

ACTIVITIES 2

Achieving Carbon Neutrality in 2050

Policies and Technologies Needed for GX

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Moderator

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The circumstances surrounding energy are going through major changes, including worsening climate change and emerging geopolitical risk. As the impact of climate change on people's lives and corporate activity is becoming increasingly significant, efforts are required both for CO₂ emission reductions to address climate change and action to ensure security and the stability of energy supplies to avoid public and business disruption. What sort of measures will we need to adopt in relation to energy if we are to achieve the overarching goal of carbon neutrality? *Hitachi Review* invited Satoru Katsuno, the 109th President of the Institute of Electrical Engineers of Japan, and Sumiko Takeuchi, a Member of the Board of Directors at the International Environment and Economy Institute and a Joint Representative of U3Innovations LLC, to share their visions for the decarbonization of society and to discuss specific measures for promoting and implementing GX.

Rapidly Changing Business Environment for Energy

Yamada: The topic for today is the green transformation (GX) for achieving carbon neutrality by 2050 and the policies and technologies that this will require. Confronted as we are by a variety of unexpected developments, what should we be doing to achieve carbon neutrality by 2050 in a way that avoids disrupting people's lives and maintains business and economic stability while also ensuring security and a stable energy supply? As you are both well acquainted with the energy industry in Japan, I would like to hear what you have to say on this subject.

Starting with the business environment for energy, the world has changed considerably since Russia launched its invasion of Ukraine in February 2022. Please give me your thoughts on recent developments and your outlook for the future.

Katsuno: Former Prime Minister Suga announced the goal of carbon neutrality by 2050 in his general policy speech in October 2020. Subsequently, in April 2021, the Global Warming Prevention Headquarters announced the specific goal of reducing FY2030 greenhouse gas emissions by 46% from their FY2013 level, which is to be accompanied by the pursuit of strategies for a stretch goal of 50%. As a national commitment, this carries a lot of weight, with companies and industry also accelerating their action on carbon neutrality. While this was happening, however, investment in the upstream end of the energy industry (exploration, development, and production) has stalled and there has been no increase in total fuel supplies. Given that demand continues to increase, primarily in Asia, this has set energy prices on a rising trend, one that is overlaid by the impact of the Russian invasion of Ukraine. Everyone appreciates that stable energy prices are just as important as a stable supply, and with all this has come greater interest in the issue of economic security. Changes in the world

order that demonstrate the indivisibility of politics and economics are a reminder that it is up to us to protect our own economy and society.

While reforms to the power system are being accompanied by experimentation with a variety of market development and market design initiatives, the end result has been that power generation plants with poor utilization have found it difficult to cover their fixed costs and have in some cases been taken out of service. The recent rise in energy prices can be attributed to a combination of factors, with both a tightening in the supply and demand situation for fuel and a shortage of generation equipment.

One option that cannot be ignored when addressing these challenges is the restarting of nuclear power generation. While ensuring safety is a key prerequisite, I believe this will be a vital factor in the pursuit of GX if we are to achieve energy security, stability of supply, and energy price stability.

Takeuchi: I would like to start by making three points about our current energy environment.

The first is the difference in how people think about climate change policy and about energy policy. Energy policy is ultimately a practical matter and its planning is forward-looking, taking account of current circumstances, while planning 10 or 20 years into the future. Climate change policy, in contrast, is nothing less than societal reform and calls for wide-ranging innovation. As projecting ahead based on a continuation of current trends will not lead to major changes, climate change policy instead involves developing a vision for the sort of future we want and then backcasting from there. While it may be possible to reconcile these approaches over timeframes in the order of a hundred years, trying to do so for 2030 or 2050 will only result in plans that are out of step.

Along with the Ukraine crisis, the last year has seen a jump in energy prices that could justifiably be called the third great oil crisis. Whereas “climate change” used to be one of the terms most commonly heard on the lips of European and other national leaders, “energy security” has taken its place. Nevertheless, when I attended the 27th United Nations Climate Change Conference of the Parties (COP27) last year, it wasn’t as if the gathered world



Satoru Katsuno

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Joined Chubu Electric Power Co., Inc. in 1977 after graduating from the Department of Electrical Engineering, the Faculty of Engineering, Keio University. Following roles as General Manager of the Okazaki Regional Office; General Manager of the Tokyo Office; Representative Director, Executive Vice President, and General Manager of the Corporate Planning & Strategy Division; and President & Director, he was appointed Chairman of the Board of Directors in 2020. Other appointments include Chairman of the Federation of Electric Power Companies and President of the Institute of Electrical Engineers of Japan.

leaders had stopped waving the flag for climate change. I do feel, though, that they are struggling with the disconnect that arises from the different ways of thinking about climate change and energy policy, and from their different timeframes.

The second point is that nations around the world are looking at climate change in terms of their own national growth strategies and there is a growing tendency to see it as a means of seizing a competitive advantage. The USA’s Inflation Reduction Act, for example, is explicitly intended to support industries with a role in addressing climate change and it is unambiguously targeted at achieving sustainable growth and economic security by directing large subsidies at these sectors. Companies, too, need to think strategically about how they can turn climate change into an opportunity for growth.

The last point is a response, from an energy policy perspective, to the issue Katsuno-san raised earlier about how a large number of reforms are happening at the same time. These include the deregulation and adoption of market principles in the power system, growth in renewable energy, and fundamental reform of nuclear safety regulations. It has been pointed out that the way that countries around the world, Japan included, have gone about reform in the



Sumiko Takeuchi

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Obtained a doctorate in engineering from the School of Engineering, the University of Tokyo in 2022. After graduating from the Faculty of Law, Keio University, she worked primarily in the environmental division of Tokyo Electric Power Company before setting up on her own. She has worked as a researcher at a few think tanks and sat on numerous government committees, including the Cabinet Office's Council for Regulatory Reform and the GX Implementation Council. Major publications include "The Truth of Energy Policies" (Wedge), "Energy Industry in 2050—Game Change to Utility 3.0" and "Energy Industry Strategy for 2030" (Nihon Keizai Shimbun, Inc.), "Electrical Collapse: The Strategy-devoid National Energy Defeat" (Nihon Keizai Shimbun, Inc.). She is a regular member of the Japan Society of Public Utility Economics.

past has made matters worse when that reform has coincided with an expansion in renewable energy, with a lack of investment in the generation capacity needed to ensure stability of supply. By leaving operators with no choice but to shrink margins for securing electricity supply, reforms have exacerbated the problem of how to maintain stability of supply. While past practice has been underpinned by a rate-of-return regulation that has enabled private-sector electricity utilities to bear some of the burden, the advantage in a competitive market goes to those operators that are prepared to shave the safety margins they keep for times when supply and demand are tight. Along with the securing of generation capacity, deregulation reforms have also impacted long-term contracts for fuel and I believe there is an urgent need to reassess the balance of risk between private-sector companies and the government.

Challenges for Japan Highlighted by GX Implementation Council

Yamada: To make progress on GX, the Japanese government established the GX Implementation Council chaired

by Prime Minister Kishida in July 2022. The council put together a guiding strategy in December. As members of the council, the two of you participated in those discussions. Can you tell us a little about the matters discussed?

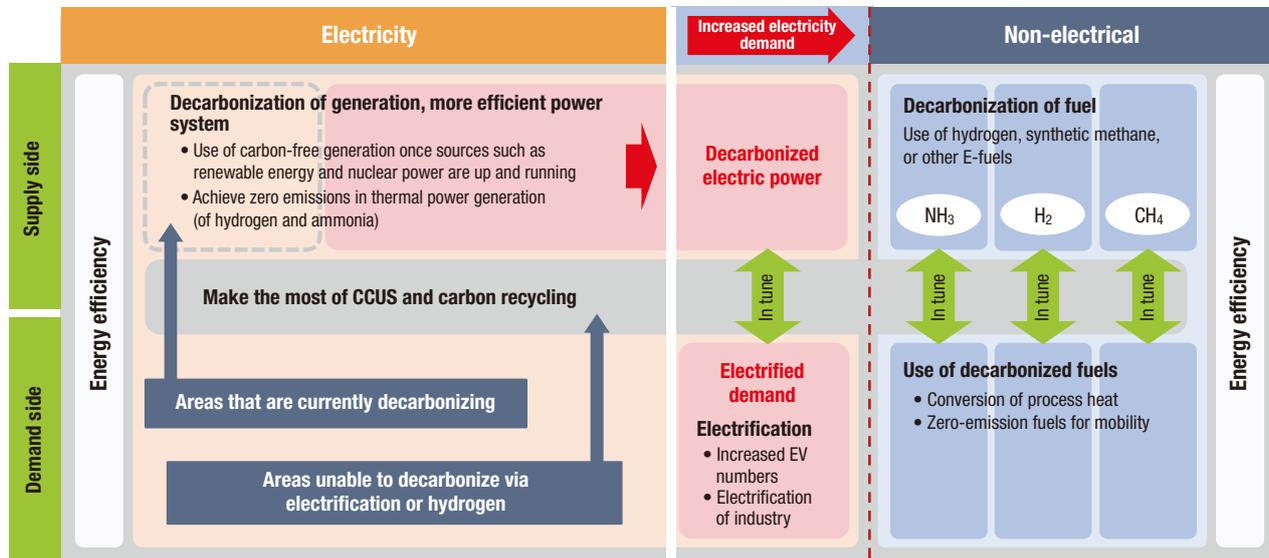
Katsuno: Rebuilding stable supply mechanisms was a major topic. That is, as we move toward achieving carbon neutrality, it is extremely important that we develop realistic plans that will maintain a stable supply through the transition process. The transition needs to be one in which disruptive innovations are combined in a way that gives us an uninterrupted path to carbon neutrality. To this end, the GX Implementation Council has highlighted the need to produce a roadmap to 2050 (overall plan and sector-specific plans), define milestones, and decarbonize in a way that keeps energy suppliers and consumers in tune (see [Figure 1](#)). While I expect that work toward carbon neutrality will include progress on energy efficiency and electrification, this still leaves the non-electrical sector for which such measures are insufficient. While it will take investment to decarbonize in a way that also encompasses these non-electrical sectors, questions remain as to how we can optimize the timeline of investment, returns, and losses, including those losses that occur along the way. This optimization needs to be undertaken at the corporate, industry, and national levels.

In addition to the use of nuclear power and a more significant role for renewable energy, the use of thermal power generation to balance supply and demand fluctuations will also play an important role in the power supply. As making the shift to carbon neutrality without compromising stability of supply will involve greater use of lower carbon fuels and the adoption of zero-emission practices, I also believe that the path Japan should be taking is one that includes our exporting the resulting low-carbon technologies to the world. I see a need here for strategic action, this also being a matter of economic security and how we can ensure that Japan maintains its presence and strategic necessity in global supply chains.

A major challenge that I have already touched on is the use of nuclear power. Unless we embark seriously on this work right now, the human resources, technology,

Figure 1 | How to Transition to Carbon Neutrality

Along with supply-side decarbonization, there is also a need for complimentary structural changes on the demand side. What is needed is a transition that keeps consumers and suppliers in tune.



Source: Fourth GX Implementation Council, Documents supplied by Satoru Katsuno of Chubu Electric Power Co., Inc. (Nov. 2022)

CCUS: carbon capture, utilization, and storage EV: electric vehicle E-fuel: electrofuel NH₃: ammonia H₂: hydrogen CH₄: methane

production base, and other infrastructure will not be ready when needed. It is essential that we restart work immediately, not only on advanced light water reactors, but also small modular reactors (SMRs), fast reactors, high-temperature gas-cooled reactors, and fusion. This is a challenge that I believe industry needs to take up for itself, with ambitious plans and targets for research and development.

Takeuchi: The topics discussed in the earlier and latter half of the GX Implementation Council were very different. The earlier half was dominated by talk about a redesign of deregulation and the rebuilding of the nuclear power industry, while the latter half addressed GX investment and carbon pricing in terms of how such investment can be encouraged.

A broad consensus was achieved on the need for nuclear power as well as on the redesign of deregulation. With a population of more than 120 million and an industry structure heavily focused on manufacturing, annual demand for electricity in Japan is around one trillion kWh. Given our small land area, 70% of which is mountainous, use of renewable energy alone is simply not a viable option for supplying that level of electricity demand. I believe that Prime Minister Kishida conveyed an important message when he used the word “and” when talking about “renewable and nuclear energy.” If we are to take advantage of nuclear power, however, a more in-depth debate will be

needed on how business and industry can be put on a sound footing, with it being essential that a comprehensive operating environment be put in place that covers



Moderator

Tatsuya Yamada

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Joined Hokuriku Electric Power Company in 1987. After secondment to the Institute of Energy Economics, Japan in 1998, he joined Hitachi, Ltd. in 2002. Having been appointed Director of the Management Planning Office at the Strategy Planning Division in 2014, Senior Manager of the Business Planning Division at the Energy Solution Business Unit in 2016, and General Manager of the Business Planning Division at the New Age Energy Business Co-create Division in 2019, he was appointed to his current position in 2020. He is engaged in policy proposal work relating to the energy business. He is Vice President of the Institute of Electrical Engineers of Japan and a regular member of the Japan Society of Public Utility Economics.

the relationships and other forms of cooperation with the communities where the plants are located, as well as providing better and more efficient compensation programs and safety regulation.

Yamada: It is a situation where a lot of things are happening at the same time, making the answers more complex. You might settle on one approach as being the best, but then the underlying circumstances could change, making alternative approaches very different and changing the outcomes. Nuclear power serves as a classic example. It used to operate safely in an environment protected by regulations, but that entire basis has been undermined. If circumstances then change in a way that calls for it to be restarted, it may be that regulations is unable to keep up.

Takeuchi: I am conscious of a lack of comprehensive debate on energy policy. While energy policy is said to be about simultaneously achieving “energy security, economic efficiency, environment, and safety” (3E+S), this still leaves us with a trilemma over where the primary focus should be. In this situation, where satisfying one requirement compromises another, you can make the case that people have failed to take a broad view and have paid insufficient attention to risk management. Looking at the situation in broad terms is extremely important.

Japan, by nature, is highly constrained in its energy policy options, leaving little scope to debate those options that are available. While I believe that communicating energy policy to the public to gain its understanding is at the heart of the matter, the truth is that this is a responsibility our government has continually evaded in the past.

Katsuno: As Japan faces diverse challenges, but its resources are limited, so it seems important to me that we clarify our priorities and gain a public consensus. This is not limited to energy, so instead of simply saying ‘yes’ or ‘no’ to specifics, we need to be considering the issue in its entirety.

Carbon Neutrality and Societal Change Brought about by Digitalization

Yamada: Takeuchi-san, in your use of the concept of Utility 3.0 to depict how the energy sector fits into a world

where digitalization is becoming an integral part of society, I understand that you have emphasized the importance of active participation by consumers as well as suppliers.

Takeuchi: There may be some people who have yet to become familiar with the term Utility 3.0. Utility 1.0 refers to how these businesses grew up as legal monopolies supplying ever-increasing demand, and Utility 2.0 refers to the era when demand had plateaued and efficiency became an important consideration. What I feel is needed now is a transition to Utility 3.0 as a new form of social infrastructure. This extends beyond the transformation of the energy industry, instead encompassing reform of all areas of social infrastructure.

When you consider the context of energy, it will continue to be a mix of both large-scale centralized infrastructure and distributed infrastructure such as local supply schemes for a time. In the case of large-scale centralized infrastructure, I believe central government has a high level of responsibility. With distributed infrastructure, on the other hand, private-sector ingenuity plays an important role, with the development of new industries through co-creation among industry and other parts of the private sector. For example, the reason why carbon neutrality has yet to spread to all citizens is because energy is essentially a means to an end and carbon dioxide (CO₂) is a byproduct of activity. It is much like the idea of how waste is generated as a byproduct of people’s activities. If, instead of demanding that they shift to activities that do not generate CO₂, consumers are offered products and services that they want to use because they find them attractive, convenient, and trouble-free, it is their choices that will bring about a reduction in CO₂. This, I believe, is the key role of industry. If we are to create such products and services, we need to be thinking about how we can create new added value through combined efforts that go beyond the energy industry to include other industries such as mobility or housing. Digitalization has a key role to play. While Utility 3.0 encompasses a multitude of meanings, this is the sort of world it is seeking to create (see [Figure 2](#)).

Katsuno: Carbon neutrality and digital technology are two sides of the same coin. Three requirements for the societal

changes needed to achieve them are: (1) combining these with economic growth and the enjoyment of new forms of abundance, (2) establishing distributed and circular networks, and (3) productivity improvement and diversity.

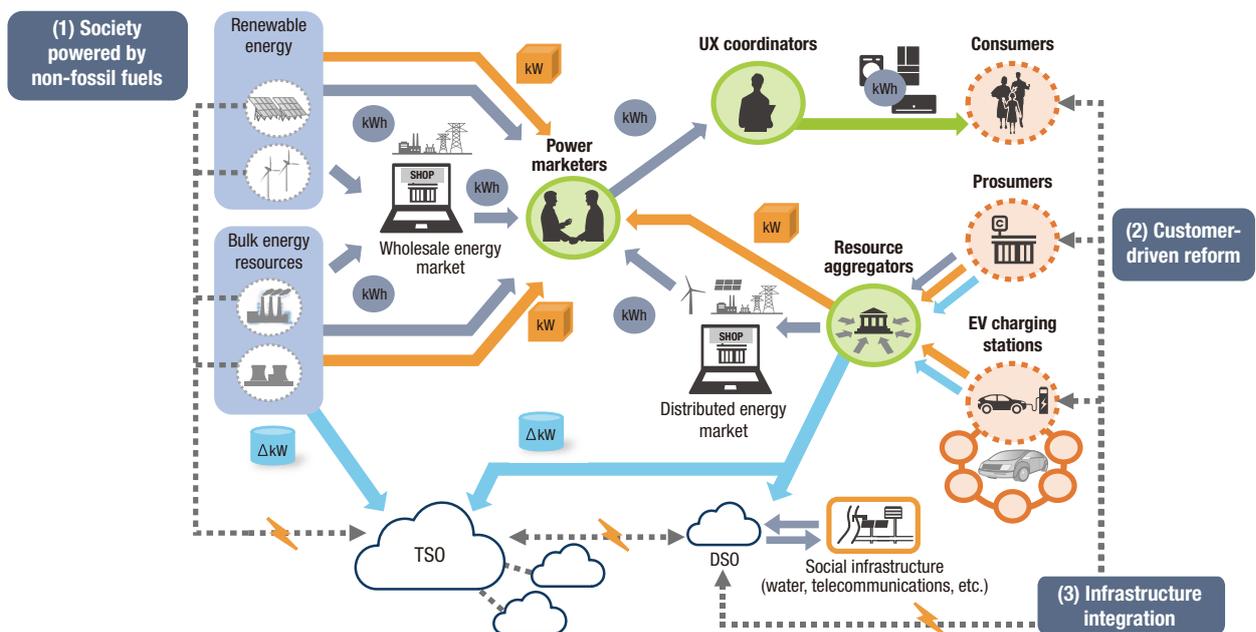
For the first of these, while there is no doubt that technological innovation is needed to achieve carbon neutrality, how we go about getting such technologies adopted quickly is crucial. We need to establish them as viable businesses that foster economic growth. Also necessary is to ensure that any increased costs are passed on to the public in an appropriate manner so that they are able to enjoy lives that are safe and secure as well as prosperous. Achieving this requires progress on international standardization and launching initiatives overseas. Without such ambitions, it is unlikely that much progress will be made on carbon neutrality. Another crucial factor is digitalization. It is likely that digitalization will open up physical infrastructure such as energy and telecommunications and societal

infrastructure such as education and healthcare to greater scrutiny. Also important is the challenge of how this data can be made available on platforms to facilitate changes in industry and in public and private life, and what new value and services can be delivered from the fusion of the cyber and physical realms. As customers and the companies and other organizations involved in the value chain make great strides, what vision should we be sharing and what approaches should we be adopting as we communicate with them? This is the first requirement.

The second requirement relates to the goal of combining resilience and quality improvement with greater efficiency in the economy and society. A more distributed energy system has a strong affinity with the circular economy in that both are associated with a way of life based on local sourcing that is underpinned by digital technology. It is anticipated that the shift to these will happen in tandem. As each community is different, they can achieve higher

Figure 2 | The World of Utility 3.0

Network unbundling is what differentiates Utility 1.0 and 2.0. Utility 3.0 refers to new societal systems that extend beyond energy. As both large-scale centralized infrastructure and distributed infrastructure continue to coexist, ways are needed to ensure that they are developed and maintain reliably.



Source: Adapted from "Energy Industry in 2050—Game Change to Utility 3.0" (Nihon Keizai Shimbun, Inc.)

UX: user experience TSO: transmission system operator DSO: distribution system operator

levels of overall efficiency and performance and improve resilience through a virtuous circle in which they make things easier for themselves by focusing on doing what they are able to do, thereby achieving stability and improved quality. I believe that making this connection is one of the roles of utilities.

The third requirement recognizes that the development and utilization of a wide variety of talent is essential for a social transformation like carbon neutrality. As well as pursuing diversity and new value creation as measures such as electrification and digitalization make the workforce more dynamic, what this involves in practice includes collaboration with educational institutions and engagement with youth to enable a next-generation approach to training in which investment in human resources enables the necessary re-skilling and recurrent education. The goal is a dynamic society in which people feel motivated and invigorated, with these initiatives contributing to the creation of new value. All three of these are implicit in carbon neutrality.

Takeuchi: I expect that quite a few of the societal challenges we need to solve fall under the banner of carbon neutrality. I am also conscious of a large divide between Japan and Western nations in how we express and convey that vision. Looking at the US Inflation Reduction Act or Europe's REPower EU proposal, for example, I think the specific technologies and approaches are much the same, but the way the vision is communicated is ingenious. The Japanese government has identified the need for JPY150 trillion in investment to achieve carbon neutrality. While the roadmap will require adjustments along the way, what is needed to achieve this, I believe, is a clearer vision and a flagbearer who can show the way.

As for the shift to distributed and circular systems, some very difficult hurdles need to be overcome. The large-scale, centralized infrastructure we have had in the past has featured systems that perform extremely well on efficiency and cost.

However, at a time when Japan's market and society are shrinking and it becomes difficult to maintain large-scale network infrastructure, a major goal like carbon neutrality calls for a transition to distributed and circular practices that take the place of infrastructural functions. When you

look at it from that perspective, there is a need for flexibility in how we go about doing things, such as using fossil fuels as a mechanism for maintaining stability of supply in emergencies. I believe this is an issue where industry should take the initiative and present its findings to those in government and the bureaucracy responsible for system design.

Yamada: This is an area where I would like to see not only energy businesses, but also manufacturers like Hitachi getting together to play their part. I would like to see us trialing various different practices to satisfy the technical requirements. As we have been saying, it is also true that little headway will be made on the practical deployment of these practices unless we put in place the three prerequisites of business viability, predictability, and a regulatory regime that underpins these. I also believe it is vitally important that we win the understanding of customers and the general public through open dialogue and debate.

IEEJ as a Forum for Japanese Innovation

Yamada: Katsuno-san, you were appointed the 109th President of the Institute of Electrical Engineers of Japan (IEEJ) in May 2022. Can you please tell us a little about this organization?

Katsuno: Since it was established in 1888, the IEEJ has made a major contribution to the progress and deployment of research into electrical technologies in Japan by bringing together academics and practitioners along with government and universities. Use of electric power has expanded continuously over those 135 years. Telecommunications became established about a decade earlier than electricity, and whereas it has progressed from Morse code to radio transmission, long wave and short wave, and ultimately optical communications, 1 kWh of electricity today is exactly the same as 1 kWh back then. As electricity is such a convenient form of energy, capable of providing light, motive force, or heat, it is fascinating how technological progress has largely been centered on generation and transmission to enable its "generation, distribution, and consumption."

Rinzaburo Shida, the main advocate for the establishment of the IEEJ, spoke at the 1888 IEEJ Annual Conference about nine technologies that he predicted would be developed in the future. In a 1967 pamphlet by Goro Inoue, the first-ever president of Chubu Electric Power Co., Inc. who also served as the 50th President of the IEEJ, he wrote about how the fun to be had from predicting the future was a spur for research and development, noting that, flying cars apart, all of Shida's predictions had come to pass. This was what Shida himself had in mind in his advocacy for the IEEJ: the idea that by providing a forum where scientists and engineers with a diverse range of perspectives and specialties could get together, it would help to advance electrical research and see it put to good use.

This is an idea that I believe makes just as much sense today. Now more than ever, scientists and engineers should themselves be imagining what sort of future society will emerge from the introduction of innovative technologies in pursuit of carbon neutrality and then focus their research and development efforts on this vision.

In its Grand New Design announced in July 2022, the IEEJ talks about how, to achieve its vision for a society that is “prosperous, safe, and secure” as well as “sustainable,” co-creation that brings the public together with industry, academia, and government can be fostered by providing a forum for exchanging and reconciling facts and opinions and sharing information, one that also features diversity by engaging and partnering with other academic societies in different fields or from overseas. In particular, achieving carbon neutrality will require not only expertise from other branches of engineering, but also that we work closely with the humanities and social sciences. Along with fostering a consensus view on transforming all areas of society, communication with companies, academic institutions, communities, and the public will be vital. In this, the question of how to convey the thinking of scientists and engineers will be crucial.

Yamada: I have great respect for how, for more than 130 years, the institute has built up large amounts of knowledge and expertise about electrical technology while also helping to bring on the people who work in the field. I recently

attended the IEEJ Annual Conference or Technical Meetings where I was able to observe the vigorous debates that took place, noticing also that many young students were in attendance along with the experts. It gave me a sense of how, in its role as a forum, the IEEJ serves as a platform where people from different generations and with different points of view can communicate with one another.

Takeuchi: I was at a symposium yesterday where the topic of discussion was “the weaponization of economics.” The value of energy security is not something that anyone gives much thought during peacetime. We don't see it as something that we need to invest in. Nor, however, is it something that we can hurriedly put together when things go wrong. Stability of supply is itself a “value” that society needs. While I talked about the importance of fostering public understanding of this value, in this regard the extensive implementation work being undertaken by the IEEJ is of great importance. It is also important that the institute maintains a prominent role as a professional community that is also involved in bringing forth the next generation of talent.

Katsuno: The IEEJ also plays an important role in international standardization. While this includes the establishment of common technical rules, the scope of standardization nowadays also extends to the value chain and business models. Given this situation, along with leveraging the forum provided by the IEEJ for scientists and engineers to work together on fostering Japanese innovation, it is vitally important that individual scientists build their network of contacts by engaging with others working overseas. The IEEJ is taking the initiative to provide opportunities for debate, inviting experts from industry, government, and academia. I believe that routine activities like this are one way in which we can gain a greater role in international standardization.

Yamada: With growth stalled in the domestic market, the standardization of products should also help with reducing their cost. Likewise, international standardization becomes important if the intention is to move into overseas markets. I see hope for the establishment of such a model with the IEEJ serving as a hub. Naturally, I would also like to see Hitachi among those involved.

Katsuno: As Hitachi is a broad-based manufacturer of electrical equipment, with activities extending from exploratory research not dissimilar to that done in academia to the rollout of infrastructure, home appliances, and other such products, I believe it has a very important role to play. With society at a major turning point, companies too need to change.

Value chains are transforming as the value provided by services evolves with advances in digitalization. Mobility provides a classic example. With the introduction of robots and artificial intelligence (AI), it is evolving into mobility-as-a-service (MaaS) where, rather than just transporting people, it is delivering value through services that derive from that role. This in itself gives it certain attributes of community. Hitachi is engaged in a wide variety of businesses. As such, and given the changes happening in the content and layers of value chains, I would like to see this getting you involved in research and development for the public good as you play your part in managing reform across all parts of society. In the process, I look forward to Hitachi promoting international standards and standardization, leading to international competitiveness and economic security.

Yamada: Hardware remains important, and televisions and cars are changing in a way that satisfies the needs of consumers with content and services, just like smartphones. Recently, a person who works for a telecommunications business told me that they want Hitachi to make society like a smartphone. What they meant by this was a world in which everything can be updated in real time, as it is on a smartphone. Hitachi, I believe, should aspire to be an organization that keeps social infrastructure up-to-date and makes it convenient for everyone to use.

Katsuno: The ability to utilize digital technology to deliver diverse services to families and the wider public creates a need for value providers who will address the issue of how to connect these services. A society built on distributed and circular principles is one that has moved on from the mass production and consumption of the past to the production and consumption of a wide variety of products in small and variable quantities. I expect data platforms like Lumada



that link different forms of infrastructure together will also have an important part to play.

Takeuchi: Electricity and other utilities have a strong affinity with manufacturers like Hitachi. While considerable faith is placed in utilities as community-facing organizations that those communities cannot do without, it cannot be said that they have always appreciated the details of how the people in those communities live. My experience of working at an electrical utility is that their goal is to supply electric power to buildings. In contrast, you can expect a manufacturer engaged in everything from social infrastructure to home appliances to have delivered value very close to those consumers' lives. As the way people live varies across different communities, there is considerable scope for both parties to work together on figuring out where we can add value. GX is a transformation of all areas of society, and as such it is important to bring as many different partners on board as we can, including startups.

Yamada: I believe that progress on international standardization can be made by first building up a successful track record of open co-creation based mainly in Japan. I wish you all the best in your future work on achieving carbon neutrality. Thank you for your time today.