MIT Climate & Sustainability Consortium

# Where can companies pool resources to lower the barriers to decarbonizing transportation?

MCSC Parallel Session Pre-read

Event Date: November 16, 2023

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## 1 Motivation

In June 2023, the MCSC hosted a study panel during which experts from industry and academia discussed opportunities and barriers faced by trucking fleets in navigating the transition to alternative fuels and powertrains. The discussion highlighted challenges anticipated during the upcoming "valley of death", or "messy middle" period (Fig. 1) as electric truck and low-carbon fuels begin to penetrate the market. During this period, up-front costs of purchasing alternative vehicles and installing refueling infrastructure will be high, and availability of public charging and alternative refueling infrastructure will be limited but growing.

Fig. 1: Illustration of the "valley of death", or "messy middle" period, during which up-front costs are high and availability of infrastructure is limited. Source: article by NACFE.

Based on the study panel, one of major the near-term priorities identified in a recent MCSC whitepaper is for industry stakeholders to work collaboratively to lower up-front costs and other transition barriers in the coming years by sharing resources and pooling demand.

## 2 Learning goals

The parallel session will explore:

1. What are the most important hurdles to transitioning fleets to alternative fuels and powertrains?
2. How can companies pool resources to overcome these hurdles?
3. What is missing from current efforts, and how can academia help fill the gaps?

At the end of the session, there will be a brief discussion of opportunities to map identified resource pooling opportunities onto other sectors, examining CCS off-taking as a case study (see Section 4 for details).

Two resource pooling approaches will be explored in detail: 1) collective support for carriers and 2) shared infrastructure investments.

## 2.1 Approach 1: Collective support for carriers

Many companies that require freight transport services (referred to as "shippers") contract these services to 3rd-party logistics service providers (referred to as "LSPs"). The LSP may operate in one or both of the following models, illustrated in Fig. 2:

**Brokerage model:** The LSP acts as a broker, managing logistics operations on behalf of shippers without owning fleet assets. The broker contracts one or more carriers to carry out the freight transport operations.

**Carrier model:** The LSP manages and carries out the freight transport by owning and operating their own fleet assets (in which case they're referred to as "carriers").

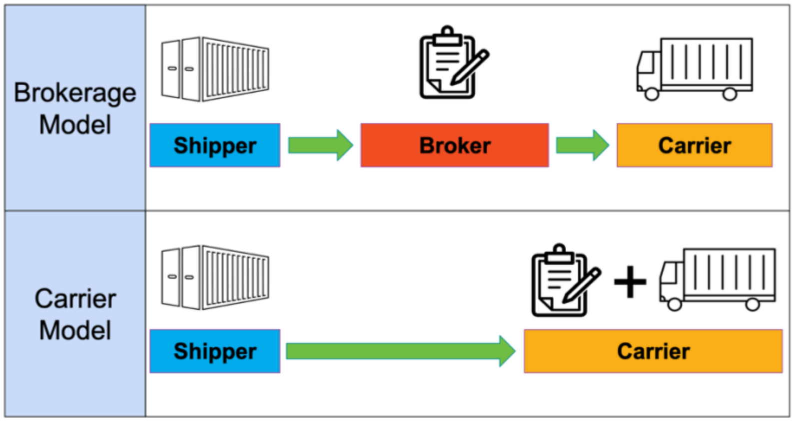

Fig. 2: Illustration of brokerage vs. carrier models for LSP operations.

We want to explore:

1) Common barriers faced by carriers in transitioning fleets, and
2) Opportunities for multiple shippers and brokers to collaborate and pool resources to collectively support carriers that they contract in overcoming these common barriers.

## 2.2 Approach 2: Pooling infrastructure investments

In areas with insufficient charging or refueling stations, there is an opportunity for shippers, brokers and carriers to collectively lower the cost of installing the needed infrastructure by identifying and sharing infrastructure costs along shared corridors, or by advocating for increased public infrastructure spending along these high-traffic corridors. These pooled infrastructure investment opportunities could be especially important early in the transition when individual fleets of alternative trucks may be too small to fully utilize the needed infrastructure.

# 3 Context

## 3.1 Learnings from interviews with LSPs

In September 2023, the MCSC interviewed representatives from three LSPs contracted by member company Apple to 1) learn about barriers they face in navigating the transition to low-carbon fuels and electrification, and 2) identify opportunities for shippers and brokers to collectively support carriers.

The major barriers identified from the discussions can be broadly categorized into **transition costs**, **information gaps** and **infrastructure requirements**. The following sections detail these barriers, then outline opportunities identified for companies to pool resources to help overcome these barriers.

### 3.1.1 Infrastructure requirements

In general, LSPs reported insufficient infrastructure as a major barrier to transitioning many fleets, combined with additional expense and delays associated with installing the needed infrastructure.

Infrastructure requirements vary by operation and energy carrier, but in the case of electrified trucking charging infrastructure may be needed in some or all of the following scenarios, illustrated in Fig. 3:

- Warehouse charging
- Truck stops
- Shipping facility

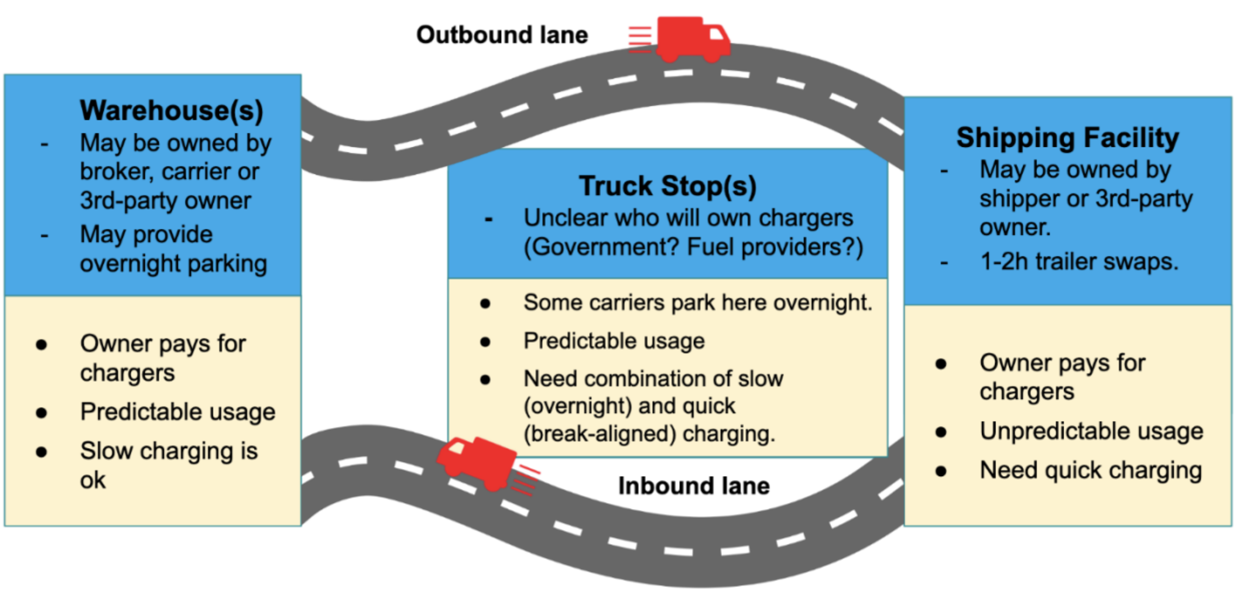


Fig. 3: Summary of general infrastructure requirements needed to electrify trucking fleets.

While Fig. 3 aims to represent general charging requirements, it's worth noting that carriers may use multiple warehouses depending on the operation, and some may not use warehouses at all, instead using truck stops for overnight parking.

Charging speed may vary depending on the operation. In general, we anticipate that owners of warehouses and shipping facilities will be responsible for purchasing chargers in these settings. Our current assumption is that charging infrastructure at truck stops will be either government-installed or purchased and operated by the truck stop owner. We welcome feedback from stakeholders in the space to help us refine this model.

### 3.1.2 Transition costs

The major transition costs identified by LSPs arise from:

- Purchasing alternative vehicle fleets
- Installing infrastructure needed to operate the fleets, and
- Operational inefficiencies, particularly in the case of electrified trucks, arising from:
    - Limited range
    - Charging time
    - Payload penalties due to added vehicle weight from the battery

LSPs reported that strong and long-lasting commitments from customers are critical to de-risk the up-front investments in alternative fleets and charging/refueling infrastructure needed to transition fleets. LSPs also highlighted a need for support in identifying and applying for available subsidies and incentives to offset both up-front and operational costs.

### 3.1.3 Information gaps

LSPs identified a range of **information gaps** that can challenge stakeholders in navigating fleet transitions. These gaps, along with proposed strategies to fill the gaps, are summarized in Table 1.

Table 1: Information gaps identified from interviews with LSPs, along with proposed resources to fill them. Green cells indicate that the proposed strategy was either proposed by the LSPs or proposed to them and received some approval during the interview. Orange indicates proposed strategy that haven't yet been discussed with LSPs, and red indicates that the strategy is currently unclear.

| **Where are the information gaps?** | **What resources would best fill them?** | **Who needs to receive the resources?** | **How would they best be distributed?** |
|---|---|---|---|
| Generalized learnings from pilots | Broad access to learnings from pilots | Brokers and carriers | Maintain central database among shippers/carriers? |
| Potential economic benefits of transition | General rules based on operational/regional characteristics? | Carriers | Alongside discussion of environmental benefits |
| How operations will need to adapt | General rules based on operational/regional characteristics? | Carriers | Interactive tools? Start by identifying existing tools? |
| Reliability/affordability of transition technology | Unsure | Carriers | Unsure |
| Where will government-installed infrastructure be located? | Geospatial tool? | Shippers, brokers and carriers. Perhaps also Infrastructure providers? | Centrally accessible tool? |
| How to identify and apply for grants and tax breaks | Centralized up-to-date tool | Carriers | Centrally accessible tool |

### 3.1.4 Resource pooling opportunities

Based on the transition barriers and opportunities shared by LSPs, the following major resource pooling opportunities are identified:

1) Shared database of learnings from pilots

   **Summary:** Carriers, brokers and other industry stakeholder could contribute high-level outcomes and learnings from pilots to a shared database, thus allowing other stakeholders to learn from the pilots. Maintaining learnings in one place would also facilitate formulation of generalized frameworks to help stakeholders quickly assess important factors such as reliability, affordability, and potential operational changes for a prospective fleet transition, rather than relying on customized case-by-case analyses.

**Open questions:** Does such a framework already exist? If not, what entity is best suited to host and maintain it?

2) Shared framework to support fleets in identifying and applying for subsidies and incentives.

   **Summary:** There's a diverse range of subsidies and incentives at various levels (federal, state/province, regional) to help lower both up-front and operational costs. A shared, community-maintained database could help fleets efficiently identify current subsidies and incentives relevant to their fleets, along with resources available to support their application process.

   A range of databases are currently maintained to collate available subsidies and support in the U.S. However, few target freight transportation (thus requiring fleet owners to sift through irrelevant information), and to our knowledge none are community maintained.

   The open-source MCSC transportation mapping tool includes layers to visualize incentives and regulations relevant to trucking fleets documented in the DOE's Alternative Fuels Data Center (AFDC). This could be improved by extending coverage beyond the U.S. and allowing partners to dynamically add missing resources.

   **Open questions:** How can existing databases and resources be most effectively collated? Could the MCSC transportation tool usefully support this?

3) Collective usage commitments for carriers

   **Summary:** Shippers and brokers with common carriers can partner to provide carriers with collective commitments to utilize alternative fleets (potentially at a short-term cost premium). These strong unified commitments could aid carriers in planning and de-risking up-front costs for fleet transitions.

   **Open questions:** Can we anticipate and minimize added complexity and delays associated with formulating collective usage commitments?

4) Collective infrastructure investment and usage

   **Summary:** Collective infrastructure investment could be considered in one or more of the three settings outlined in Fig. 3: warehouses, truck stops and shipping facilities.

   **Open questions:** What is the ecosystem of stakeholders needed to participate in and realize shared investments in these three settings? What are important factors that would make it more sensible to pursue collective investment in one setting over another?

### 3.2 First-principles analysis of potential infrastructure savings from pooled investment

A first-principles analysis of charging requirements at truck stops was performed over the U.S. interstate network to evaluate potential savings associated with economies of scale when pooling infrastructure investments. It uses freight flow data from the FAF5 framework maintained by the DOT, and looks at a scenario in which all truck trips carried out in 2022 are electrified. A simplifying assumption is made that all charging takes place at truck stops.

The analysis, detailed in Appendix A, randomly selects truck stops from the U.S. network to be provisioned with charging infrastructure, requiring that they be separated by 100 miles on average and at minimum 50 miles. It then considers two infrastructure investment and usage scenarios:

**Full Fleet (pooled investment):** The entire electrified U.S. trucking fleet shares investment and utilization in charging infrastructure at the selected truck stops.

**Half Fleet (separate investment):** The electrified U.S. trucking fleet is equally divided into two sub-fleets (representing two distinct carriers), which invest and utilize charging infrastructure separately at the selected truck stops.

It then uses the freight flow data to estimate the number of chargers needed at each truck stop to allow trucks passing the stop to charge, subject to a maximum allowable wait time for a charger to become available. Lastly, it compares the charger-to-truck ratios needed in the full fleet vs. half fleet scenarios to evaluate the relative savings from pooled investment in the full fleet scenario:

$$\text{\% Infrastructure Savings} = \left(1 - \frac{C_N/N}{C_{N/2}/(N/2)}\right) \times 100\%$$

where N is the average number of trucks expected to stop and charge at the truck stop per day, and $C_N$ is the number of chargers needed at the stop to keep average wait times below the allowable maximum.

The result can be visualized in an interactive web tool, demoed in this video. The demo allows the user to vary the following parameters in the analysis:

- Truck range (250 miles by default)
- Average charging time (4h by default)
- Maximum allowable average wait time for a charger to become available (30 minutes by default)

The interactive web tool can be accessed as follows:

1. Go to the following link on your browser to access the login page: https://climatedata.mit.edu/users/login/

2. Either create an account, or log in with the following default credentials:
   **Username:** mcsc-user
   **Password:** mcsc-datahub

3. Go to the following link to access the web tool: https://climatedata.mit.edu/faf5/transportation/

The estimated infrastructure savings from pooled investment, shown in Fig. 4 with the default parameters, vary from 3-30%, depending on the typical volume of trucks passing the station (represented in Fig. 4 by the width of the nearest highway link). In general, regions with lower truck flow volumes can expect larger potential savings from pooled infrastructure investment, because they have more potential for efficiency gains from increased usage (details in Appendix).

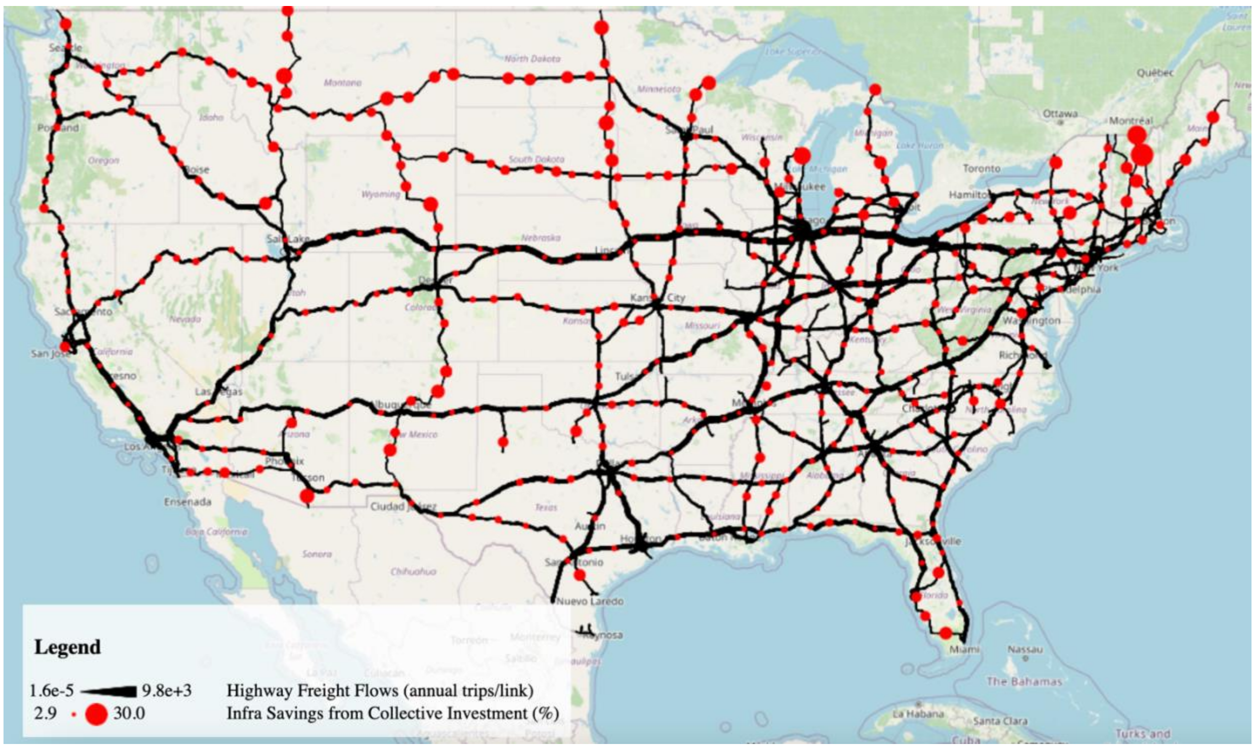


Fig. 4: Theoretical infrastructure savings from the pooled investment scenario relative to the collective investment scenario.

Though it lacks the nuance of a detailed network analysis, this thought experiment highlights two important points:

1) Appreciable savings from pooled infrastructure investment are possible in principle, even at the level the entire U.S. trucking fleet.

2) We can expect the benefits of pooled investments to be most pronounced early in the transition when fleet sizes are small, because smaller fleets can expect to reap higher efficiency gains from combining their numbers with other fleets.

Moving forward, we aim to continue improving this analysis by incorporating more considerations relevant for fleets assessing potential benefits of pooled infrastructure investments.

## 3.3 Ongoing Resource Pooling Efforts

A major aim of the session is to explore how academia can most effectively complement and amplify ongoing resource pooling efforts in the space. This section summarizes the ongoing efforts that we're currently aware of.

| **Title** | **Participants** | **Details** | **Links to More Information** |
|---|---|---|---|
| Sustainable Freight Buyers Alliance (SFBA) | Range of freight transport stakeholders (shippers, logistics service providers, IT companies, fuel providers, etc.).<br><br>MCSC member companies involved: Cargill, Dow, Inditex, PepsiCo | Initiative by the Smart Freight Center, with the stated goal of "uniting corporate freight buyers to shift towards zero-emissions freight across all modes of transport in collaboration with their supply chains and partners". | Main webpage<br><br>2023 Agenda<br><br>Webpage and slide deck for the SFBA's Fleet Electrification Coalition project.<br><br>Email address: sfba@smartfreightcentre.org |
| First Movers Coalition | 88 members from global corporations and non-profit organizations.<br><br>MCSC member companies involved: Apple, Boeing, PepsiCo | Coalition of companies using their purchasing power to create early market incentives for clean technologies across 8 hard-to-abate sectors, including trucking, shipping and aviation. | Main webpage<br><br>Introduction slides |

## 4 Extension to $CO_2$ Off-taking

This section explores possibilities to extend the resource pooling discussion from the trucking context to other sustainability challenges, looking at CCS off-taking as a case study.

Industrial decarbonization will require a multi-pronged approach that includes improving operational efficiency, bringing more renewable energy generation sources online, electrification, and engineered carbon removal such as carbon capture and sequestration (CCS). Currently, less than 1% of approximately 40 Gt/yr global $CO_2$ emissions are captured. In addition to implementing deep decarbonization measures, CCS must be rapidly scaled to keep the carbon budget at or below sustainable levels. CCS encompasses processes where $CO_2$ emissions are captured from concentrated (point-source capture) or diffuse sources (air, ocean), then transported (pipeline network, road, rail or ocean), and sequestered or utilized.

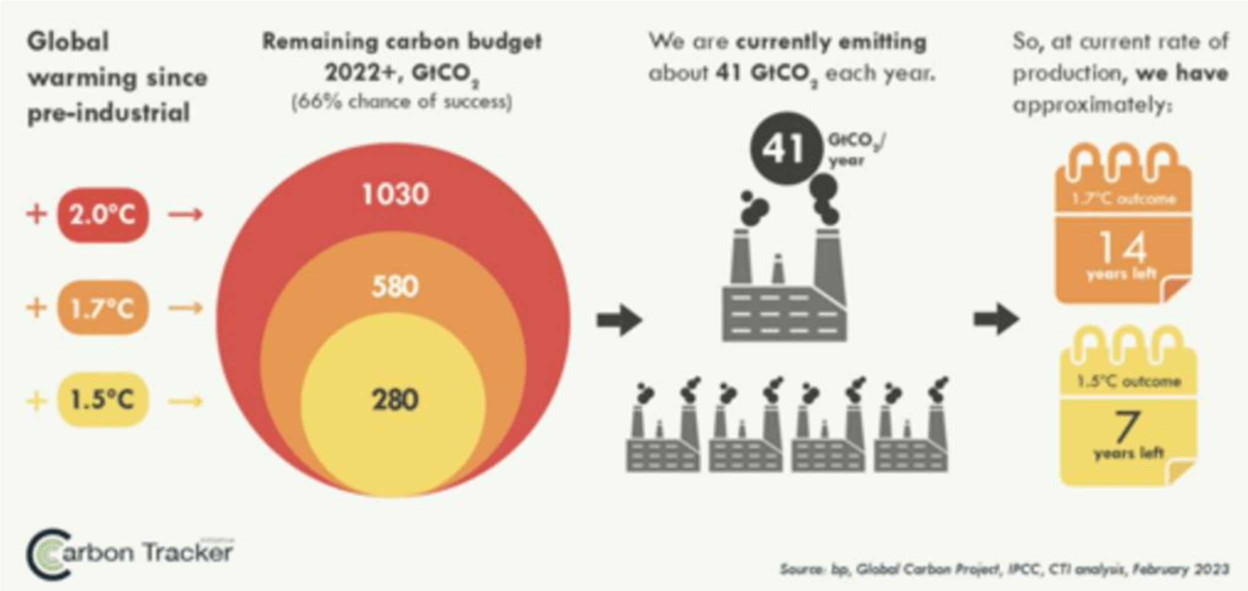


Fig. 5: Illustration of carbon budget in a net zero scenario. Source: Net Zero 2050 – Old before its time by Carbon Tracker

Among these efforts, point-source capture technologies are the most mature and amenable to gigaton-scale carbon removal. However, point-source CCS continues to face sluggish industry-wide adoption due to significant economic, technical, and policy barriers. Some challenges facing the industry include:

- **Cost:** CCS has a high capex (approx $1 - 4 B), and significant opex (approx 4-5%) of capex for each part of the chain.
- **Business case:** managing a CCS facility often detracts from the emitters' primary value chain, and "venting $CO_2$ into the atmosphere is [currently] free".

- **Infrastructure/transportation:** Carbon removal is a relatively nascent endeavor and few relationships exist between emitters and off-takers (e.g., pipeline companies).
- **Data:** Although there are very few operational CCS facilities, there are clear lessons to be learned from more than 50 years of commercial deployment.

These challenges have clear parallels with the transportation model recently discussed. For example,

- The shipper → broker → carrier model could be considered in this case as emitter → hub → offtaker.
- The same issues surrounding freight transport are relevant to $CO_2$ transport and/or storage.
- Charging and alternative refueling infrastructure along shared corridors has parallels with pipeline/trunk line networks, and the same opportunities exist for pooled investment and usage.

Therefore, it is worth evaluating lessons learned from resource pooling in decarbonizing transportation with respect to CCS.

Implementing a resource-pooling model in CCS is not a novel idea, but merits renewed attention and commitments. There are very few operational CSS hubs globally, where different companies and industries share pipeline/trunkline networks and injection sites. The existence of these shared resources is often critical to companies committing to a CCS retrofit for their industrial processes. To lower barriers to industry-wide participation in CCS, it is important to consider aspects of CCS that can be further ameliorated by resource pooling.

One of the biggest concerns within MCSC member companies is the impact of managing the full chain of CCS (capture, transport and storage/utilization) on their primary production output. Companies are motivated to retrofit their industrial processes with CCS if it significantly benefits or optimizes production. Some strategies to minimize the burden of CCS may include

- Involving additional stakeholders such as public-private partnerships in establishing hubs. This strategy enabled the rapid deployment of direct air capture facilities in recent years.
- Identifying shared regional networks (e.g. trunk lines) between companies and industries, and outsourcing their construction and maintenance to a third party.
- Emitter-independent off-takers supported by collective usage commitments.
- A Hub+ model (similar to a waste treatment plant) that accepts $CO_2$-rich flue gas from different companies and handles the CCS full chain independent of the emitter (this may benefit smaller emitters).

Nearly all these strategies are already active or under varying stages of planning in the global CCS industry. However, their industry-wide adoption ultimately depends on their success, longevity and impact on carbon removal. For example, there are 28 operational CCS facilities in North America, most of which are full chain facilities AND involve EOR as the primary fate of the captured carbon, the latter effectively ensuring a net-positive emissions impact. The same trend is observed across the world. However, there are now several hundreds of planned CCS facilities focusing on different aspects of the value chain, and shifting focus away from EOR to permanent storage.

The Global CCS institute estimates that the current CCS capacity must increase by more than a hundred fold in a net-zero by 2050 scenario. This requires sustained effort from diverse stakeholders to effectively lower barriers to industry wide CCS deployment. To ensure rapid action and short lead times for CCS deployment, these same questions are posed in the light of CCS:

- What are the most significant risks in building and operating a CCS facility?
- Who are the most important stakeholders for lowering the cost and risks associated with CCS?
- What additional infrastructure (demand, trunk lines, off-takers, etc.) needs to be in place to facilitate low risk CCS?
- How many of your facilities can be reasonably retrofitted with CCS? What is the approximate time frame for a retrofit? Are there plans to include CCS in planned facilities?
- Are there any important information gaps? If so: What resources would best fill them? Who needs to receive the resources? How would they be best distributed?