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Energy Highlights
Listening to Key Persons

Initiatives for the Achievement of Carbon Neutrality

Hiroshi Ohashi × **Tatsuya Yamada**

Vice President,
The University of Tokyo

Division General Manager, Energy Business Administration Division and Business Planning & Strategy Division, Hitachi, Ltd.

Vol. 1

Changing Society by Developing a Vision and Proposing Policies

Diverse initiatives are currently underway to establish a carbon neutral society. However, a mountain of problems that require innovation lie in the way of achieving carbon neutrality. In this new series, Listening to Key Persons, Tatsuya Yamada, a Hitachi, Ltd. official in charge of policy proposals and new business development, asks experts and people in the field about problems that must be resolved for the establishment of a carbon neutral society. Yamada looks deep into how these key people view the existing problems and what actions they are taking to solve them.

In this Vol.1, Yamada asked University of Tokyo Vice President Hiroshi Ohashi, who has been involved in the planning of various policies related to energy issues, including the Japanese government's clean energy strategy, to discuss the materiality of the issues faced by society through industry-academia cooperation and the need to use digital technologies.

■ Activities of H-UTokyo Lab. Contributing to Policy Planning

Yamada: H-UTokyo Lab, Hitachi and University of Tokyo Joint Research, was established six years ago in 2016 based on the enthusiasm of the late Hiroaki Nakanishi, a former Executive Chairman of Hitachi, Ltd., and Makoto Gonokami, the former President of the University of Tokyo. H-UTokyo Lab. has achieved many things since then, including Version 4 of the Proposal “Toward Realizing Energy Systems to Support Society 5.0” released in March 2022, which it had worked on as a part of its activities. In the course of these interviews, I had several discussions with Professor Ohashi as well.

Ohashi: It's hard to believe that six years have passed already. The complete liberalization of electric power retailing began in 2016. We can say H-Tokyo Lab. started in a symbolic period of power system reforms.
Yamada：As you said, since its launch, H-Tokyo Lab. has worked to develop a vision for the power industry as the retail power market is deregulated and the structure of the

industry changes against the backdrop of the population decrease, asking what kinds of technologies should be developed and how investment to strengthen the power infrastructure should be encouraged. Subsequently, H-Tokyo Lab. found the need to look not only at electricity but also at energy as a whole, including heat and gas, through the studies it advanced. Based on its awareness of that, the lab has expanded its field of vision beyond the reform of energy system suppliers to reform on the demand side, involving companies, ordinary households and communities.

In these conditions, the Japanese government declared in 2020 that it would reduce national greenhouse gas emissions to zero and achieve the carbon neutrality of the country by 2050. The declaration has made initiatives involving all stakeholders necessary. More new problems have emerged, including steep rises in energy prices and the tightening of the power supply-demand balance due to the recent situation in Ukraine. Those problems have created a pressing need to create a vision for the future of energy systems, that considers energy security and economic efficiency in particular.

Ohashi: The use of renewable energy began to increase with the launch of the feed-in tariff (FIT) system in 2012.

A discussion at a forum sponsored by H-UTokyo Lab.
(left: late former Hitachi Chairman Hiroaki Nakanishi, second from right: University of Tokyo Vice President Hiroshi Ohashi)

H-UTokyo Lab.

The University of Tokyo and Hitachi, Ltd. established H-UTokyo Lab. in 2016 by creating a new industry-academia collaborative creation scheme for the goal of realizing the “Super Smart Society” (Society 5.0) proposed by the Japanese government.
The Laboratory is advancing research and development projects through a new way of creating and transmitting a vision and solving problems that represents a drastic change from the conventional approach of industry-academia cooperation for solving problems. Further, information on the joint projects as well as their achievements will be actively shared with society through various channels including open forums.

Hiroshi Ohashi

Vice President, The University of Tokyo, Professor, the Graduate School of Public Policy, the University of Tokyo and Professor, the Graduate School of Economics, the University of Tokyo.

Ohashi graduated from the Faculty of Economics, the University of Tokyo. He also graduated from Northwestern University in the United States in 2000 (earned a Ph. D. in economics).
Ohashi assumed his present positions in 2022 after serving as an assistant professor at the Sauder School of Business, The University of British Columbia in Canada and an associate professor at the Graduate School of Economics, the University of Tokyo. Ohashi specializes in industrial organization theories and competition policies. He has served as a member of various committees, including the Advisory Committee for Natural Resources and Energy and the Electricity and Gas Market Surveillance Commission.
He has received include the Miyazawa Kenichi Prize (Fair Trade Institute) and the Enjoji Jiro Prize (Japan Center for Economic Research).

In this environment, H-UTokyo Lab. initially discussed matters including incentives to promote investment in the power grid. We can say these initiatives have born fruit, such as the plan for the High Voltage Direct Current[*1] transmission system to transmit power generated in the Hokkaido and Tohoku regions to the Tokyo metropolitan area, a consuming region, and the Revenue Cap[*2] system conceived as a reform of transmission charges. In other words, policies have reflected the discussions at H-UTokyo Lab. Our society has started to implementing results of H-UTokyo Lab.

Yamada: I feel that H-UTokyo Lab. has achieved significant results in its approaches to technology and the promotion of investment and policy planning.

Ohashi: I agree. However, the lab has not yet solved many problems in the area of investing and the economy. The number of suspended or decommissioned power generation facilities actually increased, tightening the supply-demand balance as a result of efforts to curb investment in power generation facilities following the deregulation of the power market. Fuel prices are also soaring due to reduced upstream investment in petrochemical resources in line with the global trend toward decarbonization and reduced reliance on Russia due to the Ukrainian situation. How we overcome this phase is an urgent issue. Naturally, increasing power conservation and

other countermeasures are necessary both on the supply side and the demand side. H-UTokyo Lab. is establishing multiple working groups and repeatedly discussing and addressing these diverse issues.

In this way, the lab has worked on issues that are a half step ahead of the times. I feel the lab has linked itself to policy planning and grown into a presence viewed as superior in various circles because it has discussed these issues based on reality.

Yamada: Professor Ohashi, what is your personal evaluation of the initiatives taken by H-UTokyo Lab. from your position in academia?

Ohashi: I think Hitachi is connecting with University of Tokyo researchers in various fields, and, in a sense, playing a role in offering them a place to foster multi-disciplinary knowledge through cross-disciplinary cooperation and collaboration between the humanities and the sciences. Further, Hitachi is providing them with diverse research resources including an array of data through its extensive off-campus networks.

I also want to praise H-UTokyo Lab. for examining power systems in Japan from a broad public viewpoint, instead of the perspective of one company. I think that is why we can take part in the lab as researchers in a neutral position, and the people around us have considered our activities there to be trustworthy.

Tatsuya Yamada

Division General Manager, Energy Business Administration Division and Business Planning & Strategy Division, Hitachi, Ltd.

Yamada joined Hokuriku Electric Power Company in 1987, and was seconded to The Institute of Energy Economics, Japan in 1998 before joining Hitachi, Ltd in 2002.
He has engaged in tasks involved in the planning of strategies for energy-related businesses, and became Director of the Management Planning Office, the Strategy Planning Division in 2014, Senior Manager of the Business Planning Division, the Energy Solution Business Unit in 2016, General Manager of the Business Planning Division, the New Age Energy Business Co-create Division in 2019, and assumed his present positions in 2020.

■ Huge Jumps Needed to Achieve Carbon Neutrality

Yamada: Japan has adopted carbon neutrality in 2050 as its slogan. What do you think the current conditions are in the country?

Ohashi: Carbon neutrality is the idea of balancing greenhouse gas emissions with greenhouse gas absorptions in 2050. We must take several steps to achieving this.

Nationally determined contribution (NDC) is one of them. It means reducing greenhouse gas emissions by 46% from their fiscal 2013 level by 2030. We must be ready to jump forward considerably, including innovation to achieve this target. First, we must discontinue inefficient coal-fired power generation that emits large amounts of CO_2. We must expand investment in decarbonized power sources that emit no CO_2 at the point of power generation and supply while guiding thermal power plants that have taken no measures to reduce CO_2 emissions toward the exit. We have been asked to set a course for ultimately shifting to decarbonized power sources while securing diverse power sources, including renewable energy, by taking steps including the mixed firing of ammonia and hydrogen using

***1 High-voltage direct-current transmission system**
HVDC (High Voltage Direct Current) is a system to deliver electricity using a high voltage direct current This system enables large-volume, long-distance power transmission with minimal loss. The system is also suited for connecting systems using different frequencies. The system is attracting attention as a solution supporting the conversion to renewable energy as a main power source and the establishment of a decarbonized society by means including the connection to large renewable energy systems and long-distance power transmission to high-demand regions.

***2 Revenue Cap system**
This is a new transmission charge system that is planned to be introduced in April 2023. Its goals are to increase the cost efficiency of general power distribution business operators and promote the investment that is necessary to strengthen the power grid. The system enables general power distribution business operators to flexibly set transmission charges within a revenue cap for a fixed period the Japanese government establishes for them following the examination of the business plans and the like that they submit. In other words, it is a system for incentivizing business operators by permitting them to post the results of their cost reductions as profit. The system can be called an initiative that contributes to the transition to renewable energy as a main power source.

liquefied natural gas (LNG). For this, we must examine the pace of initiatives and the best route based on various factors, including economic efficiency, the speed of innovation and international systems such as the Carbon Border Adjustment Mechanism (CBAM).

Of course, uncertainties exist as well. Global resource procurement changes, market trends and exchange rated fluctuate in response to the latest situation in Ukraine, impacting Japan heavily because imports are about 88% of the primary energy the country consumes. (Figure 1) Procuring oil and coal from Russia has become difficult already. Taking these points into consideration, we must generate more electric power using domestically produced fuels in the future, instead of relying on overseas energy. I think we must keep the practical use of nuclear power in mind as one solution for these problems. For that purpose, we are asked to advance programs including emergency evacuation plans by securing the understanding and cooperation of host communities after firmly guaranteeing the safety of nuclear power.

Yamada: As Professor Ohashi said, efforts to achieve carbon neutrality in 2050 do not immediately advance from the present situation in a straight line. Major reforms in areas including the structure of industry, production processes and consumer confidence are necessary for the achievement of carbon neutrality. All of us must discuss what we should do to realize the transition to carbon neutrality, viewing these efforts as our own. Those of us on the corporate side must think ahead and advance technological development in a way that suits the transition process as well, backcasting with 2050 as our starting point.

The scenario approach is one method that H-UTokyo Lab. has adopted for doing these things. In the approach, two or more scenarios are established by considering unpredictable changes and technologies are developed with those changes in mind when matters are considered over the long term. In other words, multiple scenarios are established and the technologies required to respond to them them are prepared, instead of focusing on just one technology or terminating its development based on an assessment of current conditions.

Ohashi: Achieving carbon neutrality in 2050 is probably impossible by just accumulating the technologies around us. H-UTokyo Lab. adopted backcasting and scenario analysis so that all of its members could share an out-of-the-box perspective free from existing frameworks.

■ Putting imagination to work to picture the Present based on the Future

Yamada: In Version 4 of the proposal, H-UTokyo Lab. presented two scenarios — the first one in which diverse forms of energy including nuclear power are used and the second one in which only renewable energy is used — as the conditions under which carbon neutrality is achieved. In

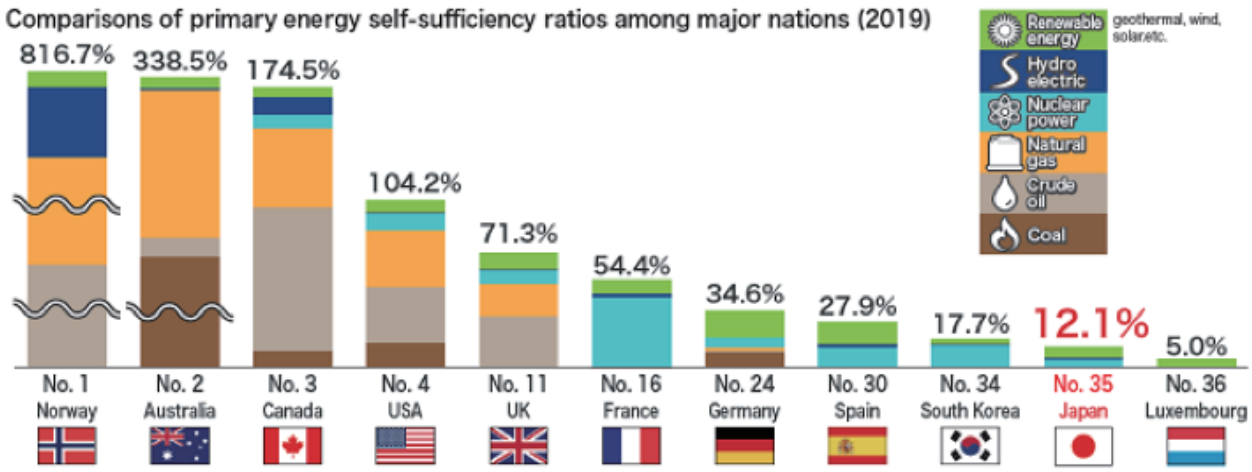

Figure 1: [Comparisons of primary energy self-sufficiency ratios among major nations (2019)]
Source:10 questions for understanding the current energy situation in Japan's Energy (2021 Edition) published by the Ministry of Economy, Trade and Industry (METI)
(Source: Estimates for 2019 from IEA "World Energy Balances 2020", except for data for Japan, which are confirmed values of FY 2019, derived from "Comprehensive energy statistics of Japan", Agency for Natural Resources and Energy. *The ranks in the table are those of the 36 OECD member countries.)

fact, the lab studied several other scenarios in the course of preparing the proposal. The situation in Ukraine changed greatly in the subsequent period, too. I think H-UTokyo Lab. must revise its scenarios in the future, taking these changes in the conditions into consideration.

Ohashi: I think that scenarios can play a role in the development of people's awareness that carbon neutrality is not an extension of the present conditions but that its achievement requires repeated jumps. In other words, the value of scenarios is their ability to change people's perceptions. We can say that the government announced drastic reduction figures like 46% precisely because its mind-set has changed.

Yamada: I agree. I also feel that people's perceptions, including people in the government, are changing. Achieving a reduction rate of 46% in 2030 by simply accumulating figures from here will be difficult. I think setting firm targets and thinking about the things that we should do by backcasting from the targets is extremely important for achieving the difficult goal of carbon neutrality.

Ohashi: What's more, Japan must think about achieving carbon neutrality in the context of its relationship with the world, instead of achieving the condition exclusively. Japan must first build a framework for the achievement of carbon neutrality in Asia as a whole by cooperating with its Asian neighbors. Contributing to value chain development by providing cutting-edge decarbonization technologies in the course of these efforts can be considered an important role for Japan, too.

The achievement of carbon neutrality may be painful for citizens. This is another point we must consider. Power rates are already rising. The could continue to increase, depending on the future energy mix. How we ensure the stable energy supply is an important issue, too, as we increase the amount of renewable energy that we use.

The risk of heatstroke will rise this summer if air-conditioning is not used properly during abnormal weather that frequently occurs in unpredictable ways. Moreover, home care has advanced. There are many people recuperating at home using medical devices. Those conditions have made power failures a human life issue. We cannot tolerate things like power failures due to a power shortage due to the suspension of all thermal power plants. Handing the global environment over to future generations is extremely important. However, we must advance matters, balancing the burdens imposed on the present generation. Continuing a trend from this spring, the balance of power supply and demand is predicted to be tight this summer and this winter. We cannot allow this tightrope situation to continue indefinitely.

What kind of world awaits us on our way to carbon neutrality? How many burdens must citizens endure in this process? What kind of world will we seek to reach at the end of the process? We must use our imaginations to visualize the way that our future should be. I think that not only presenting mere scenarios, but also strengthening initiatives to change people's perceptions and ways of thinking based on a clear vision are important.

■ Need to Plan Policies Based on Data-Supported Evidence

Yamada: You just mentioned that discontinuous jumps are necessary for achieving carbon neutrality, and it is important that each and every one of us change our perception and behaviors to realizing these jumps. What do you think will be the key for making these changes?

Ohashi: I think the first premise is the awareness shared by all people that carbon neutrality is an obligation that the members of the current generation have for the next generation.

However, it's not easy to change our current actions by imagining the future in a period like this, when consumers can freely choose many different types of merchandise. To begin with, we don't know what actions we should take to achieve carbon neutrality. We don't know the volume of CO_2 emitted in the manufacturing of a particular product and its delivery to a store or home. We must first prepare systems that tell us the volume of CO_2 emitted by our actions or the degree of contribution to CO_2 emissions reduction we can achieve by changing our actions. The introduction of digital technologies is extremely effective for preparing systems that track and visualize CO_2 emissions. I think this point lends strength to the argument that digital transformation (DX) is necessary to advance initiatives for

the achievement of carbon neutrality. (Figure 2) Meanwhile, we must ensure that energy is supplied stably as well. We must find a way to stabilize supply, ensure economic efficiency, protect domestic employment and enable the continued growth of the economy while advancing initiatives to achieve carbon neutrality. In other words, we must solve a complex optimization problem which imposes many constraints. We are still in a stage where we must refine our actions to address constraining factors such as stable supply. In this environment, H-UTokyo Lab. must continue to discuss these subjects.

I think quantitative trial calculations will be the basis for these discussions. I think the quantitative investigation of questions, such as whether or not all power supplied should be from renewable energy is the best choice from the perspective of environmental load and cost and to what degree the use of nuclear power can reduce CO_2 emissions and costs, and the application of findings to future forecasts will be essential for the achievement of carbon neutrality.

■ Building a Platform and Services to Prepare for Consumer Participation

Yamada: What do you think are issues in the way of increasing renewable energy?

Ohashi: Weather conditions affect both photovoltaic generation and wind generation at present. Accordingly, we must use other power sources such as thermal power or reduce demand when the volume of power generated is small. However, I think we can overcome a good part of this problem by applying storage cells and heat pumps and advancing the development of direct-current transmission and other technologies.

Yamada: As you said, the characteristics of generators differ depending on their types. I think the optimization of whole systems in consideration of this will be the next big issue. The issue calls for a cooperation and control platform for the integrated management and control of the many resources distributed throughout a local community based on energy data. (Figure 3) I think this kind of platform could solve problems with renewable energy, including physical distance between generation and consumption locations and time distance between consumption and generation hours.

The platform works particularly effectively in places where many resources exist, in other words, places on the demand side. The image is to feed all information, including information about solar panels and storage cells, to the platform and operate it in an optimal way. Hitachi is already providing services that contribute to the optimization to electric power business operators in nine areas across Japan using its supply-demand adjustment system. I think Hitachi can contribute more to the wider use of renewable energy if it can divert these services to the consumer side. With their diversion, I think Hitachi can draw a picture

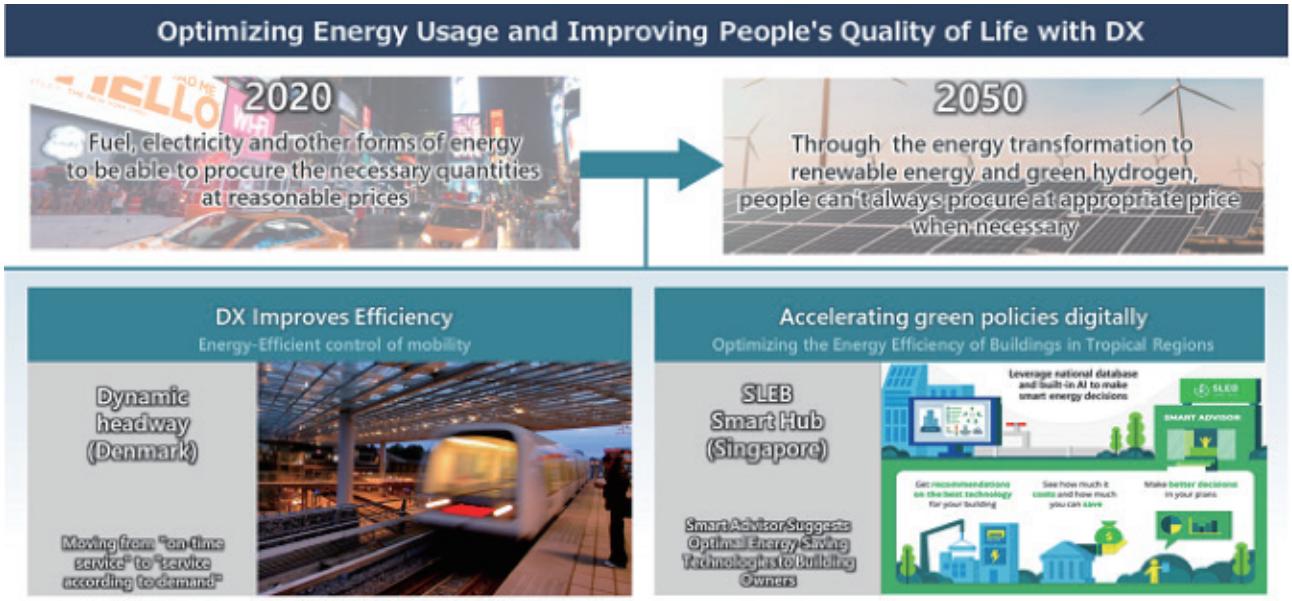

Figure 2: Promoting Energy Conservation through DX
Reference: Hitachi Social Innovation Forum 2021 - Expert Session presentation material

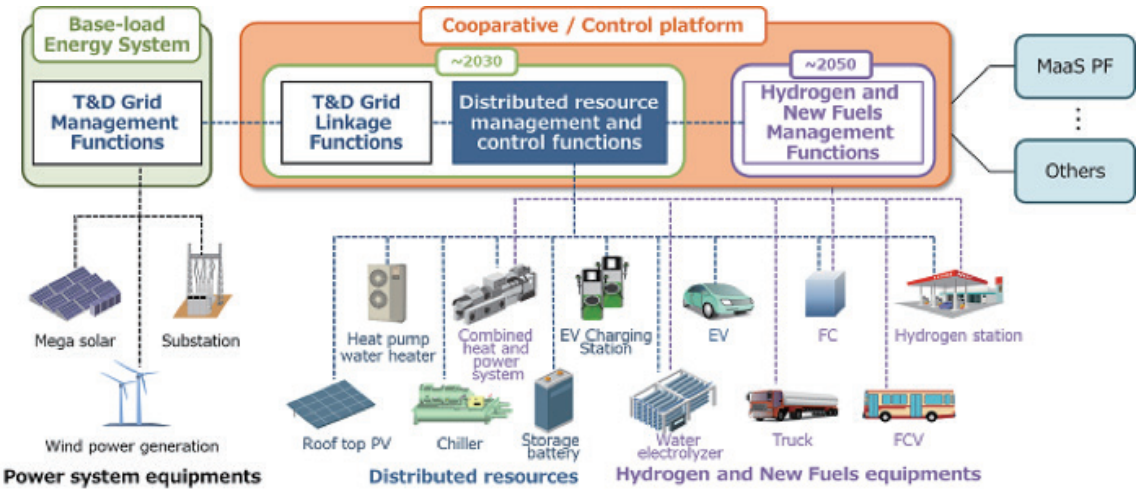

Figure 3: Cooparative / Control platform
Reference: H-UTokyo Lab. the Industry-Academia Collaboration Forum
Proposal "Toward Realizing Energy Systems to Support Society 5.0" Ver.4

that is different from past responses including requests that consumers reduce power consumption due to the tightening supply-demand balance.

Ohashi: To achieve this, Hitachi must steadily develop its aggregation business for controlling distributed power sources, supply for consumers and demand from consumers while fully leveraging the platform. There is still large ground for Hitachi to develop, including technologies for platforms and the establishment of new business models. At the same time, Hitachi will be increasingly asked to be agile in its handling of ever-changing supply-demand conditions and power source procurement realities like the situation in Ukraine.

Together with the platform, I personally expect the reduction of carbon footprints (Figure 4) to be enabled through digitization, in other words, the visualization of CO_2 emissions. CO_2 is invisible to the human eye. However, it becomes possible to quantitatively grasp emissions we can trace CO_2 using digital technologies. When that is achieved, things like the volume of CO_2 emitted before a certain product reaches a consumer through a supply chain become visible. Consumers will also become able to choose products that emit less CO_2 from a large number of products.

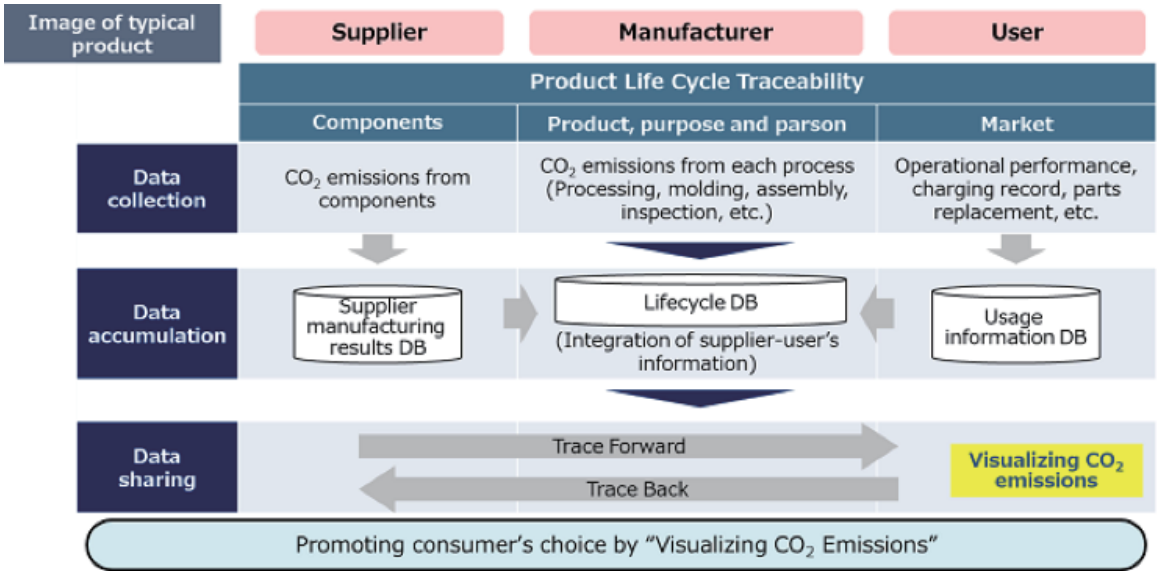

Figure 4: Carbon Visualization through Data Utilization and Choice by Consumers
Reference: H-UTokyo Lab. the Industry-Academia Collaboration Forum
The 4th Symposium of "Toward Realization of Energy System to support Society 5.0."
Pfrof. Ohashi's presentation material "Systems and policies to harmonize sustainable society and industry with carbon neutrality"

In that sense, we can say services toward the goal of carbon neutrality and technologies that support these services have not been sufficiently developed to date. I think that changing consumer perceptions through the provision of services may be essential for business operators.

Yamada: We share your view that visualization is extremely important. The quantitative visualization of efforts to reduce CO_2 emissions is extremely important. We have already started providing a service for visualizing CO_2 emissions. However, providing only tools is not a long-term solution. For that, we must design an incentive of some kind that leads to continued motivation. We are thinking about realizing this incentive through collaborative creation with our partners good at services.

■ Application of Digital Technologies Is Essential for Transformation

Yamada: How do you think the ways the industry has operated will change if a cooperation and control platform is prepared and the aggregation business makes progresses in the energy field?

Ohashi: I think the acceleration of the corporate green transformation (GX) through initiatives for the achievement of carbon neutrality will cause a shift to a horizontally-connected structure, which can be called stratified (layered) industries, instead of the conventional vertically-divided structure for each industry. I think procuring fuels such as synthetic fuels and hydrogen cross-sectionally in all industries centered on industrial complexes is more efficient than procuring them industry by industry. I also think it's a good idea to recover CO_2 and use it effectively across industries. I think that, in this way, the value chains of Japanese industries will change from their previous state with GX as a starting point.
H-UTokyo Lab. initially discussed energy centered on electric power. H-UTokyo Lab. has subsequently expanded the scope of its discussions to energy as a whole and then to the value chains of industries as the heart of the discussions has shifted to carbon neutrality. The lab has expanded the scope of its discussions not only because the replacement of existing facilities and the establishment of new power generation facilities will be necessary, but also because changes such as chemical complex restructuring will be necessary for the procurement of raw materials to generate power using fuels such as hydrogen and ammonia.

The need to build new unprecedented value chains will arise if carbon dioxide capture and storage (CCS) technologies for recovering CO_2 and burying it underground in the end are established and practically used in the future. To state this in another way, I think that companies that have stayed outside the scope of cooperation will connect with each other in various ways across fields and begin to show themselves as new industries.

Our lifestyles will change in step with these trends toward GX, too. For example, the sandwiches we buy at convenience stores are wrapped in films that repel oils and fats now. The elimination of things like this may be considered better for our shift toward carbon neutrality. Carrying a Tupperware with us in addition to a reusable shopping bag may become necessary for going shopping in the near future. The guarantee of hygiene, safety and security is an important matter. We may find ourselves in a situation where we have to pick the option of sacrificing convenience and efficiency to a certain degree. We must accumulate the wisdom needed for the development of economic and social activities together with carbon neutrality while sharing an image of the society and economy that carbon neutrality requires.

Yamada: In that sense, I feel discussions regarding the introduction of daylight-saving time, which had been repeated several times in the past, may be appropriate now from the viewpoint of using energy. Daylight-saving time was not implemented in the past because forces resisting it existed. However, the situation has changed significantly from those days. In point of fact, many advanced nations have adopted daylight-saving time.

Ohashi: Nothing leads to a great change in our way of thinking more than a change in something we have always assumed will remain the same.
In any event, energy is the foundation of a nation. Energy has an extremely large effect on industries that employ people and assist the lives of every citizen. How should we produce and use energy while protecting the economy of each region and the affluence of our lives? The question reminds us that it would be a waste to not use the power of

digital technologies. Using digital technologies, we can think up a wide variety of efficient contracts based on modes of energy use by skillfully combining a large number of power sources, instead of using energy in a uniform manner as we have done in the past. We can work to increase efficiency and achieve decarbonization on the premise of the stable supply of energy if we can control multiple power sources autonomously. This control leads to the realization of a resilient society, too.

Needless to say, the establishment of support structures and systems and the design of new services are sought as the premise for this vision of the future. The introduction of daylight-saving time is one idea for these systems. I believe we can move ourselves closer to the achievement of carbon neutrality assuming stable supply if we can reduce scenes in which power loads concentrate as a result of actions such as simultaneous power use by all people, and design a picture for society that embraces diverse economic entities using resources such as digital technologies.

● This article is published on Hitachi, Ltd.'s energy portal site.

■ **(Chapter 1)**
https://www.hitachi.com/products/energy/portal/case_studies/case_011.html

■ **(Chapter 2)**
https://www.hitachi.com/products/energy/portal/case_studies/case_012.html

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