Jupiter Oxygen Corporation : For Distribution (2)

Introduction

Climate change is one of the most labyrinthine issues facing us today. The increasing concentration of greenhouse gases (GHG) in the planet's atmosphere is making the planet warmer and is pressuring all sectors, public and private, to come to a common understanding of the short- and long-term implications. Most mitigation strategies focus on reducing fossil fuel use thereby reducing its primary emissions of CO_2. While climate mitigation goals, by global consensus, are exerting downward pressure on fossil fuel use, the global demand for energy resources continue to rise. This increased demand is not a theoretical projection. According to the U.N. over a billion people globally either cannot afford or do not have access to electricity.

We are confronted with, perhaps, the most formidable technological challenge in human history; to reduce GHG emissions by half in ten years (2030) while meeting the rising demand for energy. Renewable energy is set to play a central role in our future. However, there is no viable scientific evidence that, even with the growing public and private sector funding, renewable energy sources can replace a US$25 trillion global energy infrastructure in ten years. The best-case scenario is that renewables will be able to support <65% of the global demand by 2050. While that progress is commendable, the issues of grid stability and reliability remain as well as the challenge of providing low reactive power to re-charge from blackouts. The disparity between renewable supply and demand was evidenced by the generation gap in California this past summer resulting in rolling blackouts during the record-breaking heat wave that ran from Texas to Oregon. Simply, transition to 100% renewables cannot happen with the technology or science we have today.

What we *do* have today are transitional technologies; low carbon innovations whose development in terms of scope and scale of GHG mitigation are either at or near commercial scale. These decarbonization technologies can be applied across all sectors from power to oil & gas, transportation, chemicals, waste, cement, iron, and steel.

The solution to climate change must transcend the binary discord of either fossil fuels or renewables. Achieving 'net zero' emissions before 2050 (the goal of U.N. climate scientists) will be a conglomeration of technologies executing multiple scenarios requiring broad coalitions with varying adaptabilities across all suppliers in the energy mix value chain.

The Energy Mix

Any strategy to reduce GHG emissions must include consideration of the global energy mix incorporating statistical trends of fossil fuel and renewable development, individual nation's energy demands as well as their economic capabilities. The energy mix is total combined *primary sources* that are used to meet energy needs.

Global mega-trends, economic and geopolitical including population growth and the aging population, precipitous urbanization, and continued technological advancements are having disruptive effects on the global energy mix. These trends have begun to strain the planet's resources as well as exhausting the carbon budget with a steeper demand curve than projected 35 years ago when "global warming" broke into global consciousness with NASA testimony to the U.S. Senate; *"Global warming has reached a level such that we can ascribe with a high degree of confidence a cause-and-effect relationship between the greenhouse effect and observed warming…In my opinion, the greenhouse effect has been detected, and it is changing our climate now." (Dr. James Hansen, then director of NASA's Institute for Space Studies).*

Globally, fossil fuels (oil, coal, and natural gas) are the principal suppliers of the energy mix. In 2019 over 80% of the world's energy consumption is attributed to fossil fuels. The power generation mix – the primary sources that support power/electrical generation - are also dominated by fossil fuels.

About 75% of global GHG comes from fossil fueled emissions for energy. Driven by what is projected to be a doubling in global electricity demand and by the preference for fossil-based energy production around the world (by cost, efficiency and reliability measures) a clean energy transition has begun in the power and energy industry. Responding to the opportunity for transitional decarbonization technologies, low carbon ventures can meet the growing demand while concurrently reducing GHG emissions. Decarbonizing the power sector with carbon capture can result in a 90% reduction in greenhouse gases. Emissions across the full value chain of these low carbon ventures will be 'net zero'.

Gernot Wagner, Associate Professor at the Department of Environmental Studies at NYU wrote in *Climate Shock, "It has become imminently clear that there is simply no way to decrease CO_2 emissions without capturing (the) CO_2 that is part of the fossil fuel supply chain"*. Dr. Wagner was referring to carbon capture, a suite of low carbon technologies with technology readiness to "capture" GHG emissions – specifically CO_2 – from both the atmosphere as well as from the source of fossil fuel emissions.

Carbon Capture

Carbon capture is the singular most important technology in climate mitigation plans, globally. Carbon capture technologies allow for the use of fossil fuels in a sustainable way and in cooperation with climate goals for 2030, 2040, and 2050. As of the writing of this paper, there are nearly 350 coal-fired power plants in pre-construction phase, globally. Multiple sources have underscored the necessity of the deployment of carbon capture projects in conjunction with these new builds. A coal-fired power plant with carbon capture technology on new construction as well as retrofitting all existing fossil-fueled power plants could be the most significant step to decarbonizing the global power and energy sector by 2050.

The Great Plains Institute estimates that there are more than 400 near- and medium-term carbon capture opportunities in the U.S. alone today. These projects are increasingly important in delivering the required reductions in carbon emissions domestically, further restraining global carbon emissions. To meet the Paris Agreement goals, it is estimated that large scale deployment of 2,000 carbon capture sites are needed to be operational by 2040. This deployment would include new construction as well as the retrofit of existing fossil-fueled sites, preventing nearly 4.4 gigatons of CO_2 from entering the earth's atmosphere.

In consideration of both economic and environmental realities and constraints, it is imperative to apply efficient and suitable technology for carbon capture with low operating cost and energy consumption on new construction. And, to retrofit existing coal-fired plants with carbon capture technologies.

Types of Carbon Capture Technologies

Direct Air Carbon Capture

Direct Air capture (DACC) is the removal of CO_2 directly from the atmosphere and not from an industrial source (point source). This technology captures CO_2 directly from the air using large fans that act as a giant vacuum, literally sucking ambient air into the fan, through a physiochemical process whereby the CO_2 is pulled through a filters, adsorbed by chemicals producing a stream of CO_2 which is then contained. No other carbon capture technology can remove GHG or draw down the CO_2 currently in the atmosphere. All other carbon capture technologies are ‘point source’ technologies that remove emissions from a power or manufacturing facility.

DACC’s outstanding value proposition is its unique ability to reduce existing atmospheric CO_2. Further, the technology is easily transportable. This system can be set up virtually anywhere. The disadvantages are as substantial – if not more – than its benefits. The disadvantages include the substantial water input that is required raising questions of the sustainability of long-term use DACC. There is a high amount of energy required to run this process. The substantial energy requirements raise serious questions of downstream environmental challenges. A proposed benchmark for carbon capture technologies is that *the amount of CO_2 removed by the process must exceed the amount of CO_2 emitted by the process over the entire life cycle of the process*. DACC technology would not meet this benchmark unless renewable energy powers the fans. DACC is net CO_2 additive without renewable energy sources. Should DACC utilize renewable energy sources the land usage for that energy would be massive. Finally, the high cost of energy utilized in the operations of DACC is a primary reason why it is the most expensive of the carbon capture technologies.

DACC is the carbon capture that is most recognizable to the public. The beneficiary of an astute public relations and marketing teams through endorsements and investments from celebrities in business, DACC companies have become well known through popular media while other forms of carbon capture are largely limited to publications in academia and research.

Post Combustion Carbon Capture

The most mature of the carbon capture technologies, post combustion carbon capture (a ‘point source’ carbon capture) technology is utilized in relation to the combustion process in power plants and industrial facilities that use fossil fuels. When fossil fuels are burned for energy to run the plants the additional substances created include water, carbon dioxide, particulate matter, heavy metals, and acidic gasses. These substances are the emissions vented into the atmosphere as flue gasses.

PCCC removes CO_2 from the flue gasses; after burning (post-combustion) the fossil fuels. CO_2 is scrubbed out of the flue gasses by either membranes or solvents. Most carbon capture technologies operating today are post combustion. And most of the PCCC technologies are “retrofit” which means they have been added to existing power or industrial facilities as opposed to “new build” power or industrial facilities. While “point source” carbon capture technologies are more efficient than DACC this “end-of-pipe” process, PCCC – like DACC – is energy intensive giving it a high efficiency penalty and making it less efficacious and more costly when additional fuel is taken into consideration.

Oxy-Fuel Combustion Carbon Capture

Also, a ‘point source’ carbon capture technology, oxy-fuel combustion carbon capture applies a relatively simple concept in which substantially pure oxygen is substituted (in the combustion process) in the place of ambient air. Oxy-fuel combustion with recycled flue gas was first carried out by the International Flame Research Foundation (IFRF) at a pilot scale in the 1990’s. Subsequently, air separation technology has made considerable progress, promoting oxy-fuel combustion as it becomes a viable option for carbon dioxide capture in the industry. Oxy-fuel combustion provides a promising option for achieving higher CO_2 removal and lower pollutant emissions. The Air Separation Unit creates near pure oxygen which is then used in the combustion process to oxidize the fossil fuel. The resulting flue gas contains primarily CO_2 and water vapor with smaller amounts of oxygen, nitrogen, and sulfur oxides. A significant reduction (approximately 60%) in the formation of nitrogen oxides (NOx) emissions can be achieved for oxy-fuel combustion, due to the absence of N_2 in an oxidant stream. Oxy-fuel combustion provides a more concentrated stream of CO_2 than other carbon capture technologies. And the more concentrated the stream of CO_2, the higher the efficiency and the lower the cost of capture.

Oxy-fuel has been used in industrial furnaces with success primarily because this process decreases the volume of fossil fuel required. The industrial furnaces run at much higher efficiencies and generating ultra-low emissions. Transformation to a sustainable energy system with low greenhouse gas emission is far less challenging with oxy-fuel combustion carbon capture than any other technology in the carbon capture suite because of these lower costs and efficacy improvements.

A Business Case for Carbon Capture

In 2019, PricewaterhouseCoopers estimated that early stage investing in ‘Climate Tech’ (technologies to mitigate climate change) exceeded US$16.1 billion. Less than a year later, and in the middle of the roiling economy of the pandemic, Goldman Sachs estimates the ‘Clean Tech’ infrastructure to be US$1 trillion through public and private collaboration. The market size for carbon capture and the accompanying applications of Utilization and Storage exceeded US$2.3 billion with estimates as high as US$5.6 billion by 2026.*(Bloomberg)* Investors are taking advantage of the disruption in the traditional utilities industry and are targeting climate technologies for their growth opportunities.

Previously identified as too-costly, tax incentives and policy initiatives are creating a credible near-term investment opportunity and are key in the maturation of a carbon-free energy infrastructure. The lowest cost applications for carbon capture utilization and storage (CCUS) are the industrial processes that emit highly concentrated CO_2 streams. These applications require relatively little energy or equipment to isolate and capture emissions. These applications typically cost less than $30 per ton versus the higher cost processes at more than $50 per ton. Oxy-fuel carbon capture, as explained below, is the most efficient in the suite of carbon capture technologies.

The creation of value in CCUS technologies will be found in the Utilization. Sequestration is pure cost. The value of sequestration is best posited as a societal value much as waste and water management. Early adopters of Utilization opportunities will enjoy a marketing benefit from the implementation of processes ranging from enhanced oil recovery to mineralization. Further, establishment of ‘Clean Tech’ and ‘Climate Tech’ will lead to net job creation up and down the value chain. Capital allocation will experience a drastic shift as organizations re-allocate assets in response to carbon pricing.

Among all Utilization opportunities, enhanced oil recovery (EOR) offers the most value, accounting for approximately 90% of all CO_2 utilization today. The associated revenues from oil fields (increasing productivity from 30% - 60%) make EOR economically attractive.

Jupiter Oxygen Corporation - Transitional Technology for a Zero Emission Future

Jupiter Oxygen Corporation is a privately held company in Chicago that has patented an innovative carbon capture technology to capture CO_2 emissions at the source. With *near zero* emissions, our technology offers a viable solution to address emissions control from fossil fueled power generation sources. We are leading the application of oxy-fuel carbon capture technology worldwide.

In the 1990’s, Jupiter Oxygen conducted experiments with the use of oxygen in industrial melting furnaces. Knowledge from these experiments let to a new technology for combustion and burner systems for the oxy-fuel combustion process that had been used in industrial plants for decades. The results are dramatic; a 78% reduction of natural gas fuel and a waste oil fuel usage reduction as high as 68%.

The unique oxy-fuel technology was then transferred from industrial melting furnaces to fossil fuel steam generates and power plants, focusing on efficiency and emissions benefits in cooperation with the U.S. Department of Energy and its National Energy Technology Laboratory.

Our technology features significantly in every low carbon scenario resulting in an economically efficient and carbon neutral energy supply. Our pragmatic and practical approach will augment the environmental benefits at Near Zero emission power plants. Positioned to be first-of-a-kind carbon capture in Wyoming, Jupiter Oxygen has a valuable role in unlocking the profitability of carbon capture.

Our Advantages

- We provide capabilities to generate energy from fossil fuels with near zero emissions providing 99+% decarbonized electrical generation. Virtually emission free power production.
- The increased heat in our combustion process with near pure Oxygen allows for the capture of not only CO_2 but Nitrous Oxides, Sulfur Oxides, Mercury, and Particulate Matter.
- Our technology creates more efficient heat transfer for industrial furnaces with moderate process temperatures. Improved efficiency is due to elimination of airborne nitrogen, more radiant heat transfer, and longer gas residence time.
- Our high flame temperature oxy-combustion technology offers fuel efficiency gains in the boiler and latent heat recovery for additional efficiency, as well as process water reuse.
- Parametric studies performed to determine the optimal performance conditions and to generate the necessary technical data required to demonstrate our technology substantiate the technology is viable technically and economically at levels not yet achieved by other carbon capture technologies.

- Jupiter Oxygen Corporation's technology is, in general, at a higher level of maturity and is a simpler concept compared to other more novel technologies suggesting a buffer against the growing divestment from fossil fuel investing.
- We are targeting smaller scale fossil fueled units to retrofit with our technology. This will significantly lower the overall capital cost expenditures, reducing financial hurdles that would be found in new build fossil fueled power plants.
- Jupiter Oxygen's timeline represents one of the fastest to market of the low-carbon advanced coal technology allowing it to capitalize on the existing 45Q CO_2 tax credits.
- Our cost of capture and EOR application offers price efficacies far superior to membrane, solvent, or direct air carbon capture technologies.
- Given the nascent state of development of many renewable energy technologies, our speed to market provides an immediate solution for climate change mitigation and offers a competitive advantage in the growing low-carbon economy.
- Jupiter Oxygen is partnering with some of the most progressive engineering and energy companies with a combined focus of meeting the rising energy demand with our innovative technologies.
- Our innovation and the scaling up of our decarbonization technology has led to major reductions in the cost of our technology, the primary challenge in any carbon capture demonstration project.

Milestones

- Jupiter Oxygen is the project owner, director, and technologist for the High Flame Temperature Oxy-Fuel Combustion carbon capture project at PacifiCorp's Dave Johnston Power Plant in Glenrock, Wyoming.
- Our patented technology has undergone rigorous testing at our Hammond, Indiana Pilot Plant while working with the U.S. Department of Energy over a ten-year period. Our technology is ready for full scale demonstration at an operating coal-fired plant (TRL 6).
- Our nimble operations have fast-tracked our carbon capture technology through Feasibility Study to FEED Study of Retrofit of a Coal-Fired Electric Power Generating Unit with a vital CO_2 off-take market.
- A Feasibility Study was completed in 2018. A Front-End Engineering and Design study began in February 2020 and is scheduled to be completed in June 2021. This FEED

study will ultimately lead to a complete plan to build the largest oxy-combustion CO_2 capture facility in the world and to demonstrate a viable cost-effective strategy for retrofitting existing coal-fired power plants with low-carbon, poly-generational technology.

- The proposed demonstration project involves the engineering and construction of a carbon capture utilization and storage (CCUS) facility involving the retrofit of PacifiCorp's Dave Johnston Unit 2 to oxy-fuel combustion with carbon capture for delivery of CO_2 to a nearby oil field for CO_2-EOR long term operations.
- Our demonstration project will capture the power plant emissions, purify, and deliver the CO_2 to an oil field approximately 10 miles away. The CO_2 will then be injected in the oil field for enhanced oil recovery, a proven means of producing residual oil from older and depleted oil fields that would otherwise be stranded when using convention oil production techniques
- Following successful deployment of demonstration, Jupiter Oxygen's plan is to further deploy its oxy-combustion carbon capture technology as a retrofit to existing fossil-fueled units throughout Wyoming, the U.S. and abroad.