2024 US merchant CO_2 report

An uptick in sourcing activity

By **Maura D. Garvey**

The 2024 merchant carbon dioxide (CO_2) business will face the typical sourcing issues encountered every year – primarily, the normal plant turnarounds that start in March and carry into the summer, when ammonia plants are taken down for maintenance after the growing season.

The industry did not experience any severe disruptions this past year, such as was experienced with the Jackson Dome and railroad shipping delays in 2022. However, the merchant CO_2 industry is threatened by the federal government's push toward decarbonization using tax credits, which looks set to impact the critical CO_2 supply chain to some extent, including important end-use markets like food processing. In response to this threat, the Compressed Gas Association (CGA) established the CO_2 Solutions Coalition last year to begin to address these concerns (see the coverage on p32).

Demand is projected to grow at 2%, but the industry does not have sufficient new sources coming online to support that growth. Maintaining and improving current processing system efficiency, investing in recycling systems, or investing in alternative sustainable sources of CO_2 are all options that need to be investigated.

Last year's report emphasized the need for end-users and suppliers of CO_2 to strategically manage CO_2 supply and act now to mitigate future disruptions as far as possible. There is evidence this has happened in some quarters, with industrial gas distributors making a better job of diversifying their sourcing to take more control.

The regional variations that mean the West and East coasts remain underserved is still a reality. More than 75% of CO_2 sources today are located in the Midwest and South. New England and the West are burdened by having very few CO_2 sources and therefore higher transport costs for supply. In the US, rail transport is critical to bringing product to where it is needed.

The independent producers POET and Reliant are bringing on more supply in 2024, but there is a real potential for the industry to start to lose merchant CO_2 sources to carbon capture and sequestration (CCS) pipelines that are taking advantage of the 45Q tax credit ($85/ton for CO_2). This tax break effectively makes it more lucrative for clean CO_2 producers of ethanol and fertilizer to sequester their CO_2 by-product in the ground. Investors, project developers, and emitters can add significant financial value to their bottom lines from this, but this will of course squeeze merchant CO_2 supply and soon send prices up.

There are three companies – Summit Carbon Solutions, Tallgrass Trailblazer Pipeline and Wolf Carbon Solutions – that have proposed these pipelines. Navigator was a fourth pipeline, but it cancelled its project in October 2023 due to permitting issues and landowner resistance.

Summit plans to build a pipeline across Iowa, Nebraska, Minnesota, and South and North Dakota to move the CO_2 to North Dakota to be sequestered underground. It has signed on eight plants currently producing merchant CO_2 to sequester using the pipeline, and it looks set to remove about 1,600 tpd of merchant CO_2 from the market. Other companies like POET and Valero have also signed on, but the plants in question do not currently recover CO_2 for the merchant market.

Summit has faced significant regulatory hoops and pushback from landowners. The South Dakota legislature passed a trio of bills in March designed to clear the way for Summit's pipeline while protecting the landowners.

Tallgrass, for its part, plans to utilize an existing unused natural gas pipeline from Beatrice, NE to Cheyenne, WY to permanently sequester CO_2 from plants along the pipeline's path. And Wolf Carbon Solutions has plans to put pipelines in Iowa and eventually expand into Indiana and Ohio to capture CO_2 from refineries, and from cement and steel facilities. The concern about the safety of those pipelines by citizens in the affected states put these companies a long way off achieving final approvals. How many of the Midwest CCS pipelines will ultimately be built remains in doubt.

> "More than 75% of CO_2 sources today are located in the Midwest and South"

Single plant sequestering, where the geology below can allow for sequestration on site, is also being pursued. Cardinal Ethanol with its joint venture partner Vault 44.0, plans to sequester on site in Indiana. In April 2022, Lapis Energy and LSB Industries, Inc entered into an agreement to capture and permanently sequester more than 450,000 metric tons of CO_2 per year at LSB Industries' El Dorado facility in Arkansas. The first CO_2 injection here is expected by 2025. Also in 2022, Matheson (Continental Carbonic) opened a liquid CO_2 plant and dry ice manufacturing facility next to the LSB plant and is supplied crude from LSB industries for its merchant CO_2 business operations. Those operations are not expected to be affected.

The growing need to diversify sourcing to maintain and grow CO_2 supply has made some costlier alternative sustainable sources of CO_2 production more economically viable. As luck would have it, these new sources can also be installed nearer to demand centers or in regions historically lacking merchant CO_2 supply. For example, landfills creating biogas and CO_2 are typically located around all major cities.

Some of those potential new sources, in order of stage of development, include building decarbonization, carbonate fuel cell generation, biogenic CO_2 from waste (ie, landfill, dairy, etc.), direct air capture (DAC), and vehicle decarbonization. While these alternatives can be very capital intensive compared with existing supply, the price of merchant CO_2 has been increasing over the past few years such that the investment can be justified.

As mentioned, there is also progress on the capture of CO_2 from giant boiler systems in large apartment complexes. CarbonQuest, headquartered in Washington state, installed a CO_2 capture, liquefaction and storage system in a tower on Manhattan's Upper West Side. The CO_2 is trucked to a concrete factory nearby where it is mixed with cement and permanently sealed into concrete blocks using CarbonCure technology. There are also several fuel cell energy companies able to capture CO_2 for sale into the merchant market.

By the end of 2024, US nameplate (NP) CO_2 capacity is estimated at 36.8 thousand tons per day (ktpd). This is flat over last year, as some plants closed or suffered reduced feedstock, while others will be coming online. As noted earlier, this capacity growth is not keeping up with CO_2 demand, which looks set to continue at 2% each year. The upshot will be continued tight supply whenever there are planned or unplanned plant outages, as well as seasonal demand spikes. In these moments, prices will rise.

In this report we do not cover the large volume of CO_2 that is piped for enhanced oil recovery (EOR), estimated at over 80 million tons per year in the US, a very small part of which is used for merchant CO_2.

Intelligas Consulting, on behalf of **gas**world (US Edition), spoke with the independent CO_2 suppliers, equipment manufacturers and CCS pipeline companies to get the insider's view of this critical market and the changes underway within it. In addition, discussions with managers at major industrial gas companies and distributorships occurred throughout the year. Those views and opinions are reflected here.

Dry ice manufacturing locations in the US, 2024

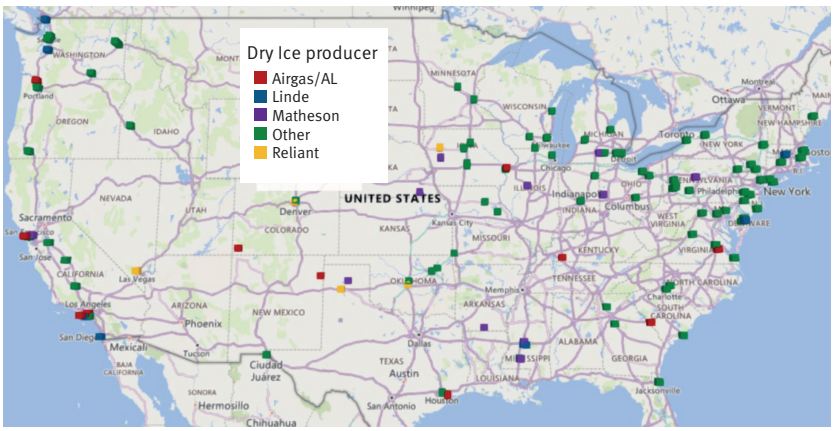

Figure 2. Source: Intelligas Consulting

US CO_2 demand by application, 2024

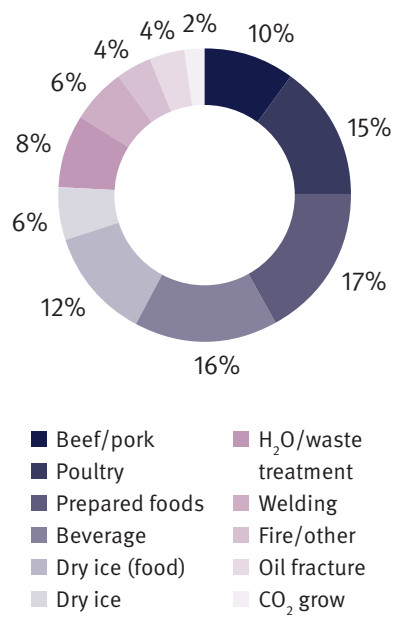

Figure 1. Source: Intelligas Consulting

CO_2 markets

CO_2 is integral to how food is processed and packaged. In terms of the US markets for all modes of CO_2 supply, food and beverage accounts for 70% of the higher purity merchant CO_2 supply as shown in Figure 1. Dry ice includes blocks, pellets, snow, and transport ice. Many consumers changed their food buying patterns during the pandemic and continue to buy weekly groceries through delivery services or specialized food service providers, many of which require dry ice to keep food cold or frozen.

Beverage use was on the decline over the past decade as consumers moved away from high-sugar carbonated soda toward lighter, flavored non-carbonated beverages such as vitamin water. However, CO_2 use in carbonation for seltzers and microbreweries has brought this segment back, and it is steadily growing once again.

The industrial sector makes up 30% of the US CO_2 market – for welding, wastewater treatment, dry ice blast cleaning, production of cannabis, fire systems, and oil field services like well workovers. Dry ice is used in food processing and transport, but the fastest growing segment is pellets used for

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Crude CO_2 sources for the US merchant market, 2024

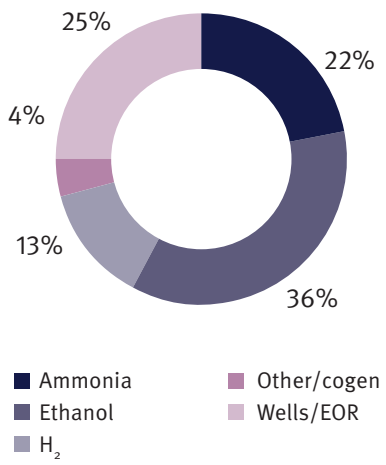

Figure 3. Source: Intelligas Consulting

Player share of US merchant CO_2 capacity, 2024

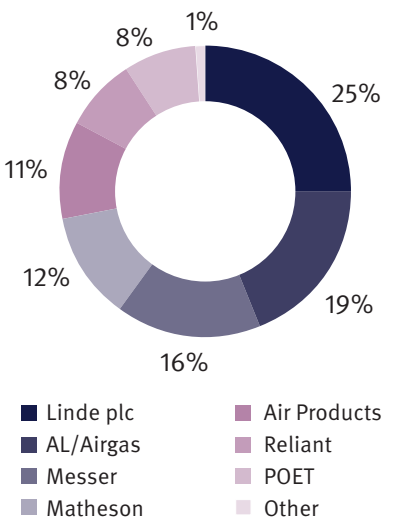

Figure 4. Source: Intelligas Consulting

blast cleaning in the industrial sector to clean and disinfect equipment, tools, and molds. Dry ice consumption grew 5% annually over the past eight years, and dry ice blasting alone has grown at least 10% annually over the past five years. Figure 2 shows the number of dry ice manufacturing locations across the US. Many of the newer locations are independent industrial gas distributors (Other).

> "The merchant CO_2 market is serviced by a complex supply chain, where some companies are fully integrated in the CO_2 supply chain"

Recycle systems for dry ice manufacturing are a significant way to reduce overall CO_2 consumption. On average, it takes about 2.4 pounds (lbs) of liquid CO_2 (LCO_2) to produce 1lb of dry ice. With a recycle system, it only takes 1.2lbs to 1.3lbs of LCO_2 to produce 1lb of dry ice. The return on investment, depending on scale, can be significant. With over 130 dry ice manufacturing locations in the US, the reduction in CO_2 consumption from locations without recycle systems would be significant.

CO_2 use is also climbing in the cannabis supply chain, for the cultivation and extraction for hemp and marijuana. Cannabis is currently fully legal in more than 20 states and the District of Columbia for medical and recreational use. And CO_2 for cannabis greenhouses has been increasing as more states legalize the use. This looks like a great growth opportunity, so long as risks are properly assessed.

Another growing application is the injection of CO_2 into cement as a means of improving the strength of concrete and permanently embedding the CO_2. Techs like CarbonCure ensure that the CO_2 will never re-enter the atmosphere even when the concrete is demolished. There are various concrete construction projects in the US that are using this technology, and new players are emerging.

The merchant CO_2 market is serviced by a complex supply chain, where some companies are fully integrated in the CO_2 supply chain as they produce the crude, purify it to liquid, and distribute to distributors and end-users. At the other end of the spectrum, there are some companies that are strictly CO_2 and/or dry ice distributors.

As a product, CO_2 is delivered in several forms, including crude, gaseous, compressed liquid, and solid (ice), and is transferred via pipeline, bulk and microbulk trucks, cylinders, and as dry ice. There are many different sources of CO_2, but in the US it is primarily sourced from ethanol (fermentation), natural CO_2 wells, ammonia, and hydrogen/refining. It can also be captured from the gas streams emitted by power plants. There are several potential CO_2 sources in the Midwest (ethanol), South (ammonia) and alternative fuels plants that remain untapped due to the high cost of new plant capital and cost to distribute from those locations.

Sourcing merchant CO_2

Merchant CO_2 is recycled and purified from existing CO_2 emissions from other processes that would otherwise have been vented to the atmosphere. CO_2 is a by-product of a main supplier's operations, so understanding the dynamics of the industries supplying the feedstock is critical to understanding supply. Most US merchant CO_2 is sourced from hydrocarbon conversion facilities where the primary product is ethanol, ammonia, hydrogen, and wells/EOR. There are a few plants sourced from ethylene oxide and one from biogas at an RNG facility. Because CO_2 is always a by-product of another process, this makes sourcing riskier, with planned and unplanned maintenance of facilities, and complex market dynamics that need to be understood.

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Carbon dioxide sources are also highly sensitive to location, but due to a lack of strategically located alternatives the current ethanol plant supply cannot be economically replaced. For example, there are not enough ammonia plants, the second-largest CO_2 source, available to replace ethanol sources.

Conserving CO_2 use, fixing leaking systems, or switching cryogen products should all be considered to maintain and improve processing system efficiency. Investment in recycle systems or investment in alternative processing equipment should also all be investigated. In all cases, these options need to be strategically considered now to avert costly plant shutdowns.

New merchant CO_2 sources

POET, the only vertically integrated CO_2 supplier, has 15 CO_2 production facilities after adding capacity in recent years. This year POET has said it will be adding a sizable biogenic CO_2 facility in Fairmont, NE. According to Brad Jones, Director of Business Development, "POET continues to take an aggressive path to growth, demonstrating its strong commitment to the merchant CO_2 market. Our vertically integrated system of supply allows POET to deliver ratable and redundant solutions to our customers, providing the foundation for our incredible growth over the last decade."

Independent CO_2 supplier Reliant Gases has been strategically increasing its portfolio of merchant CO_2 plants. It will be adding another plant this year in Carrolton, MO and has plans to expand and add more supply annually. Part of its strategy is to continue to evaluate non-traditional CO_2 sources to diversify feedstock sources.

Merchant CO_2 capacity

US NP CO_2 capacity is estimated at 36.8 ktpd in 2024 based on known capacity additions and plants that have gone offline. This equates to a growth of less than 0.5% per year over the past five years. As mentioned earlier, CO_2 demand growth has been higher at around 2% per year. But the capacity utilization rate, which affects the CO_2 available to the market, has been increasing to try to keep up with demand. Capacity utilization was about 85% five years ago but is about 90% today. Periodic tight supply in different regions across the US will continue this year due to common issues like crude feed source reliability, weather, and source plant maintenance.

As shown in figure 4, Linde plc is the number one merchant CO_2 supplier while AL/Airgas is number two. Combined, they own 44% of supply. Messer LLC is a very close number three, while Matheson and Air Products are at four and five. Between them, the major industrial gas companies represent 83% of CO_2 supply, but this is declining as POET and Reliant have been growing capacity and share over the past decade. By the end of 2024, POET will operate 16 plants along with a comprehensive fleet of both truck and rail transports. Reliant will have 12 CO_2 plants operating by the end of the year, sourced from ethanol, wells/EOR, and ammonia. Reliant has a large fleet of portable storage units and a fleet of railcars for CO_2 delivery.

Merchant CO_2 production is about 10.4 million tons per year. Non-industry independents have increased their share of the merchant CO_2 business over the past five years from 9% to 17%. Significant players remaining from outside of the traditional industrial gas company circle include POET and Reliant, each with an 8% share. Other small companies account for another 1%. There should be growth in the non-industry independents going forward. For example, CeeKay Supply, headquartered in St Louis, MO, owns a merchant CO_2 plant in Malta Bend, MO that was purchased from Air Products several years ago. We may see more independent distributors follow this path.

> "In the year ahead, merchant CO_2 suppliers need to strategically think about how to secure their infrastructure"

Market opportunities

With supply growth not currently matching demand growth, and the inevitability of some merchant supply being diverted for sequestration, new sources are needed. The industry needs capacity growth and alternative new sustainable sources should be considered.

In the year ahead, merchant CO_2 suppliers need to think strategically about how to secure their position in this environment of CCS tax credits. This includes actively pursuing new sources of crude CO_2 feedstock as well as considering diversifying their own sourcing. And merchant CO_2 end-users need to act now to purposefully conserve CO_2 use by investing in recycle systems, diversifying sources, or pursuing the new sustainable sources of CO_2 that will grow in importance and become more available over the new few years. gw

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