Panel Discussion

Efforts toward Carbon Neutrality and Systems Thinking

Now, we are moving on to the panel discussion titled Efforts toward Carbon Neutrality and Systems Thinking.

First, let me introduce the panelists today.

Professor MATSUHASHI Ryuji, Director, Collaborative Research Organization for Comprehensive Energy Sciences, The University of Tokyo, will moderate the discussion with four panelists including:

Ms. MIWATA Yuko

Former Director, Energy and Environment Innovation Strategy Office, Ministry of Economy, Trade and Industry

Dr. MAEDA Seiji

Principal Project Manager, Hydrogen Business Department, ENEOS Corporation

Mr. EZAKI Tetsuhiro

Head of a section Development Strategy Promotion Department, Coastal Area International Strategy Headquarters, Kawasaki City

Dr. KUDOH Yuki

Deputy Director, Global Zero Emission Research Center, National Institute of Advanced Industrial Science and Technology (AIST)

So, Professor Matsuhashi, the floor is yours.

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Thank you very much for the introduction. I am Matsuhashi.

Please excuse me for remaining seated while moderating the discussion.

We appreciate your coming to the event in this poor weather.

Before opening the discussion, let me summarize the valuable presentations from the earlier program that may have made you understand deeper.

First, Dr. MAEDA from ENEOS introduced various significant company initiatives like GI projects toward carbon neutrality.

Second, Mr. Ezaki spoke from the municipality’s perspective on their carbon-neutral initiatives, managing the most advanced manufacturing and energy supply and demand area in Japan, in some sense.

Third, Dr. Ozawa from AIST talked about the scenario analysis applying the MARKAL optimization model and how energy will innovate toward achieving carbon neutrality by 2050 in Japan.

Although each entity is making efforts to achieve carbon neutrality on its own and collaborating with others to reach the goal, Dr. Maeda and Mr. Ezaki of Kawasaki City believe that they need to work towards total optimization as a collective entity. Dr. Ozawa from AIST also mentioned the same concept, with adoption of the total model.

The MARKAL model can be challenging for those who have never worked with it, including Mr. EZAKI and Dr. MAEDA. The model computes the total optimization based on every single cost information of various technologies that make up the Japanese energy system, which makes the model precise. In fact, the MARKAL model has a long history and I worked on this when I was a student, and I think it is great that AIST has taken it over and even developed it further.

Representatives from companies and governmental bodies are present today. Each organization may find it hard to sort out how its activity functions in the total optimization, for example, procuring materials like captured CO_2 or green hydrogen to produce ethylene, e-fuel, or e-methane. In the case of a power company, it may be unclear how much it would sell for electrolytic hydrogen-sourced electricity after all, as the company was required to switch its source partially to hydrogen due to the current restriction in the system. Similarly, the petrol industry may find it hard to grasp the cost of CO_2 to produce ethylene in the total optimization model.

You can pick up individual costs, such as hydrogen, CO_2, and finally produced ethylene, from the detailed and precise Dr. OZAWA's model calculated by mathematical constraint equations with shadow prices, only applicable for your information.
However, the model cannot avoid eliminating detailed information if a single model covers the entire country. For example, in a case from Kawasaki City, Company A sends CO_2 to Company B to produce something with hydrogen in the complex, but the model omits such details.
Likewise, the model does not include information on which petroleum refining facility ENEOS produces e-fuel synthesized with hydrogen from other areas. The model cannot be so specific as to reach that level.

If Kawasaki City pursues to achieve total optimization of the project locally, it must customize and develop the MARKAL model by itself, inputting detailed information, such as the amount of CO_2 transported and the pressure of the pipeline to the model.
This series of work will enable each company to learn the feasibility of its project in detail like the projects presented today.
In the meantime, stakeholders such as companies and governmental bodies can assess their project feasibility by checking if it meets the total optimization.

In my opinion, bridging between the total optimization and the stakeholder goals is key to achieving true carbon neutrality.
During today's discussion, one of the main themes is the total optimization mentioned repeatedly.
What it means to each of you is that you need to ensure consistency between the optimization and your projects to achieve carbon neutrality practically.
From my standpoint, what is important is that individual companies should maintain consistent and feasible plans toward social implementation for synthesizing and producing ethylene, e-fuel, and e-methane. The plans include the sources of CO_2 and hydrogen with the price.

So, without further ado, let me give you questions to four panelists, please.

First, this question is for Ms. MIWATA of METI, please.
You, METI, must ensure the consistency of the whole Japan and the consistency of the total optimization.
I believe the GI fund has already allocated a large budget for research and development. When it comes to discussing CO_2 and hydrogen recycling, there will be several companies, including power and steel manufacturers, who are willing to either emit or capture these gases. This will result in the introduction of energy or chemicals. Throughout this progress, it is important to coordinate efforts to ensure consistency between CO_2 emission and capture. Additionally, the progress calls for an enhanced analysis like Dr. OZAWA's MARKAL model developing individual customization.
However, the research on consistency analysis often struggles to secure adequate funding from the government compared to new research and development.

Now, could you please give us any comments on the chances of research funding from METI, considering even only one thousandth out of a big GI fund would work for it, to those who perform the consistency analysis, or maybe to Zero-emission Bay, for social implementation toward achieving carbon neutrality practically?
We have already discussed this repeatedly. I understand it is a harsh question, and we would appreciate your answer to the extent possible.

The next question is for Dr. MAEDA of ENEOS please.
As the energy tends to become electrified to some reasonable extent, including that of vehicles with the current of the times, as mentioned in Professor KASHIWAGI and Dr. OZAWA's presentation, the petroleum industry must be in a delicate position.
Apart from electrification, the petroleum industry would be willing to contribute to realizing a carbon-neutral society by developing liquid fuel or e-fuel with economic feasibility for supply. According to Dr. OZAWA, liquid fuel enhances energy security because it has the highest energy storage capabilities.
Could you please share your views on how much you expect the cost of hydrogen and CO_2 and any issues you have with e-fuel? In addition to that, can new fuels like e-fuel and jet fuel be adjusted with consistency

to the existing petroleum refining process, which has already been fully integrated and comprehensive, to satisfy the demand?

This is for Mr. EZAKI of Kawasaki City, please.
Kawasaki City has displayed the strong energy carbon neutrality initiative based on the local production and consumption. Especially, the advanced initiatives on hydrogen are so strong that one hotel has already applied plastic-sourced hydrogen energy through the pipeline. On top of this initiative, how will Kawasaki City lead it to social implementation from now on as a business after the demonstration stage, and could you please share with us how you manage the issues on the progress as an advanced local government?

The last question is for Dr. KUDOH of AIST, please.
Thank you very much for Dr. OZAWA's presenting the MARKAL model analysis, which is indeed nationally valuable.
I know Dr. KUDOH and Dr. OZAWA's group examine $LCCO_2$ while conducting cost engineering analysis. Besides the country-wide analysis introduced today, achieving carbon neutrality, in some cases, would require a customized approach that accommodates the specific needs of each company or local government.
Do you think more funding, for example from the government, would help Dr. KUDOH's group provide the industry and local governments with the MARKAL model, cost engineering, and $LCCO_2$ analysis more on an individual basis? Could you please give us your thoughts on this?

Starting with Ms. MIWATA from METI, could you, all four members, please answer the questions one by one?

Thank you very much. I am MIWATA from METI.
I would say that the global policy competition for investment in GX has recently intensified.
In this recent trend, METI plays a key role in realizing GX by promoting investment in private-sector companies.
In the process, it is METI's mission to provide a complete and sustainable picture of carbon neutrality. Based on this background information, the government has formulated the GX Promotion Act to realize and implement pro-growth carbon pricing. The GX Promotion Organization will lead this act, and the government plans to announce the GX Promotion Strategy by the end of July. The government takes a huge responsibility of allocating investments amounting to 20 trillion yen while considering the full image of the future, in which how we maintain consistency.

About the Zero-emission Bay project, performing regional analysis within the area would be one good example of optimization study from my personal point of view.
While MARKAL could be a good option for conducting analysis, there are various other methods available,

and METI cannot give you a clear answer at this time.

Thank you very much for sharing valuable insights that may provide clues for the future.

Now, I would like to hand it over to Dr. MAEDA from ENEOS, please.

Thank you very much.

The future of the petroleum industry is a critical concern, as you suspected.
ENEOS assumes it is a matter of life and death and prioritizes preparing for a world without gasoline, carbon-based fuel, after 130 years of supporting the value chain.

ENEOS aims to transition toward providing next-generation fuel and services through its platform, by leveraging the knowledge and expertise gained over 130 years of supporting the value chain, as outlined in our carbon-neutral plan. This approach is how ENEOS is creating business opportunities and actively working toward achieving carbon neutrality in the petroleum industry.

Decarbonization has once seemed to be the only way to achieve carbon neutrality. However, there should be room for carbon utilization, carefully using CO_2 in some way, such as through carbon recycling, which I mentioned in my presentation.
The petroleum and city gas industries face the same issue, and we have frank discussions about our future in the workings while sharing a sense of fellowship. According to the discussions, our mission is to effectively and reasonably supply carbon to material plants or others in the complex area.

E-fuel of the topic is another focus for us.
Generally, the Japanese government tries to make things electrified to the most through its big strategy.
Regarding vehicles on the topic, small cars are becoming electrified with heavy duties deploying hydrogen and e-fuel.
Jet aircraft are the biggest concern when discussing internal combustion engines.
Since all aircraft are inevitably equipped with internal combustion engines, how to apply e-fuel to SAF would have great significance.

Several simulation studies are currently underway. They indicate that the price of supply is dependent on how low the procurement price of hydrogen material can be suppressed, as hydrogen is the most influential component.

One project overseas, in which Porsche is involved, is producing synthetic fuel from DAC CO_2 and hydrogen generated by local wind power.

The project unveiled the e-fuel cost at 600 yen per liter, which seems too expensive for mobilities' widespread implementation, except for Porche owners, in my understanding.

Assuming hydrogen cost to be at the targeted 20 yen per Nm^3, the e-fuel can be approximately at the upper 100 yen per liter level (including tax), making the price more realistic compared with current gasoline at 170 yen per liter.
Anyway, what matters the most is how low the cost of hydrogen we can achieve.
Out of the e-fuel total cost of 200 yen per liter, 35 yen per liter is spent on production, and another 35 yen per liter is on CO_2 capturing. The cost of capturing CO_2 is calculated based on the current technology available. If we can develop more efficient and cost-effective technology in the future, the overall e-fuel cost will decrease.

Significantly, ENEOS can easily handle the captured CO_2 within the complex.
As the ENEOS petroleum refining plant is in the center of the complex, it has strengths in geographic conditions to have easy access to other chemical plants supplying and demanding materials now and ever. This infrastructure advantage encourages the supply of e-crude-based synthetic chemical materials that are produced from CO_2 or a combination of CO_2 and hydrogen.
The choice of where to capture CO_2 largely depends on the regional specialization of a plant. As a result, some plants may be more suitable for producing e-fuels than others.

The MARKAL model allows us to understand the overall optimization trend in Japan, and I agree with Professor MATSUHASHI that individual optimization is the key to achieving total optimization.

That concludes everything from ENEOS. Thank you.

Thank you very much for the beneficial information. I learned a lot from the comment.

Next, could I hand over to Mr. EZAKI from Kawasaki City, please?

In addition to the project Professor MATSUHASHI mentioned, Kawasaki City showed another world's first supply chain demonstration project today, and even other than those projects, the city is struggling to lead numerous demonstration projects to social implementation, feeling difficulties on the practical path.
The major challenge is the significant investment required for the social implementation.
As mentioned repeatedly, our responsibility should lie in the enhancement of predictability to companies who would make huge investment in implementation, unlike those in demonstration with a rather small scale.
No matter how hard it may be, Kawasaki City, as a regional government, is committed to providing companies with a road map directing to a clear future goal. Along with the road map, the city must build

an environment for companies' smooth project creation or progress while organizing laws and regulations, providing support, and securing land. On top of that, each project should correlate with each other regionally to make a good collaboration coordinated by a governmental body that Kawasaki City hopes to be.
That is the comment from Kawasaki City, thank you very much.

Thank you very much for all the specific information from the regional governmental perspective, such as future views and securing land.

Lastly, could you please show us your view, Dr. KUDOH?

I am KUDOH, who works with Dr. OZAWA at AIST on the model.
First, I must emphasize that the model's calculations are based solely on preconditioned data to achieve carbon neutrality. Therefore, the model only provides requirements for achieving carbon neutrality.
In my opinion, even with all expected technologies fully developed, it does not guarantee carbon neutrality. Negative emission technologies are desperate for carbon neutrality as described in Dr. OZAWA's presentation, and currently it appears the model relies too much on DACCS.

For example, as Dr. OZAWA showed in the last slide of his presentation, the outcome could be different if the model included technologies like hydrogen reduction steel and carbon recycled e-fuel, which the model has not done so far.

Total optimization models, including MARKAL, provide an overall direction from macro perspectives, as mentioned by Dr. MAEDA.
The model prepares multiple scenarios per each social or technological factor, offering alternative options when difficulty arises on its path. To make the scenario more specific, we would need to gather more detailed information, including where the scenario will be implemented, the level of demand, the cost of energy, and the unique lifestyles of individuals in each respective area. It is also worth considering that other models besides MARKAL may be more suitable for the scenario.

In connection with the LCA that Professor MATSUHASHI quoted, I would like to add that the MARKAL model indicates that hydrogen has no environmental impact, specifically the one we import. However, even blue hydrogen produced through CCS emits small amounts of CO_2. It is important to note that achieving carbon neutrality in a country like Japan, which has limited natural resources, would require importing resources and inevitably emitting CO_2 abroad on the way. The MARKAL model only calculated factors within the country, so we must also consider CO_2 emissions abroad that were not accounted for in the model.

For instance, hydrogen is currently under discussion by ISO regarding its environmental impact. We must monitor these discussions, otherwise, Japanese efforts toward achieving carbon neutrality could be given the cold shoulder by other nations across the globe. Therefore, we must remember that the LCA of hydrogen included all CO_2 emissions produced overseas, even in the energy supply chain.

That covers everything from me, thank you.

Thank you very much, Dr. KUDOH.
That was a precious talk to lead us to a future.

Japan relies heavily on overseas energy so far, and even after achieving carbon neutrality, the country will continue to import energy while also producing energy domestically.
In that case, we will need to address the challenges of how to manage the CO_2 life cycle and how the international community will perceive it.

We are running out of time and only have five-or- six minutes left. Could you all please give your comments each on another challenge, the standardization, in 1.5 minutes?
According to Mr. WATANABE, Director of the International Standardization Division, ISO standardization may boost technological development. Meanwhile, Dr. KUDOH mentioned a few minutes ago, that ISO may help Japanese technology gain international recognition as carbon neutral when the world does not identify the technology as such, despite our best efforts.
The standardization trend spreads across the energy industry, and ISO has already started shaping CCU standards.
One standardization is a strict restriction like the Revised Act on Rationalizing Energy Use, regulating each form of energy to contain a certain proportion of non-fossil, and the other is a less strict type like ISO standardization, setting criteria for proper carbon neutrality or CO_2 reduction.
Now, I would like to ask you the questions: How can technology be recognized as carbon neutral and achieve social implementation? What should be expected from governmental bodies or the country?
Could we begin with Ms. MIWATA, please?

Thank you very much.
I definitely agree with Professor MATSUHASHI and Dr. KUDOH on the idea that we must pay attention to the big picture of where to produce and store CO_2 globally instead of only making zero emissions domestically. True carbon neutrality will not be achievable without this global perspective, as Dr. KUDOH explained in his comment regarding blue hydrogen.

Japanese technology should importantly ensure its international acceptability when development is in progress due to its nature of interrelation around the world.

Standardization is another consideration when research and development is underway, as METI has expressed in GI fund explanation so far and here again emphasizes it not only for consideration but for practically leading to implementation.
METI finds standardization to be an indispensable effort for implementation.
Thank you very much.
And next, Dr. MAEDA please.

Thank you very much.
As METI has just stated, standardization is critical for international CO_2 management.
ENEOS plans to produce e-fuel and synthetic fuel domestically and abroad, while city gas companies will also produce e-methane likewise, and due to economic and quantitative reasons, reliance on overseas production of these energies may be necessary to a certain extent. Ideally, international rules or standardization should ensure our reduction efforts on imported e-fuel invested by Japan. Otherwise, more importantly, the accumulation of bilateral agreements like JCM credit should bring the society to make it happen.
That is all from me.

Thank you very much, and next, Mr. EZAKI, could we have your comment, please?

Based on our experience, we have come across a challenge where, despite being a local government, we need to be mindful of global trends in addition to focusing on our local efforts. This is crucial to ensure that our endeavors lead to achieving carbon neutrality at a local level.

In line with this, Kawasaki City has joined the Transitioning Industrial Clusters towards Net Zero initiative, led by the World Economic Forum, as presented. This is our international initiative for further intelligence gathering.

Putting all the initiatives together, Kawasaki City has drawn the local future vision, which may be subject to modification. Anyhow, the city is committed to creating a better activity environment for companies and will adjust the vision accordingly as progress is made.
That is all for my comment.

Thank you very much for the valuable comment.

And now, Dr. KUDOH, the floor is yours,

For the last ten years, AIST has initiated various projects to evaluate its technologies in parallel with technological development, toward achieving social implementation thoroughly.

As we discussed earlier today, it is essential to consider both individual and total models when evaluating technologies leading to carbon neutrality. Similarly, AIST must undertake a technological evaluation to check its positioning from diverse viewpoints, such as the environment, economics, and others.
During the presentation today, Dr. MAEDA shared with us the extensive efforts of the Zero-emission Vision Study Working Group, and I guess, having a physical presence on top of the Zero-emission Bay Map would make it much better. It could be any size, but the important thing is that there should be something tangible there.
One example from the AMACHAN that reruns on TV recently, one woman diver bravely declared in the TV drama ‘Let’s open Ama café!’ during the winter when she could not dive. This declaration eventually led to the actual opening of the café located at the then Kita-Sanriku City Tourist Association, where the georama is.
I am not sure if a similar mindset to the AMACHAN will work on the Zero-emission Bay case, but something tangible on the map would help us show off the Zero-emission Bay presence worldwide in various ways, I expect.
That covers everything I want to say.

Thank you very much.
We are about to the end of the discussion with the punchline of ‘AMA Café.’
Although the time allocated for the panel discussion was insufficient, we are more than happy if at least any one thing from the sympodium, including valuable presentations, will remain memorable for you.
That should not be the end, but just the beginning, and hopefully, the valuable insights from the panelists will encourage you to create true carbon neutrality constructively, executing research and development step by step back at your work toward social implementation.

Dr. TANAKA has already been around, and I shall hand it back to you.

Thank you very much, Professor MATSUHASHI, and to all the panelists.