

Event Name: Carbon Neutrality Briefing

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Speakers: Eisaku Ito, Executive Vice President & CTO
Masayuki Suematsu, Senior Vice President, Head of Business Strategy Office

Questioner 1

Q: I believe your company plans to focus primarily on the CO₂ solutions ecosystems first. For example, what is the overall size of Energy Transition businesses in the current fiscal year? Also, will the engineering of CO₂ capture systems be the main focus for the time being? Regarding CCUS, I have heard that where to put the carbon dioxide after it is captured is an issue. Will the business grow dramatically through the conversion and utilization of collected CO₂ into CO?

Ito: We believe that the initial focus will be on large carbon capture systems which will be sold to electric power utilities and chemical manufacturers, and we are aiming for ¥50 billion in revenue in 2023. From there, we plan to expand our small to mid-size CO₂ capture systems to all industrial sectors. As small businesses lack the resources and know-how necessary to operate CO₂ capture systems, we are planning to start a business where MHI Group delivers and replaces CO₂ absorbent. Internally, we are calling this our “Duskin business,” after Japanese company, Duskin Co., Ltd.’s mop service business. Duskin distributes mops to households, collects the dirty mops, washes them, and delivers new mops the next month. We believe that by doing business in a similar way, our customers will be comfortable with using our systems due to our large knowledge base regarding CO₂ capture system operation. Moreover, we are also considering providing a lineup of modular CO₂ capture systems which MHI would operate remotely. We would like to expand the scale of our business in these three areas: 1) Large, commercial facilities, 2) the Duskin-type service business, and 3) Remote monitoring of thousands to hundreds of thousands of CO₂ capture systems.

Q: I do not believe that there is any CCUS revenue now, but am I correct in understanding that you will first expand to ¥50 billion in revenue in FY2023, and then grow the business with the Duskin-type service business and remote monitoring?

Ito: Currently, we are responding to a great many inquiries and are working on the engineering. It will take several months to finish this process, and then we will shift to plant construction, so revenue recognition will begin shortly after that.

Suematsu: We understand that FY2021 will be nominal in terms of revenue. However, we are receiving a great number of inquiries from around the world, so we feel confident in our target for FY2023.

Questioner 2

Q: I heard previously that you have implemented a pivot development system. Please share any examples you have of how product development was linked to R&D.

Itō: We began using the pivot development process in FY2021. Pivot development is a system whereby researchers at our Research & Innovation Center propose technologies related to the Energy Transition or Carbon Neutrality that they are interested in, formulate hypotheses, and then test those hypotheses themselves. We encourage our researchers to complete their hypothesis and testing cycles faster than a start-up would.

MHI has over 500 products, and we recently reorganized the technical fields within our Research & Innovation Center into 600 areas. We are constantly optimizing our technology portfolio, and we are working to incorporate more new topics in the fields of physics, chemistry, and mathematics. Even in the cases of seemingly difficult new product development, around 80% to 90% of the development is often already covered by existing MHI technologies, so that in effect only 5% to 10% of the new development is completely new. We are working to quicken the pace of development on this remaining 5-10%, and in some cases we are able to make a prototype in as few as three months to confirm the design.

One specific example of pivot development at work is the high-temperature heat pumps mentioned in today's presentation. By combining heat exchanger and coolant compressor technologies from heat pump products in our HVAC business with compressor technology from our Gas Turbine and Turbocharger businesses, we were able to develop a new product extremely quickly.

Q: I think that human resource strategy is important for effective R&D. How do you manage your personnel? If you have any specific KPIs, could you share them with us?

Itō: In terms of human resource utilization and efficiency, the leaders of each technical area and I meet regularly to discuss development activities. By involving people from our Research & Innovation Center, IT, Value Chain HQ, and other departments in these discussions, we have established a system that allows for us to develop technologies quickly. We do not manage our R&D human resources with any particular KPI.

Q: Is ¥2 trillion in investment in Carbon Neutrality enough? Or is it the case that the ¥2 trillion amount is the result of optimization of your R&D processes? Please explain your thinking on the investment amount.

Itō: By increasing the ratios of R&D and investment and focusing investments in the area of Carbon Neutrality, we are planning to proceed with development in an efficient manner. We have prepared a system that allows us to immediately work on various

proposals as they emerge, and at this point, we believe that with this amount of money, we will be able to release products more quickly than our competitors.

Questioner 3

Q: Regarding the breakdown of ¥300 billion in revenue forecasted in FY2030, what ratio do you envision first of all between domestic and international business? Please also let us know your forecast, if any, for profit margins. Could you let us know if the ¥300 billion in revenue consists mostly of components or equipment, or if it will be in large part from after-market services or licensing?

Itō: Regarding large-scale CO₂ capture systems, I believe they will be deployed starting outside of Japan, where there are suitable sites for CO₂ storage. The CO₂ Capture as a Service (CaaS) business (a business covering CO₂ capture, collection, storage, and conversion/utilization) using small to mid-size systems will target all industrial sectors, both domestic and international. As for profit margins, we have not performed any estimates yet, but I believe that we will be able to provide customers who have begun considering environmental value with economical decarbonization technologies in all areas. Many companies have established internal carbon pricing programs and view efforts to reduce CO₂ emissions as necessary cost. We believe that our customers will see value in converting the money they have spent decreasing CO₂ emissions into an increase in their profits by adopting our technologies. These customers, we think, will purchase our technologies at a price commensurate with the value we provide to them.

Questioner 4

Q: Regarding small, modular CO₂ capture systems, I believe that, similar to large-scale systems, cost reductions is an issue. Please let us know what the current challenges are and timeline for solving them.

Itō: We believe that small, modular CO₂ capture systems will be first adopted by customers who place a particularly high value on environmental issues. For example, apparel or food product manufacturers sell to individual customers and are therefore very environmentally conscious, and such activities can enhance the brand value of their products. I think the key challenges are whether initial costs of installation can be lowered and whether operating costs can be lowered with efficient operation. I believe that we will be able to reduce the cost to the customer by preparing a lineup of standardized systems according to the volume of CO₂ capture and by providing remote, optimized operation services.

Q: I believe that economics will also be a topic of debate regarding the replacement of GT combustors during hydrogen firing retrofits. Could you let us know, for example, if you

have any target for the amount of investment that would be required to retrofit a 1 GW-class gas turbine?

Ito: Regarding a 100% hydrogen firing retrofit of a heavy duty gas turbine, I cannot talk about the price, because the technology is still under development. However, if we take the typical example we have seen so far, I believe the price of a hydrogen combustor would be 10-30% higher than existing products. If technological development progresses rapidly, and we are able to standardize the combustor, the price should not be much different from that of hardware being purchased by our customers today. Also, turquoise hydrogen is very economical, and we believe it to be the lowest-cost hydrogen production method that does not emit CO₂.

Questioner 5

Q: I personally believe that the geopolitical conflict between Russia and Ukraine may be a major turning point in the trend toward ESG and decarbonization. How does MHI view the current changes in global affairs, and what discussions are you having internally?

Suematsu: We are aware that geopolitical uncertainties have been increasing. However, we do not believe that the move to the Energy Transition will change as a major trend. There may be large changes to the route to achieving Carbon Neutrality, but we believe that this may present new opportunities to MHI, which has a diverse product lineup that is able to meet the needs of all regions.

Questioner 6

Q: The technology development roadmap in your presentation materials does not include ammonia or Direct Air Capture (DAC). Please let us know the timeline for these technologies.

Ito: Due to space limitations, I have limited my explanation today to hydrogen development. However, we are also steadily advancing development of ammonia technologies, including mixed and 100% ammonia combustion in coal-fired boilers. For Gas Turbine Combined Cycle (GTCC), we are developing systems to use waste heat from exhaust gas to separate ammonia into nitrogen and hydrogen and fire the hydrogen in the gas turbine, as well as direct combustion of ammonia. As for DAC, CO₂ can be recovered from all sources. We are considering this as well, although it will probably be on a smaller scale at first.

Q: MHI is a leader in liquid CO₂ absorbent, but I read an article saying you will use a solid adsorbent for DAC. Is this true?

Ito: There are various methods of CO₂ capture available, and we are considering all methods, including liquid and solid. Other than liquid absorbents, we also have solid adsorbent technology.

Q: Is there any possibility of using solid adsorbent technology for CCUS?

Ito: It depends on how far advanced each technology can be developed. We will use the most suitable technology available at the time.

Q: 2030 is also the target year of the Japanese government's 6th Strategic Energy Plan, which aims to halve the proportion of fossil fuels from about 80% to 40%. If renewable energy increases, then revenue from some of your existing businesses will have to decrease. Which businesses will see decreased revenue, and how large will the decreases be?

Ito: New coal-fired thermal power plant installations will be difficult going forward, so revenue from that business will decrease. That said, we believe that some of this decrease will be replaced by fuel conversion, which is under development. Regarding gas turbines, this business is projected to grow steadily mainly in the area of hydrogen-fired plants, so I do not think that there will be much of a decrease.

Q: Do you think that Turbocharger business will decrease during the shift to EVs?

Ito: We are forecasting that even in 2040 or 2050, internal combustion engine vehicles will remain in considerable volumes, so we would like to secure revenue for turbochargers for these vehicles. Also, we are moving forward with the development of electric car air conditioners (battery-run air conditioners which can be used at low temperatures or a wide range of temperatures and which use our HVAC technologies) for use in EVs.

Questioner 7

Q: During your presentation, you stated that MHI will invest ¥2 trillion in Carbon Neutrality through 2030. Is this the 9 years starting in FY2021? If the amount of investment per year remains at ¥300 billion, which type of investments will you reduce in order to increase Carbon Neutrality-related investments? Also, what kind of investments do you expect to increase in the future, and would that include New Mobility & Logistics, for example?

Ito: The period of investment is the 10 years¹ from FY2021-2030. In terms of the breakdown, we are considering decreasing traditional capital expenditures and increasing the ratio of R&D and investment. Also, for New Mobility & Logistics, there are

¹ During the briefing, Mr. Ito responded that the period was 9 years, but the correct number is 10. We have corrected the figure in these minutes.

many items related to Carbon Neutrality, which are a little difficult to classify. Some of these are included in the Carbon Neutrality-related investments I mentioned during my presentation, while some are not.

Suematsu: The decrease in capital expenditures, which accounted for the majority of investments during the 2018 Medium-Term Business Plan (MTBP) period, and the increase in R&D and investment during the 2021 MTBP is based on the idea of obtaining results by investing in partners operating in areas where we do not. New Mobility & Logistics is positioned as the decarbonization of the electricity demand (use) side, which, in addition to the supply side, will be an integral part of achieving Carbon Neutrality. The portion of investment for decarbonization initiatives within New Mobility & Logistics is counted within the Carbon Neutrality-related investments portion.

Q: Could you explain the reasoning behind reducing capital expenditures? Also, what areas will see decreases from the 2021 MTBP period onward?

Suematsu: We made large investments in Commercial Aviation during the 2018 MTBP. Shifting the focus of our investments naturally resulted in the breakdown we presented today.

Questioner 8

Q: You are planning to increase investments, but what specifically will you be investing in? For example, are investments in start-ups with elemental technologies included in this?

Suematsu: Investments in start-ups are included in this. M&A are also a possibility if we invest with the intention of obtaining a majority interest. We also envision many minority investments including partnerships. We will work together with partners in areas in which we are not able to operate on our own.

Q: Do you have any specific idea of the scale of areas that you can operate on your own and those that you cannot?

Suematsu: I think that there will be a need for a variety of partnerships in New Mobility & Logistics.

Q: You mentioned that Yokohama Hardtech Hub (YHH) will play a role in Energy Management Systems development. Since the establishment of YHH, have there been any changes in the results obtained from the various initiatives or in the positioning of the facility?

Ito: When YHH was first established, its purpose was to be a base of operations for a variety of hard tech start-ups. Recently, however, we have increasingly used YHH as a proving ground for research topics that have arisen during our pivot development

activities. One example is of this is Energy Management. Also, during the validation of micro data center technology, representatives of many companies operating in related fields as well as customers have come to see the prototype, and we have received many hints about new business prospects from them. Pursuing development ourselves allows us to directly identify technical challenges. Even in cases where though we thought there would be no technical problems, we have found supply chain issues. By pursuing development by ourselves and exploring new areas while also having customers come to visit the facility, YHH has evolved as a place where creative collaboration can flourish. To share some other internal initiatives we are pursuing at YHH, we are working increasingly on automated logistics systems, automated distribution centers, and remote operations.

Questioner 9

Q: Regarding the CO₂ solutions ecosystem, you explained in your presentation that you can capture CO₂, but the fact that there are no uses for it is hindering expansion of the CCUS market. Where do you see CO₂ in 2030? Also, how will you dispose of the CO₂ collected by the CaaS business?

Itō: How to use captured CO₂ is seen as a very difficult problem, both globally and technologically. We are proposing ways of utilizing CO₂ which leverage a variety of MHI Group technologies. One example is using CO₂ to produce CO, which can be used in many industries. CO can be used as a reductant in the iron and steel industry, as an ingredient in chemical products, and as an ingredient for oil. We believe that synthesized oil can be effectively utilized as Sustainable Aviation Fuel (SAF). A large carbon cycle where CO₂ is collected from waste-to-energy boilers and food product or textile factories, converted to CO, used as SAF, and re-captured as CO₂ will likely be a very big business. To provide some more detail on SAF, I don't remember the exact figure, but I think the size of the aviation fuel business is around ¥20 trillion, and the aviation industry says it will cut CO₂ emissions in half by 2050. That would mean replacing at least half of all aviation fuel with SAF. As customers will likely purchase SAF at a higher price than kerosene, the current aviation fuel, we believe the scale of this business will be very large. We are planning to develop many such areas.

Q: You mentioned that MHI will begin the CaaS business in FY2024. What level will commercialization have reached by then?

Itō: We already have technologies that can be commercialized, but we need to make various preparations before we can actually sell them to customers. We project that will have already partially started this business in FY2024.

Questioner 10

Q: Regarding the ¥300 billion in Energy Transition-related revenue in FY2030, a note in your presentation materials says that this does “not include revenue from renewal/decarbonization of H₂ gas turbines, Nuclear Power, or other existing businesses, or New Mobility & Logistics.” What is the positioning of the Carbon Neutrality initiatives included in the ¥300 billion (hydrogen and CO₂ solutions ecosystems, etc.)?

Itō: Conventional gas turbines are included in the small bar graph on the left side of the graph on the same page (page 30 of the presentation materials) in the “Energy/Environment” category, and we plan to grow this area with mixed hydrogen combustion and other initiatives. Completely new types of businesses are broken out into four categories (Carbon Cycle, Factory Decarbonization, Hydrogen Solutions Ecosystem, and CO₂ Solutions Ecosystem) in the graph to the lower right.

Q: Would you say that the bar to the right side of this page represents your expectations for the CO₂ capture systems business?

Itō: We have indicated the expected portion made up by CO₂ capture systems in 2030, but we are now focusing development efforts on technologies that enable the exchange of CO₂, including nodes connecting the value chains of all industrial sectors. I believe that our ability to develop all of these technologies is where MHI’s strength lies. By releasing products and services that can be used in all industries, we envision that this ¥300 billion figure will grow considerably in FY2030 and beyond.

Q: What businesses in particular do you want to grow?

Itō: In the case of Carbon Neutral fuel, I believe that how large a share of the potentially over-¥10-trillion market that we can obtain by fuel produced with our gasifier technology will be of great importance. In the hydrogen solutions ecosystem, turquoise hydrogen will be a major piece of the puzzle.

Questioner 11

Q: Regarding CO₂ recycling in waste treatment, I think that synthesizing CO into chemical products is still technically quite difficult. Is this actually possible? Are there any areas that could potentially become bottlenecks for this process?

Itō: We are currently conducting research and development on this topic at our Research & Innovation Center, and many items are being pursued in parallel. Several of these are already at a fairly high level of technical readiness and have reached the level of prototyping as large-scale engineering systems. Just as in any chemical plant, optimizing the synthesis process could be a bottleneck. That said, we aim to optimize

the process by accumulating and leveraging our R&D knowledge base regarding selective reaction, increasing reaction efficiency, and effective chemical segregation. There are some compounds that we could synthesize with a certain level of efficiency if we were to set up a prototype system today.

Q: Earlier, it was explained that increasing the volume of CO₂ capture will be difficult until we gain a line of sight on how to utilize the captured CO₂. Does this mean that, as of 2030, CO₂ capture business size will increase ahead of the CO₂ recycling business?

Itō: Currently, we envision that CO₂ capture will get off the ground first. After that, areas that utilize the captured CO₂ will emerge, and we will commercialize those areas.

Q: When do you expect the scale of the CO₂ recycling business to reach the same level as that of CO₂ capture?

Itō: This includes some slightly sensitive information on technology development, so I would like to share that information at another time. Let me just say that we have arrived at a fairly good place in that regard.