

Event Name: CO₂ Capture, Utilization, and Storage (CCUS) Briefing
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Speakers: Hitoshi Kaguchi, Member of the Board, Executive Vice President, CSO,
President and CEO, Energy Systems
Makoto Susaki, Leader of CCUS Business Taskforce, Growth Strategy
Office
Shuji Hori, Subleader, CCUS Business Taskforce, Growth Strategy Office

Questioner 1

Q: Please answer these three questions: 1) What is the significance that heavy equipment manufacturers are involved in CCUS? 2) What comprises the largest portion of the high costs indicated on page 6? 3) Is there any room to reduce costs?

Susaki: 1) (Rather than speaking about heavy equipment manufacturers generally) allow me to explain the significance of MHI's involvement in CCUS. MHI has completed several commercial-size CO₂ capture plants which use proprietary liquid CO₂ absorbents (KS-1™ and KS-21™) in an MHI original process (KM CDR Process™). I believe that our ability to use this technology to contribute to the global Carbon Neutrality effort is one motivation for our involvement. MHI can also provide many components within the CCUS supply chain, including compressors, CO₂ capture and liquefaction systems, gas tanks, ships, CO₂ capture plants, and CO₂NNEX™ (a CO₂ logistics visualization platform that MHI is developing jointly with IBM Japan).

2) It is difficult to give a general answer regarding costs, but when treating exhaust gas after combustion, the concentration of CO₂ is at most around 10%. We need equipment large enough to be able to pass all of this low-CO₂-content exhaust gas through liquid CO₂ absorbents. The sheer size of this equipment drives up construction and operating costs, which account for most of the total cost.

3) It is difficult to provide specific figures for cost reductions, but we expect costs to decrease by at least 30% due to economies of scale and standardization as the number of plants increases. Technical innovation will be needed to achieve cost reductions beyond this level.

Q: Are we to understand that total CCUS costs will drop by 30%?

Susaki: 30% refers to the costs incurred by the construction and operation of the CO₂ capture equipment. The entire CCUS system requires a variety of equipment and processes, such as transport via pipeline, ship, land/rail, and other means, liquefaction, and storage, and MHI alone cannot commit to a 30% reduction in total costs at this time.

Q: You mentioned that at present, capture and transport almost exclusively involve bilateral transactions between CO₂ emitters and end-users. When do you expect to see positive effects from MHI's offering a variety of products?

Susaki: I believe it will take around five years for markets to get off the ground in areas where storage sites have been established and for attempts at commercial operation to begin.

Questioner 2

Q: Regarding MHI's CCUS R&D organization, I understand that a CCUS Taskforce is working within your Growth Strategy Office. How many people are on this taskforce? Also, page 5 indicates that the expected size of the CO₂ capture market is 6 trillion yen in 2030 and 10 trillion yen in 2050. What were your assumptions when making these forecasts?

Susaki: We established a CCUS Taskforce within the Growth Strategy Office at our Japan headquarters, and the members of this team (approximately 10 in all) are leading CCUS efforts within MHI Group. Our subsidiary, Mitsubishi Heavy Industries Engineering Co., Ltd. is in charge of CO₂ capture technology and business development, and they have around 100-120 staff working in these areas. At Mitsubishi Shipbuilding Co., Ltd., around 20 people are involved in the development of liquefied CO₂ carriers. Finally, 20-30 people are working on carbon capture at the MHI Research & Innovation Center, which brings the grand total to around 150 people across the entire organization.

Hori: To answer your second question, the graph and table on page 5 are based on data published by the Japan Ministry of Economy, Trade and Industry (METI). The International Energy Agency (IEA)'s World Energy Outlook 2017 report includes breakdowns of minimum CO₂ capture volumes by year and decade, and we calculated market size by multiplying these figures by the cost of CO₂ capture and transport. My understanding is that this includes all capital expenditures and operating costs related to CO₂ capture.

Q: Are we to understand that carbon emission trading system planning and market size forecasts are still well into the future?

Hori: I don't believe we can draw any conclusions about that topic from this data.

Questioner 3

Q: Allow me to ask about the size of the CO₂ capture business. How much would it cost to build a plant that captures 1 million ton/year of CO₂? Costs may decrease in the long term, but how much revenue, for example, would 2 billion ton/year in CO₂ capture plants produce today? Also, please tell us about expected revenue levels and opportunities for CO₂ capture other than plant construction, such as monetization of CO₂NNEX™.

Susaki: The total construction costs required to build a 1 million ton/year CO₂ capture plant vary according to location, utility supply method, status of pipeline installation, and plans for CO₂ transport. That said, according to information from the U.S. Department of Energy and other sources, CO₂ capture costs around US\$60-70/ton as of 2020.

Q: Would the total cost to build a million-ton-class plant be around 10 billion to a few tens of

billions of yen? Please also give us an idea about future cost reductions.

Susaki: I believe that construction costs would be around the figure you mentioned. In the future, we will need to reduce costs by 20-30%, and we will need to pursue various initiatives to achieve this, including further technology development.

Questioner 4

Q: MHI's vision for 2030 includes creation of 300 billion yen in revenue from hydrogen, CCUS, and other new businesses. How do you imagine MHI's CCUS revenue will increase from now to 2025-30?

Kaguchi: As hydrogen businesses require time to develop and validate new technologies, we believe that CCUS will take the lead in new business revenue creation. More than half of the 300 billion yen target for 2030 is expected to come from CCUS-related businesses. We believe that CCUS will comprise the majority of new business revenue in 2025.

Q: Currently, the KM CDR Process™ makes up 70% of all CO₂ capture in the world. Please tell us your thoughts on MHI's positioning considering the competitive environment in the next five to ten years.

Susaki: We believe that it will be difficult to maintain our 70% global market share through 2030. This is because, in addition to forecasted rapid expansion of the market, each company has its own strengths and weaknesses in each region. That said, MHI hopes to maintain over 30% of the global market share in 2030, when the CO₂ capture business is expected to become established around the world. We are working to develop and improve our technologies to achieve this.

Q: According to reports from think tanks and other organizations, Europe remains the most promising market for CO₂ capture, followed by the U.S. Could you please tell us about your sales organizations in Europe and the U.S.? Also, in order to promote CCS in Japan, I believe that changes to a variety of laws and regulations will be necessary. Other than deregulation, could you tell me what kind of guidance you would like to receive from the government in Japan and how you are making such requests?

Susaki: The U.K. is poised to emerge as the first country to establish a CO₂ capture market, and MHI has posted some CCUS sales representatives from our Japan headquarters to our London office. Regarding policy in Japan, I think that storage represents the biggest challenge. I believe that it is necessary to build relationships with other Asian countries especially using Japanese technologies and economic cooperation, all of this as a part of the Asia CCUS Network, in which METI and other organizations are currently participating. However, we likely will not be able to realize this for some time.

Q: Would you say that it is more important to focus on obtaining orders internationally than

within Japan?

Susaki: We expect that CCUS projects in the U.K., the rest of Europe, and the U.S. will launch sooner than those in Japan, and we will share the results of these first projects with our teams in Japan. This doesn't mean that Japan isn't a priority for us, but we will proceed according to each project's timeline.

Hori: I would like to add that we recognize Japan as one of several countries whose governments are focusing on carbon recycling (CCU), and we in turn need to focus on how much incentive can be offered. MHI hopes to expand the CCUS market using our CO₂NNEX™ platform to add carbon recycling to the mix.