation:** Respondents overwhelmingly said that policy was the key dimension to address in order to unlock more innovation and commercialization in the sector, and that governments and policymakers were the most critical audiences needing to be engaged. Entrepreneurs also ranked capital as a key priority.
- 7. Opportunities:** The most exciting aspects of the sector were perceived to be the sector’s potential to mitigate climate change, and the business opportunity.
- 8. Challenges:** Economic feasibility ranked high as a major hurdle, along with technical feasibility, engineering feasibility, and timeframe for impact.
- 9. Ranking Support for This Space:** Respondents felt that public and private support should focus on renewable energy over the next 10 years. They felt that the conversion of CO₂ into products should share second priority, along with energy storage and efficiency. This suggests that CO₂ conversion can be considered a complement to renewables, not a competitor.

INTRODUCTION

Carbon is the backbone of the modern economy and a building block for a wide array of products and materials we depend on every day. Carbon dioxide (CO₂) emissions have also become a serious liability: The world must reduce CO₂ emissions by 200 billion tons over the next five decades to avoid the most drastic climate change scenarios.¹ There is an emerging opportunity to make productive use of CO₂ emissions by capturing and transforming them into valuable and useful materials and products, such as concrete, carbon fiber, polymers, food, fertilizer, and liquid fuels. CO₂-derived materials have the potential to offer superior performance, lower cost, and a lower carbon footprint than incumbent materials. The long-term vision is of a low-carbon economy built around recycling CO₂ emissions, producing superior products, and supporting a stable global climate while providing significant economic opportunity. This emerging industry is known variously as “carbon-to-value,” “carbontech,” and “carbon capture utilization and storage (CCUS),” among others.



CO₂ is one of the building blocks of life, and is inherently valuable.

Next-generation business will be based on carbon.

The market potential for CO₂ products is also coming into focus. The Global CO₂ Initiative and CO₂ Sciences have estimated that by 2030, CO₂ products could generate between \$800 billion and \$1.2 trillion annually and reduce CO₂ emissions by 10% to 15%.² Small and large corporations alike are increasingly focused on minimizing climate change risk, maximizing clean energy opportunities, and identifying sustainability solutions that are tangible and additive.

Despite the growing momentum of this space, it remains confusing to many due to a lack of consistent terminology and messaging, the technical complexity of the field, and widely disparate approaches from the range of experts working on carbon issues (engineers, economists, policymakers, etc.). A better understanding of the perceptions and messaging in this space will make it possible to improve communications, rally support, and grow the community. To that end, the NRG COSIA Carbon XPRIZE, The Circular Carbon Network, Carbon180, and CO₂ Value Europe launched a survey to explore the terminology, messaging, perceptions, challenges, and opportunities of this space. Over 100 investors, corporate leaders, entrepreneurs, researchers, policymakers, and media professionals were surveyed who actively work in, or follow, this space.

This report summarizes the most salient results of the survey, including raw data, key takeaways, and analysis.

¹ Carbon Mitigation Initiative, “Stabilization Wedges” (Princeton University, 2015).

² Global Roadmap for Implementing CO₂ Utilization, CO₂ Sciences and the Global CO₂ Initiative November, 2016, p. 5.

METHODOLOGY AND RESPONDENTS

The survey targeted individuals who have some familiarity with this space, but represent a diverse cross-section of professional approaches. The target population included investors, corporations, entrepreneurs, researchers, policymakers, and marketing professionals. One hundred and six (106) responses were collected over the course of four weeks during the summer of 2018.

Survey questions were designed in consultation with a number of experts intimately involved in this space. The questions were intentionally designed to produce a qualitative sampling of opinion and suggestions, using a question format designed to limit bias as much as possible. The survey was never intended to inform a statistically rigorous analysis, but rather to provide a reasonable data set from which to draw some valuable, directional insights, and support further action.

FIGURE 1
How would you describe your core area of expertise?

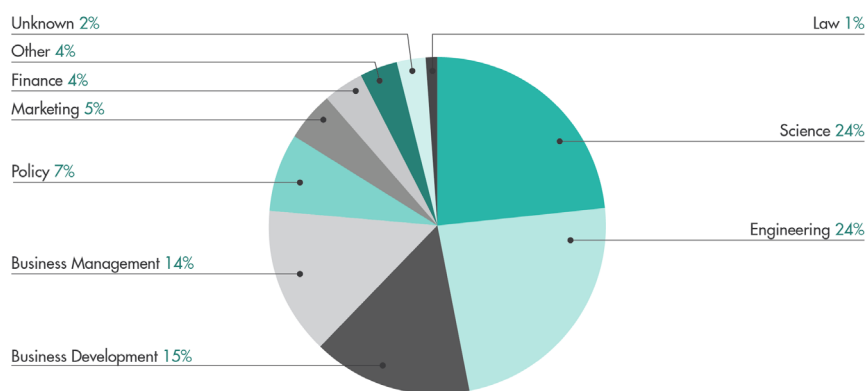
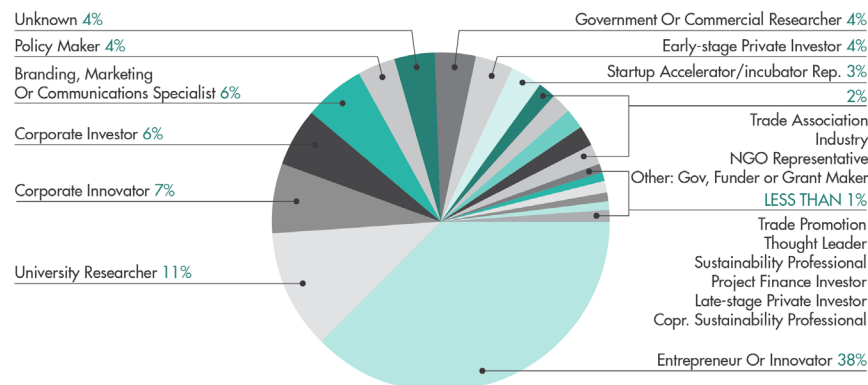


FIGURE 2
What audience do you most identify with?



Approximately 60% of respondents were from North America (primarily the U.S.), 35% were from Europe, 1% from South Asia, 2% from East Asia. The rest did not list their location (*Figure 3*). Nearly half of respondents listed their core area of professional expertise as either science (24%) or engineering (24%), with those from business development and management representing 29% (*Figure 1*). Entrepreneurs and innovators represented the largest block of respondents at 38% (*Figure 2*).

Over half of respondents identified this sector as their “core area of focus” (44%), or where they spend the “majority of their time” (23%); just under a quarter indicated they were “interested or engaged in minor ways” (20%). The remainder (13%) said they knew little about the sector (*Figure 4*). A majority of respondents say they are “intimately involved” in this space; 72% among North American respondents, and 62% among European respondents.

FIGURE 3
In what region are you based?

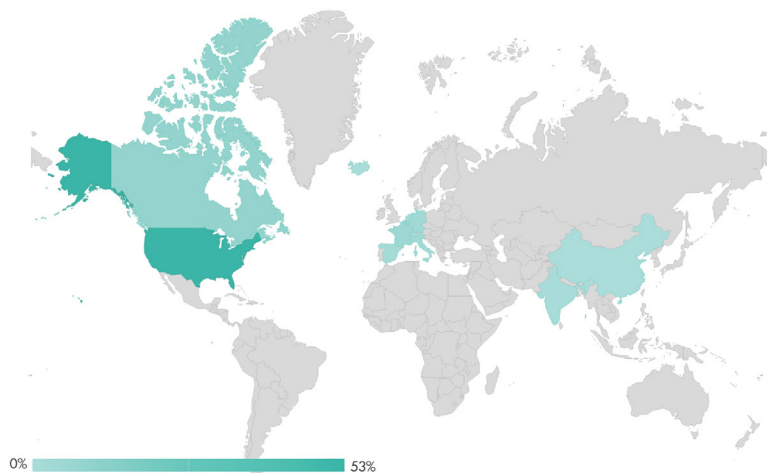
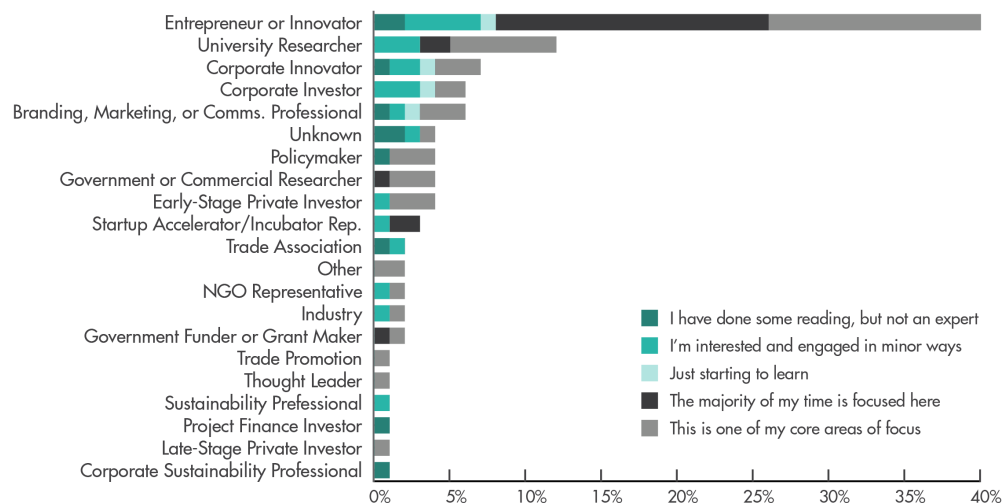


FIGURE 4
How familiar are you with this sector?



RESULTS AND TAKEAWAYS

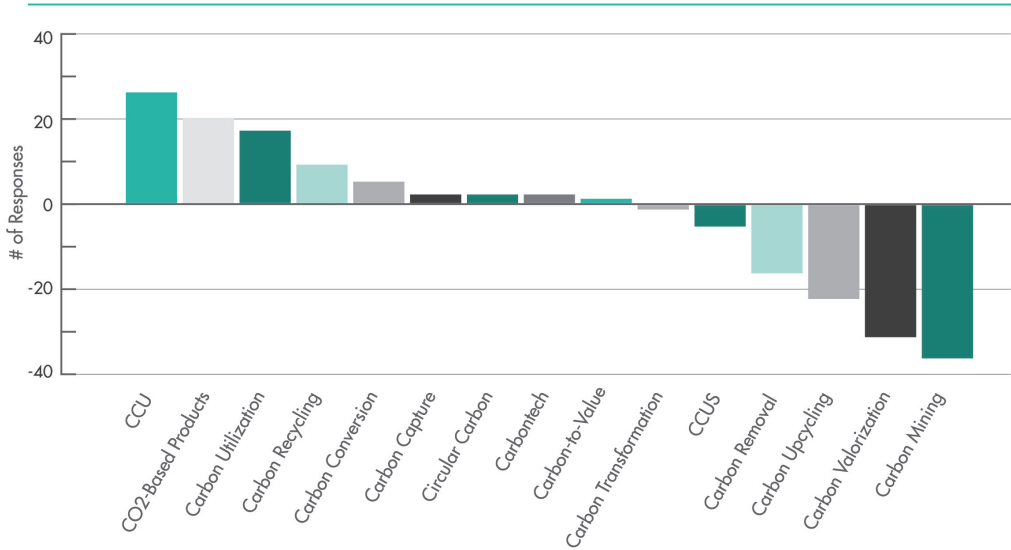
TERMINOLOGY

A key focus of the survey was to assess stakeholder views on the many terms being used to describe the sector. We hear a broad variety of names being applied to the conversion of CO₂ from waste into valuable products, sometimes by the same people in the same conversation. Because clear and effective terminology can be key to gaining society’s understanding and support for a new trend, we wanted to see what terms stakeholders currently favored and disfavored, and why. We also wanted to see if this varied by stakeholder type, geography, or other factors. To do this, we asked respondents to prioritize and comment on ten specific terms (Figure 5, 6, 7).

KEY TAKEAWAYS

- The terms “Carbon Capture & Utilization (CCU),” “CO₂-based Products,” and “Carbon Utilization” were identified as the most effective terms by respondents, as measured by net favorability.
- “Carbon Capture & Utilization” (“CCU”), “CO₂-Based Products,” “Carbon Utilization,” and “Carbontech” received the most favorable reviews, although no clear favorite emerged.
- “Carbon Valorization,” “Carbon Upcycling,” and “Carbon Mining” were the least favored terms.
- There was no strong preference for using “CO₂” vs “Carbon” in each term, although European respondents clearly preferred “CO₂” while North American respondents preferred “Carbon.”

FIGURE 5
New Favorability Score (# liked minus # disliked)



RESULTS AND DISCUSSION

Most-Favored Terms

- Although no term emerged as a clear favorite, “Carbon Capture & Utilization” (12%) and “Carbontech” (12%) were most favored, with “CO₂-Based Products” (11%), and “Carbon Utilization” (10%) trailing close behind (Figure 6).
- The positive response to “Carbontech,” primarily felt by North Americans and those whose core expertise lie in business development and marketing, may reflect growing use in that region and context, and invokes recent success in other “tech” sectors such as biotech and fintech. However, “Carbontech” was almost as widely disliked by other respondents, yielding an almost-zero net favorability score.
- “Carbon Capture & Utilization” rated particularly highly among those with professional expertise in science and engineering.
- The term “CO₂-Based Products” is distinct from the other terms, as it most closely relates to the actual products produced by these technologies as opposed to the feedstock. It was received by respondents as positive, but most notably it received the least negative reviews of all the terms.

Least-Favored Terms

- “Carbon Valorization” (19%), “Carbon Mining” (19%), and “Carbon Upcycling” (12%) were the least favored terms.
- Many respondents make clear in their comments that “mining” too closely resembled the description of environmentally damaging resource removal, and/or that it incorrectly described the process of carbon capture.
- “Valorization” is not a widely used term in general and is likely unfamiliar to many respondents.
- “Upcycling” is somewhat vague, and may suggest the upward release of carbon into the atmosphere.
- We are also surprised by the relative unfavorability of “Carbon Removal” and “Circular Carbon.” Perhaps the former simply doesn’t do enough to emphasize the transformational aspect of the sector, and the latter speaks more to an aspirational system rather than to any specific procedural mechanism at work.

FIGURE 6

Which of these terms do you like best?

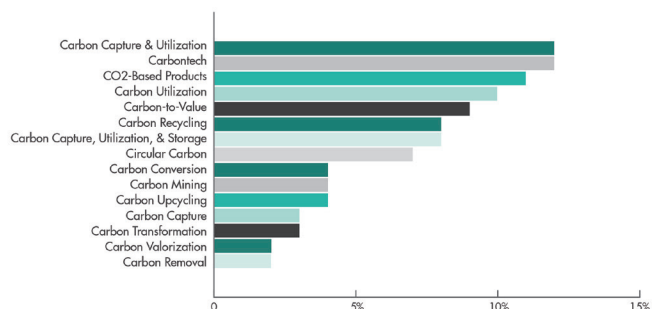
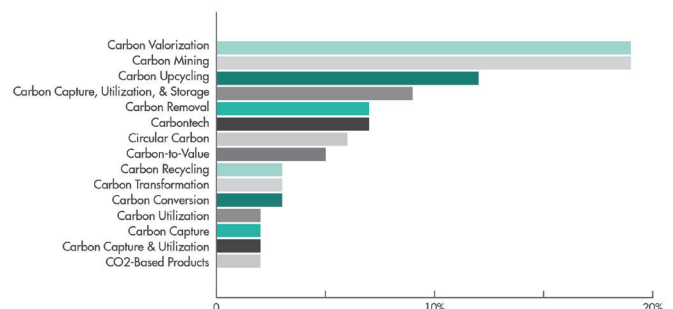


FIGURE 7

Which of these terms do you like least?



CO₂ vs. Carbon

- Opinions are split evenly between the use of “CO₂” vs. “Carbon” in describing this sector. This may speak to a perceived interchangeability between the two terms, either among people well versed in climate change or among outsiders.
- There was a clear regional divide, with European respondents expressing a preference for “CO₂” over “Carbon” by a margin of 69% to 31%. North American respondents preferred “Carbon” over “CO₂” by a margin of 62% to 38%.
- Some members of the community take care to distinguish CO₂ (carbon dioxide) from other carbonaceous greenhouse gasses such as CO (carbon monoxide) and CH₄ (methane) when discussing climate change mitigation potential. Those more focused on CO₂ as a feedstock prefer “CO₂” to “Carbon,” which conflates CO₂-based processes with processes concerning other carbon-feedstocks.
- Since the survey targeted experts either working in, or close to, this space there is still an outstanding outstanding question around whether “CO₂” or “Carbon” is more resonant to broader stakeholder groups like investors, corporates, or the general public. As this topic becomes more mainstream, additional focus-group work must be done to test terminology for future marketing efforts.



*People are still confused about what all these words mean!
Simplifying and unifying our language will help us grow the space.*

PERCEPTIONS

Five years ago, CO₂ utilization was barely on the radar of mainstream conversation on climate change, energy, and innovation. In the past year this space has gained more attention from policy leaders and the media than perhaps any time in recent history: Major policy announcements in Canada, United States, and Europe have coincided with funding calls from agencies in all three regions and a surge of media coverage highlighting work being done in this space. Perception seems to be shifting and trending positive. We wanted to gauge respondents' current perceptions of this space. To do so, we asked them to rate their personal perceptions of this space, and those of their peers on a positive/negative scale.

KEY TAKEAWAYS

- Most respondents felt very positively about this space, with some saying they felt only somewhat positive.
- When asked how their peers felt about this space, half chose “somewhat positive,” and said they thought perception is trending upward.
- The vast majority of respondents, even those only peripherally engaged with this space, believe that its favorability is trending upward.

FIGURE 8
How would you characterize your personal opinion of this space?

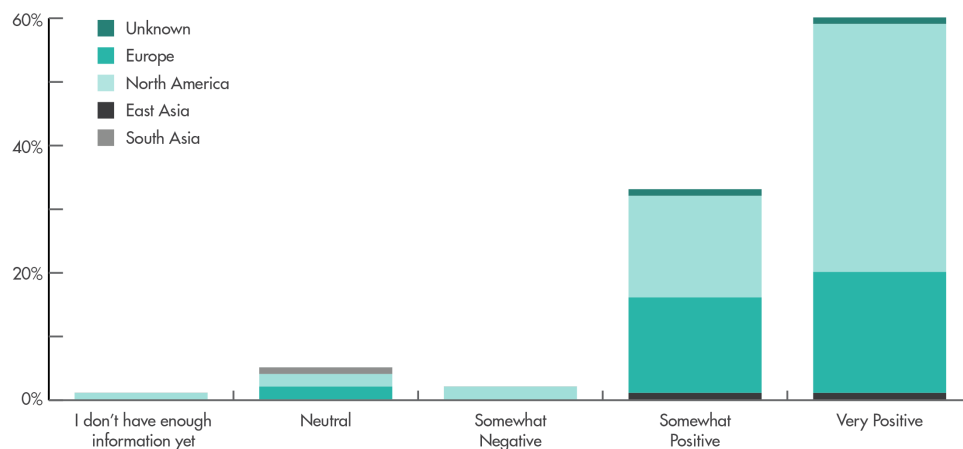
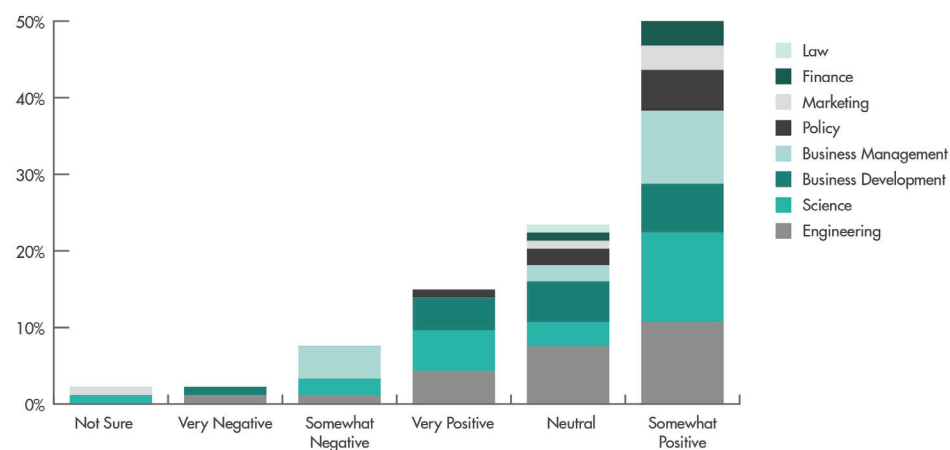


FIGURE 9
How would you characterize the overall perception of this space amongst your peers?



RESULTS AND DISCUSSION

- The majority of respondents (60%) said they felt very positively about this space, while most of the remainder said they felt only “somewhat positive” (Figure 8).
- Fifty percent (50%) of respondents said their peers’ perceptions of this space is “somewhat positive”, 23% said “neutral”, and 15% said “very positive”.
- When asked how the sector’s favorability was trending, 83% answered “trending up” (9%: “about the same”, 7%: not sure, 2%: “trending down”). Even 62% of those who identify as “interested and engaged in minor ways” said it is trending upward, which suggests that even outsiders are seeing an increase in general perception of the sector.



Because there is more and more evidence that this can become a viable business (i.e., cost competitive). It is also a novel and market-based solution to climate change, which means that it has more appeal to a business and financial audience.

Positive perceptions of this space are likely due to some or all of the following factors:

- The new \$85 per ton U.S. federal tax credit (“45Q”) for capturing and utilizing CO₂ that will support the development of new large commercial projects
- New interest in the carbon space from groups such as Breakthrough Energy Ventures, Oil and Gas Climate Initiative, and Y-Combinator
- The formation of new accelerators and industry associations such as Carbontech Labs and CO₂ Value Europe
- Corporate engagement efforts being driven by Carbon180, Volans, CO₂ Value Europe, the Circular Carbon Network, and Lawrence Livermore National Laboratory
- Demonstrations of real advances in technology by the Carbon XPRIZE teams and other growing companies
- The increasing urgency of climate change, and public awareness of that urgency
- Increasing understanding of carbon removal and utilization
- Increasing commercial interest/activity from entrepreneurs, investors, and corporations
- The development of the Carbon XPRIZE and increasing interest in economically sustainable solutions
- The thirst for something new and/or less financially risky
- Appetite for smaller scale projects and distributed solutions to CO₂ emission mitigation

MESSAGING

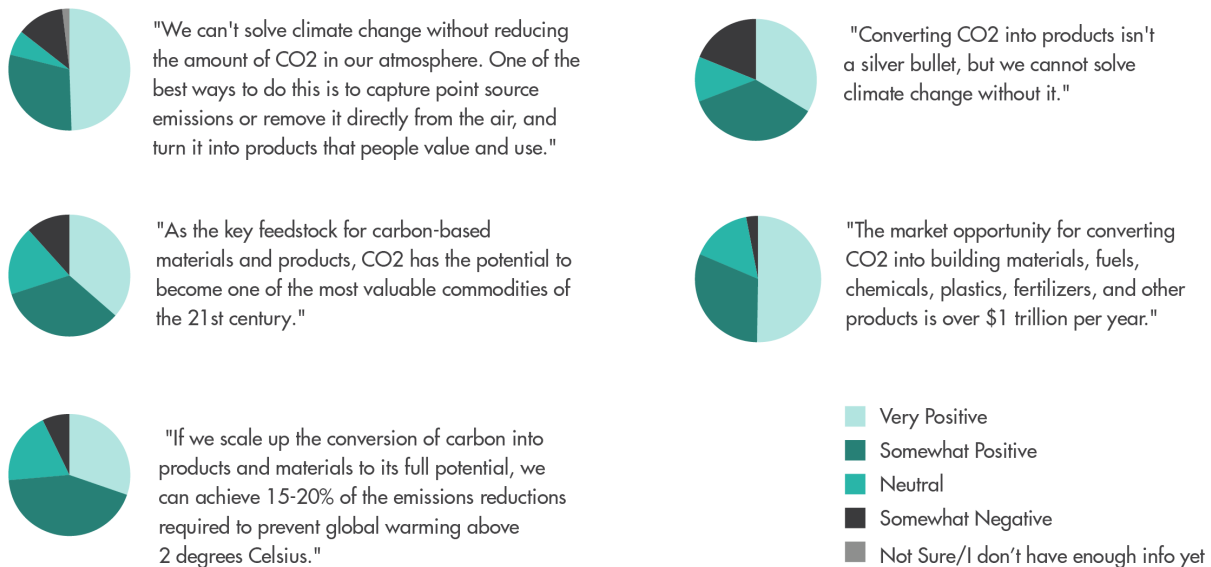
We have observed a range of key messages used in communications for this space, including “solving climate change,” “creating economic opportunity,” “transforming a liability into an asset,” and “creating a new carbon economy.” Growing this space will require tuning our messages to our audiences, clarifying the fundamental problems we are trying to solve, and communicating the impact of those solutions. For instance, when we talk about CO₂ as a feedstock for materials and products, is the primary interest in tackling climate change by reducing anthropogenic CO₂ emissions? Or is it primarily in the economic opportunity inherent in harnessing an abundant and cheap carbon feedstock, with reducing emissions as a secondary benefit? Or something else? Understanding

which messages resonate with broader audiences is crucial to clarifying the value proposition for investors, policymakers, and innovators, and for growing this space.

KEY TAKEAWAYS

Messages that focus on climate change and economic opportunity are both viewed positively, but the latter are favored over the former. Many commentators argued that both messages should be emphasized simultaneously.

FIGURE 10
What is your reaction to the following messages?



RESULTS AND DISCUSSION

Many respondents felt that messaging should emphasize the economic potential of the sector, pointing to existing successes and the potential for these technologies to compete with incumbent technologies on economic terms (Figure 10).

These respondents suggest that the climate change narrative has not and will not be an effective driver of investment or growth in the sector:

"This has to be spoken about in positive economic terms: saving the planet won't cut it... Economies respond to opportunities for growth."

"Our ability to tap into, refine, and increase the value of ubiquitous resources has increased our quality of life for centuries. Carbon dioxide utilization represents that next opportunity."

"Dislike the normative statements that threaten we can't solve climate change without CO₂ removal. Fear hasn't worked yet."

Some argued for a measured messaging strategy, cautioning against overselling the capabilities or potential of the sector:

Emphasize that this is not the silver bullet but a necessary component of any reasonable strategy for abatement."

"Messages need to be more realistic in tone and should not oversell CCUS."

"Add the word 'potential' to any future market or market value. Otherwise, the message is corrupted and not believable."

One response stood out for its take on how to reposition CO₂ as an asset rather than a waste product:

"It would seem counterintuitive to use a molecule that we normally associate with damage to our environment for positive purposes. But it is indeed possible, imminently achievable, and absolutely necessary. We can use this pollutant to help solve the very crisis it has created."

Another addressed the positive aspects of the construction materials subsector:

"Using carbon in industrial processes can actually make products better. I am thinking in particular of concrete cured with CO₂, which comes out stronger than concrete cured in air."

MOST PROMISING SECTORS

Newcomers to this sector are often surprised and amazed to learn that an invisible gas can actually be transformed into tangible, practical items like bricks, shoes, and fuels. On the other hand, veterans of the sector often ask which materials and products represent the greatest opportunities for CO₂ conversion. “Most promising” can mean different things to different people: most economically attractive; strongest business case; most viable in the near-term; greatest long-term CO₂ reduction potential, etc. We wanted to know which subsectors our respondents perceived to be most promising (see *Figure 11*), and whether that perception varied by geographic region.

KEY TAKEAWAYS

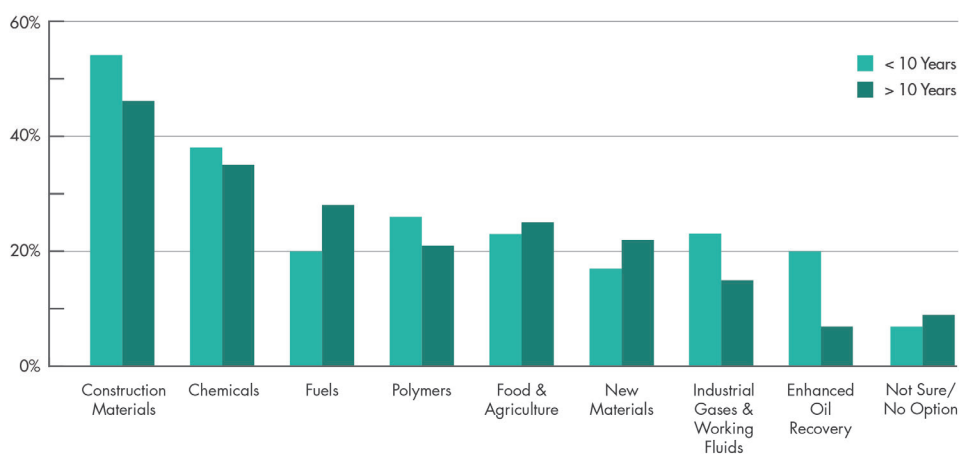
- Asked what subsectors looked most promising in the short and long terms, respondents highlighted constructions materials and chemicals.
- Europe was perceived as the most active region overall.



EOR, construction materials, and chemicals have demand for them now. Ultimately, I think industrial photosynthesis/fuels, plus construction materials (cement replacement!), plus advanced materials represent a chance to disrupt the global supply chain towards CO₂-based economy.

FIGURE 11

Which sub-sectors of the carbon-to-value space are most promising for their economic and climate potential?



RESULTS AND DISCUSSION

Subsectors

- Respondents felt clearly that construction materials hold the most promise in both the short term (54%) and long term (46%), while chemicals also had high potential in the short and long term (38% and 35%, respectively) (*Figure 11*). Construction materials and chemicals represent the two largest industrial sectors considered here. The responses reflect high confidence that consumption in these sectors will continue to provide both the greatest economic opportunity, as well as providing robust markets that represent the most significant CO₂ sequestration potential.
- Enhanced oil recovery, the best proven use case to date, is expected to fade in the long term, perhaps due to the anticipation of carbon taxes or vehicle electrification depressing the size of the market (and thus, both economic and CO₂ sequestration potential).
- Respondents believe fuels show promise in the long term. However, unless CO₂ emissions associated with fuel combustion are recaptured and used or sequestered, fuels are not an effective long-term sequestration strategy. Confidence in this sector may reflect a belief that fuels will emerge as an effective storage medium for excess renewable electricity production.
- The high numbers for chemicals stand in contrast to a recently released study, which predicted that the markets for concrete and aggregates (\$165B - \$550B) and fuels (\$10B - \$250B) would likely dwarf that of chemicals (\$1B - \$12B) by 2050.³ This may speak to more insight and/or optimism into those subsectors by respondents who have some stake in it.
- There is relatively little interest in “new materials,” which include the likes of carbon fiber, carbon nanotubes, and carbon-based nanoparticles, although respondents identified it as a growth sector. This may reflect the opinion that these materials have not yet gained significant enough industrial market sizes to sequester CO₂ on the order of magnitudes required by the climate prerogative. It may also reflect the fact that while these materials have shown promise at a small scale, few have been realized at a commercial scale. Nevertheless, these materials are estimated to be among the fastest-growing material sectors.⁴ Evidence suggests they may even be able to enhance or supercede traditional materials, such as concrete and structural steel, and play an important role in emerging energy technologies, such as in the manufacture of electrodes used in batteries and fuel cells.

Regions

- Forty seven percent (47%) of respondents felt that Europe was the most active region in this space, while 39% chose North America.
- Europeans identified their home continent as more active in this space (67%), while North Americans showed a slight preference (51%) for their own.
- Asked which countries/regions are most active in this space, the U.S. and Canada received more mentions than others (22 and 21, respectively, out of 79), with Germany leading among European countries (13 mentions).

³ Global Roadmap for Implementing CO₂ Utilization, CO₂ Sciences and the Global CO₂ Initiative November, 2016, p. 7.

⁴ “Carbon Nanotubes Market Size Worth USD 8.1bn by 2024: Global Market Insights Inc.”, 2016. [Online].

Available: <https://globenewswire.com/news-release/2016/08/31/868341/0/en/Carbon-Nanotubes-Market-size-worth-USD-8-1bn-by-2024-Global-Market-Insights-Inc.html> [Accessed: 01-Nov-2016].

UNLOCKING INNOVATION AND COMMERCIALIZATION

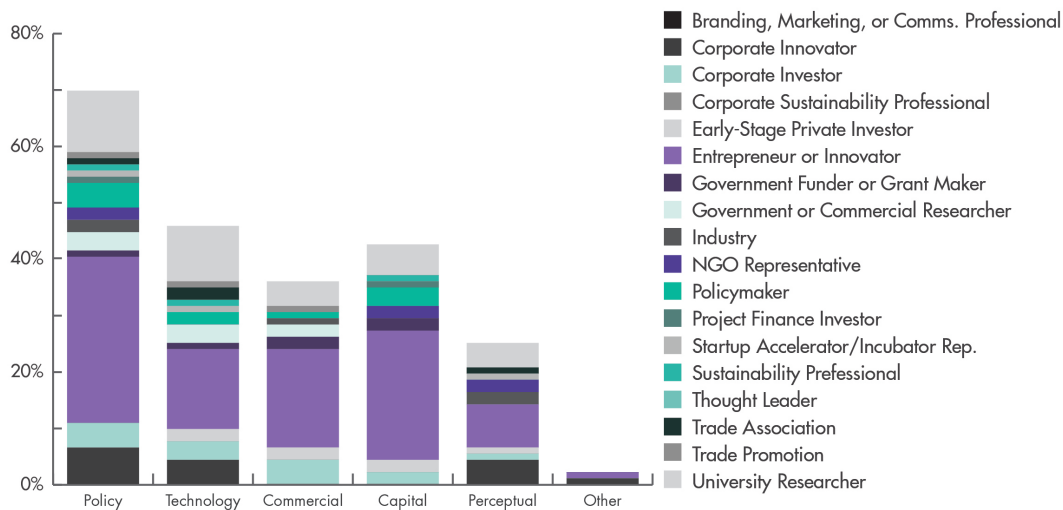
It is a promising sign that this sector has moved firmly beyond a question of technical viability to a discussion around economic viability. There are many promising technologies in this space, but few that are commercial. We estimate that the entire sector has garnered a total investment of less than \$250 million to date, despite the estimated \$1 trillion market opportunity. Even though more work is needed at the level of scientific and engineering innovation, many emerging technologies are ready to advance along the path toward commercialization. We asked survey participants how best to accelerate the pace of innovation and commercialization in the sector (*Figure 12*), and to identify the audiences that are most important to engage (*Figure 13*).

KEY TAKEAWAYS

- Respondents overwhelmingly said that policy was the key dimension to address in order to unlock more innovation and commercialization in the sector, and that governments and policymakers were the most critical audiences needing to be engaged.
- Entrepreneurs ranked capital as a key priority.

FIGURE 12

What are the most important dimensions that need to be addressed to unlock more innovation?



RESULTS AND DISCUSSION

Respondents overwhelmingly (70%) identified policy as the key dimension to address in order to unlock innovation and commercialization in the sector, and that governments and policymakers were the most critical audiences needing to be engaged.

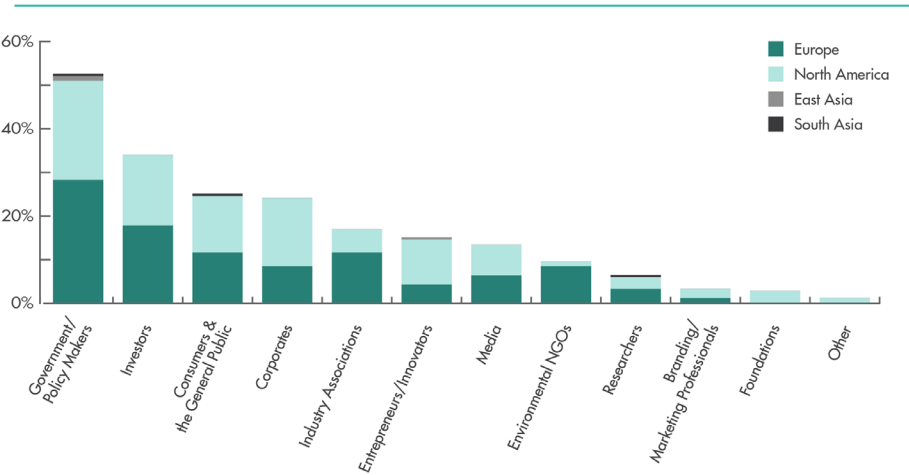
The recent passage of the 45Q tax credit in the United States continues to be a significant headline in the sector, and has stimulated significant new interest and discussion, but its long-term impact on this space has yet to be seen.

- Some respondents expressed the position that carbon taxes and subsidies can be helpful policy levers while others remain sceptical of subsidies, viewing them as artificial and a hindrance in the long term.
- Entrepreneurs clearly felt that access to capital was a barrier to innovation and commercialization, with 53% of them ranking it as a necessary dimension to address.
- Other audiences deemed critical to engage were investors (by 34% of respondents), corporations (24%), and consumers and the general public (25%).



This space has the potential to revolutionize the economy, create jobs, spur innovation, and enable us to create sustainable supply chains and products.

FIGURE 13
Who are the most critical audiences for any effort toward increased awareness, understanding, and urgency?



KEY OPPORTUNITIES AND CHALLENGES

In order to better understand how to effectively engage with key audiences about this sector, we wanted to see what attributes of this space stakeholders find most exciting and important, as well as most challenging. Are people primarily attracted to this space because they are inspired by its potential to help address climate change? Or because of its economic potential? Or something else?

We also wanted to confront head-on some of the challenges, even outright skepticism, we sometimes hear about this space. As this space is still relatively young, with only a few major success stories, there remain questions about whether these technologies can remain technically and economically viable as they scale beyond pilot demonstrations and towards industry scale operations. We wanted to understand what stakeholders perceive as being the greatest

challenges facing this space and why, since any effort to recruit broader interest and support will need to effectively address these issues in both perception and substance.

KEY TAKEAWAYS

- Asked to identify aspects about the sector that they found the most interesting or exciting, respondents as a group ranked the sector's potential to mitigate climate change and the business opportunity.
- Economic feasibility ranked high as a major hurdle, with technical feasibility, engineering feasibility, timeframe, and the relevance to climate change also ranking highly.

FIGURE 14
What aspects of this emerging space are most exciting to you?

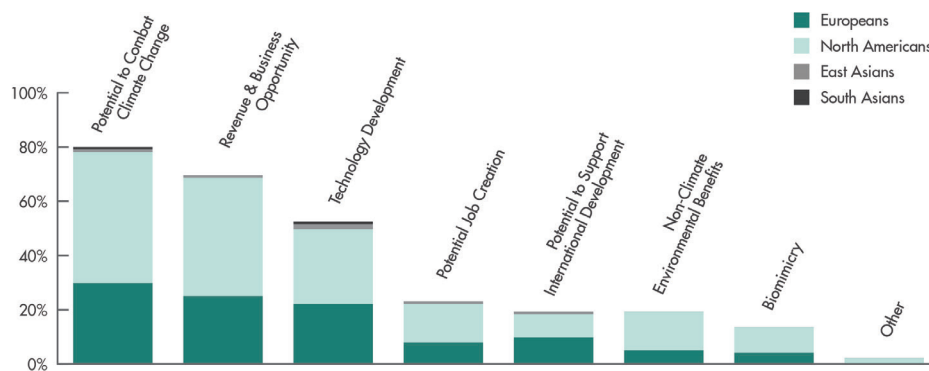
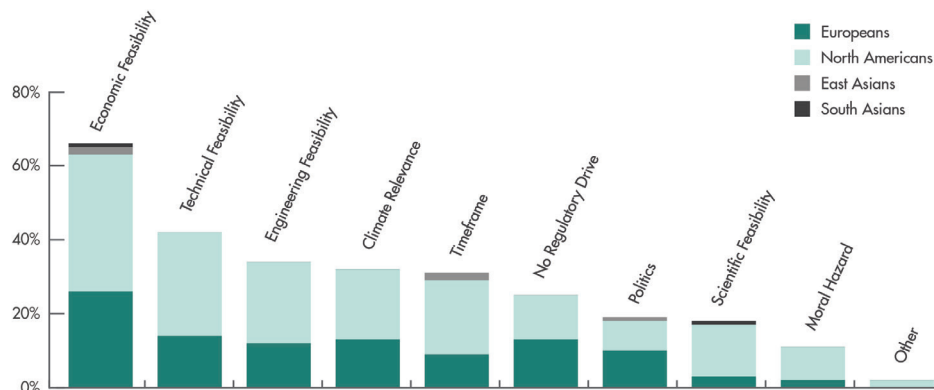


FIGURE 15
What do you see as key challenges this space should overcome to achieve full potential?



RESULTS AND DISCUSSION

Opportunities

- Respondents overwhelmingly said that the sector's potential to combat climate change was most exciting to them (*Figure 14*).
- The high ranking of "revenue and business opportunity" may reflect the high proportion of entrepreneurs and innovators among survey respondents (38%), but nevertheless, it was chosen by 70% of all respondents. This demonstrates a strong belief, at least among insiders, that there is clear profit potential in the sector.
- It is of note that respondents highlighted the sector's potential for technological development, which may be due to the high representation of people with scientific and engineering backgrounds. But it makes clear that respondents believe strongly that R&D in one area of the sector (e.g., carbon capture efficiency from point sources, or increased efficiency and reduced cost of renewable electricity generation) can lead to advances throughout the sector, enabling more rapid scaling of new solutions and perhaps even leading to advances in wider economic sectors.

Challenges

- Concerns about the current cost of carbon capture and opportunities for scalable, profitable business models may explain why the largest percentage of people ranked economic feasibility as a major challenge (*Figure 15*).
- The high ranking of technical and engineering feasibility speaks to the skepticism many hold regarding both the cost of carbon capture and its ability to be transformed at scale into products.
- Policy support, or lack thereof, seems to be of less concern, perhaps due in the U.S. to the recently passed 45Q tax credit, anticipation of new or expanded carbon pricing in Canada, Europe, and several states, or to a belief that the sector can scale without government assistance.
- The "moral hazard" argument scored low, suggesting that it does not have wide currency amongst a techno-economic crowd.⁵ It is also possible that many respondents are simply not familiar with the term. However, in comments, many voiced strong concerns about it. As one person noted: "Most carbon recycling [technologies] will not actually reduce the amount in the atmosphere, just increase it less than fossil options."



[The] sector is still small, and there are few commercialized technologies. Potential is huge, but the technology needs to develop.

There is a general lack of transparency on the state of technology and common metrics to assess cost and carbon balance.

⁵ Moral hazard refers to the concern that "techno-fixes" for CO₂ emissions such as capture, utilization, and storage will actually support continued, unabated use of fossil fuels and their associated greenhouse gas emissions. It also refers to the risk that the existence of CO₂-utilization technologies will give the perception that the CO₂ and climate problems are now solved, and that no further action is required.

PRIORITIZATION

A final set of questions in this survey were aimed at understanding how stakeholders would rank the importance of this space compared to other key climate and clean economy sectors, such as renewables, energy storage, electric vehicles, and others. If they had to choose today, how would they prioritize societal investment and support in these sectors versus the carbon-to-value space and why? Though we assumed there would be some meaningful bias toward the carbon-to-value space given the stakeholders in our circles that we asked to participate in this survey, we wanted to see how even this likely favorably disposed audience would prioritize sectors (Figure 16). It is critical that advocates of this space have a clear view of how much weight its key audiences attach to it in the bigger picture.

KEY TAKEAWAYS

- By a clear margin, respondents felt that public and private support should focus on renewable energy over the next 10 years.
- Conversion of CO₂ into products should share second priority with energy storage and efficiency, suggesting that it should not be considered “instead of” renewables but rather “in addition to.”

RESULTS AND DISCUSSION

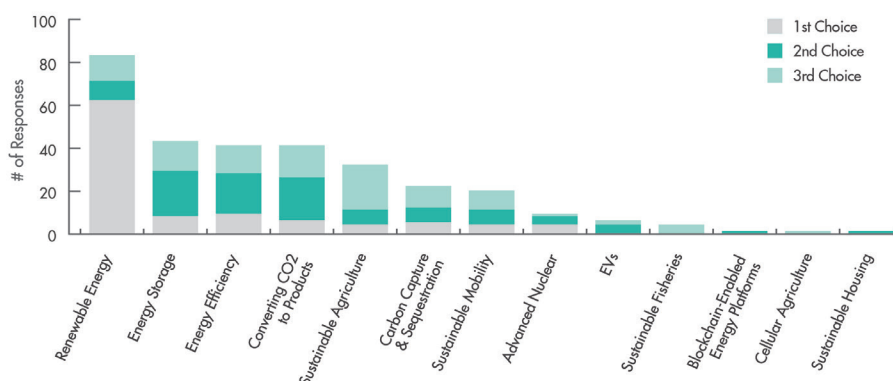
- “Renewable Energy” emerged as the most important priority in the clean economy sector.
- “Conversion of CO₂ to products” ranked very closely with “Energy Efficiency” and “Energy Storage” in priority, as the second most important priority in the clean economy sector.
- It is not surprising that the conversion of CO₂ into products was high on the list of priorities, given that the target audience were those involved in that sector.



With the fall in the price of renewable power it has given people hope that CO₂-based products will someday compete on price.

FIGURE 16

How would you prioritize public and private support for clean economy sectors in the next 10 years?



CONCLUSIONS AND CALLS TO ACTION

We launched this survey to explore the terminology, messaging, perceptions, challenges, and opportunities of this space. Our hope was that by polling members of the community, we could gather and share data that sharpened conversations about how to grow and enhance this space. We also see an opportunity to use these results to articulate and motivate concrete actions and next steps for the community. Each of these calls to action is an opportunity for leadership and collective action in the community.

Go Deeper to Clarify Terminology, Messaging, and Perceptions

The lack of consensus over terminology remains a key problem that we believe should be addressed as soon as possible. Use of language that does not resonate with audiences outside of core experts will be a barrier to growth in this space. If one term is not the best fit to communicate with all audiences, we should assess this with more in-depth focus-group testing, and clearly articulate how the various terms are related (e.g., Does “Carbon Capture” include making products from waste CO₂? Does “CCUS” include “direct air capture”? Does “CO₂-Based Products” include carbon capture technology, or is it restricted to materials synthesis and manufacturing?) An in-person convening of sector experts joined by marketing and branding experts outside this space could be a good start.

Emphasize Links Between Renewables Development and CO₂ Transformation

Respondents identified renewables as the most important sector focus for public and private support over the next 10 years. They also felt that the conversion of CO₂ into products should share second priority with energy storage and efficiency. This suggests that this space is not a competitor to renewables, but is in fact complimentary. Our community needs to become more effective at communicating this point. The promise of realizing meaningful CO₂ emissions reductions by using CO₂ beneficially, using climate neutral or climate negative technologies, almost certainly requires low carbon or zero-carbon footprint electricity and hydrogen. The renewables revolution could actually underpin a CO₂ utilization revolution. We need to tell that story among policymakers, media, capital providers, and innovators who are active or interested in this space.

Connect with Parallel Communities in China and India

The overwhelming majority (95%) of respondents are based in either Europe (35%) or North America (60%). Europe was perceived to be the region most active in this space to date, with North America close second; the U.S. and Canada were perceived to have the most activity on a country-by-country basis. Is this because Europe and North America are truly the centers of activity? How much of this result is due to lack of professional relationships and contacts in Asia, or to lack of Asian respondents? We suspect that all may be true, the latter two especially so. China and India are regions with ambitious industrial development

agendas, strong public concern over air quality and emissions, and overall strong candidates for research, development, commercialization, and scale-up of CO₂ utilization solutions. Our European and North American communities need to become better integrated with communities in these regions.

More Analysis and Better Communication of the Climate Impact and Economic Potential

Messaging that emphasized the climate change benefit and economic potential of transforming CO₂ into products were well supported. But how can these

benefits be quantified, and communicated more broadly? We are aware of a handful of analyses that address one or both of these questions, but they are either not publicly available, not widely circulated, or incomplete. We therefore call for greater depth of analysis into these questions, but also, and crucially, clear and simple communication of the main results. More publicly available analyses of these questions from scientific, policy, economic, and investment lenses will help to accelerate this space. We also feel there is still room for a comprehensive, straightforward articulation of the business case for CO₂ utilization.

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