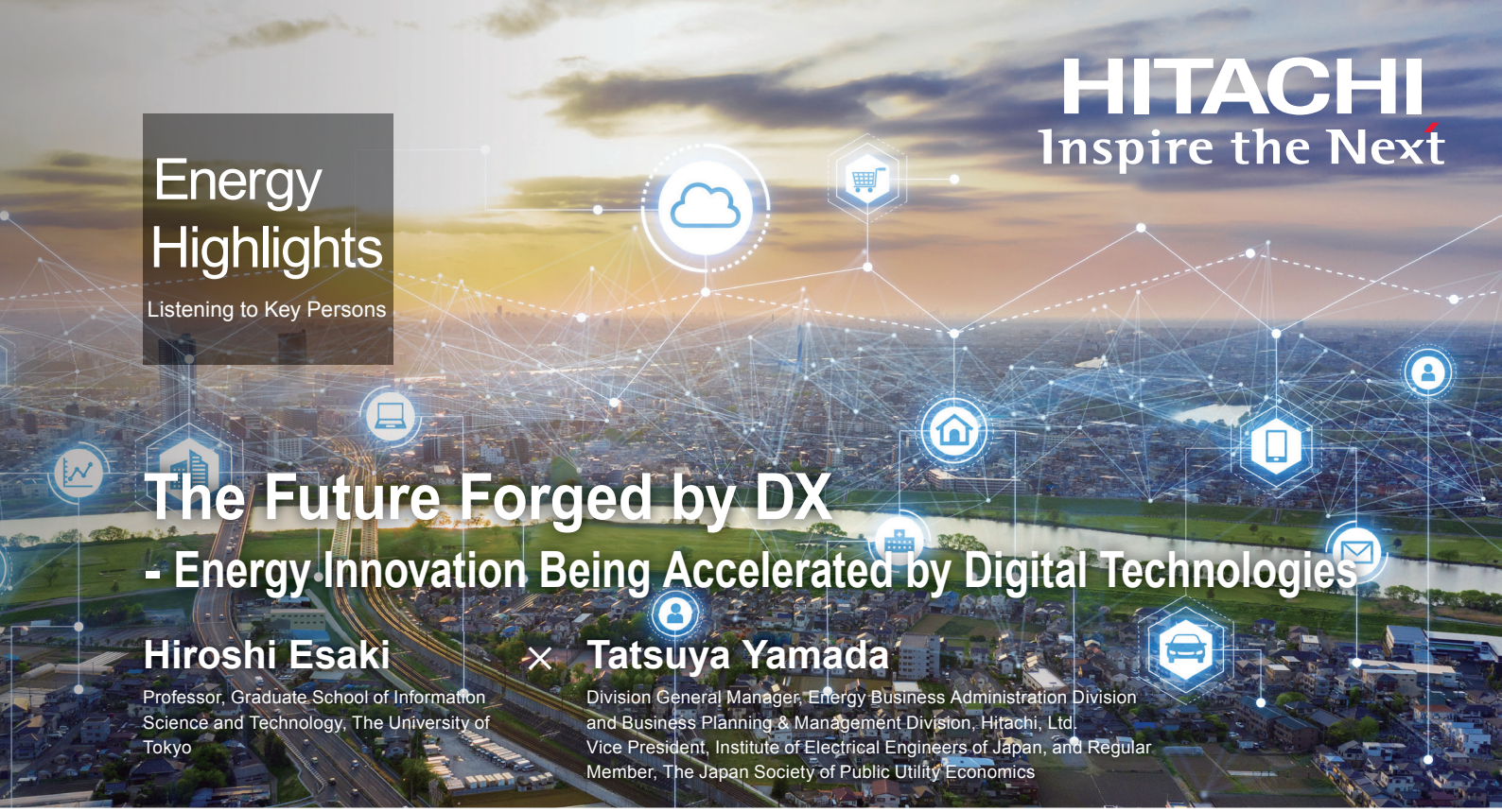

HITACHI
Inspire the Next

Energy Highlights
Listening to Key Persons

The Future Forged by DX
- Energy Innovation Being Accelerated by Digital Technologies

Hiroshi Esaki
Professor, Graduate School of Information Science and Technology, The University of Tokyo

×

Tatsuya Yamada
Division General Manager, Energy Business Administration Division and Business Planning & Management Division, Hitachi, Ltd.
Vice President, Institute of Electrical Engineers of Japan, and Regular Member, The Japan Society of Public Utility Economics

Vol. 4

What role does DX play in energy management?

For this fourth edition of the series we invited Hiroshi Esaki, a professor of the Graduate School of Information Science and Technology from the University of Tokyo who has been extensively involved in everything from research into smooth network utilization to policy recommendations as an information network expert. Professor Esaki is also driving the digital transformation of Japan as a senior expert at the Digital Agency. During this interview we talked about the key points for promoting the utilization of digital technologies that will accelerate energy innovation, the value that will be created, the future that will be brought, and other topics.

■ Building an ecosystem that is good for everyone

Yamada: In January this year during the Industry-Academia Collaboration Forum organized by H-UTokyo Lab. titled "Proposal Toward Realizing Energy Systems to Support Society 5.0," there was a panel discussion about value creation through energy and regional innovation led by data utilization. To start with, were you left with any impressions after listening to this discussion?

Esaki: I was told by a certain major chemical manufacturer that in addition to reducing total power generation, their challenge was how to make a structural switch to using renewable energy for plant operations that had been based on fossil fuels. On that point, I think an example shared by Hiroshi Komiyama, the former president of the University of Tokyo who is currently the chairman of Mitsubishi Research Institute, offers some insight.

In the 1960s, the area around Kita-Kyushu City had developed as a heavy industry and chemical industry zone, bringing economic growth and the rise of industry, but it also brought pollution issues that had never been experienced before. Initially, local companies were against the demands to make improvements, believing it would make it impossible to continue with business activities. But when there was a focus on a company's basic principles of improving profits and boosting productivity, pollution was eliminated as a result, and we saw the return of blue skies. After that, they sought to transform industry further, which led to the creation of a data center where a factory had once stood. This was an ecosystem, so to speak.

I think this is one example of DX and even GX (green transformation).

As a company, there is a hesitance to invest in something that is good for the environment but not for profits, but if it is something that contributes to the development of a company, the company will invest in it. This approach is the model of the SDGs, and recently it is what even the Keidanren refers to as "sampo yoshi," meaning "good for everyone."

Yamada：This is the management philosophy of the Omi merchants, who thought that "what is good for the buyer and good for the seller is good for the world." I think in today's modern world, everyone has encountered a situation where the benefits only affect one person, and don't extend to everyone.

Esaki: And at the time, the wives of employees were putting pressure on their husbands, saying, "if I can't hang my washing outside. It's a problem. Do something about it!" This is similar to the "stakeholder capitalism" that has now become mainstream. When users, companies and countries try to solve issues together, they end up with an environment in which people can do their laundry comfortably under clear skies, and a management environment where companies can boost production efficiency while generating profits. This also contributes to the international commitment to eliminate pollution, and makes everyone happy. For the manufacturing industry, I think restructuring by making changes to production processes and creating this sampo yoshi (good for everyone) structure will be increasingly important going forward.

Hiroshi Esaki

Professor, Graduate School of Information Science and Technology, The University of Tokyo

Completed master's program in the Department of Electrical Engineering and Computer Science, School of Engineering at Kyushu University in 1987. Joined Toshiba in April of that year. Spent two years from 1990 at Bellcore Inc. in New Jersey (USA) and two years from 1994 at Columbia University in New York (USA) as a visiting scientist. Associate professor at the Computer Center of the University of Tokyo since October 1998, and at the Graduate School of Information Science and Technology since April 2001. Professor at the Graduate School of Information Science and Technology since April 2005 (current position). Representative of the WIDE Project. Representative of MPLS-JAPAN, Senior Director of the IPv6 Promotion Council, President of JPNIC, Director of the Japan Data Center Council and Chairperson of its Steering Committee, concurrently serving as Chief Architect (now Senior Expert) at the Digital Agency from September 2021 Doctor of Philosophy (the University of Tokyo).

■ Making companies the hubs of regional energy management through digital adoption

Yamada：Now, companies are truly confronted with similar problems in terms of energy. During the recent pressure on the supply of electric power, I think we have been forced to think seriously about how to create circumstances that are beneficial to everyone. I'd like to ask you thoughts on this.

Esaki: In terms of how major companies that maintain extensive private electric power generating capabilities and have large-scale power consumption should achieve sampo yoshi (good for everyone), I think there should be a focus on ΔkW (delta kilowatts: adjusting output in the

short term and matching it to actual demand), and efforts to contribute to regional energy adjustment capabilities. If companies can work to boost productivity on the premise of social contribution and play a part in adjusting electric power, then overall we should be able to reduce the fossil fuel-derived power plants that make up the bulk of current power regulating functions. At the same time, by engaging in transactions with power companies, we should be able to curb electricity prices.

In addition, considering the current vulnerability of power supply systems, having companies in regional areas that maintain private electricity generating equipment and can avoid power outages during emergencies also pose benefits to local residents. In other words, a four-party energy ecosystem can be created, including neighboring end users, plants, the national government and in this case the power companies as well. That kind of new structure is now coming into view.

1: **Total electricity demand** (electricity sold by electricity utilities + specific supply from electricity utilities and private consumption*1) was 881.6 billion kWh, an increase of at least 2.1% year on year.
2: Of this, **total electricity sold by power providers***2 was 837.4 billion kWh (breakdown: 225.5 billion kWh of extra-high voltage, 296.5 billion kWh of high voltage, 313 billion kWh of low voltage [278.1 billion kWh for electric lights, 34.8 billion kWh for electric power]), an increase of 2.0% year on year.
3: **Of the electricity sold in the low-voltage designation**, specific demand (transitional tariffs) amounted to 113.5 billion kWh and other demand (free tariffs)*3 totaled 199.5 billion kWh, accounting for 63.7% of the electricity sold in the low-voltage designation.
4: **The amount of electricity sold by power producers and suppliers***4 was 179.2 billion kWh (breakdown: 23.9 billion kWh of special voltage, 82.3 billion kWh of high voltage, 73 billion kWh of low voltage [66.7 billion kWh for electric lights, 6.2 billion kWh for electric power]), accounting for 21.4% of the total amount of electricity sold (percentage of specified high voltage: 10.6%, percentage of high voltage: 27.8%, percentage of low voltage: 23.3%).
5: Of power producers and suppliers (730 entities), the number of entities with a track record of demand was 582 (specified high voltage: 134, high voltage: 446, low voltage: 511).
6: **Looking at electricity demand by prefecture**, the highest was Tokyo at 76.4 billion kWh (9.1% of the total), followed by Aichi Prefecture at 58.1 billion kWh (6.9%), and Osaka Prefecture at 54.2 billion kWh (6.5%).

*1 Not including the private consumption by private power plants.
*2 In reports from power providers (monthly reports on power generated and received), it is permitted to record the results from the meter reading date for month N-1 to the day before the meter reading date of month N as the figure for month N, and since most companies report results up to the meter reading date, this does not match actual consumption for month N.
*3 The transition to free tariffs includes switching to free tariffs within the same equivalent electricity retailer and continuing with a contract based on old optional supply provisions, in addition to switching to another electricity retailer.
*4 A power producer and supplier refers to an electricity retailer other than an equivalent electricity retailer (formerly a general electricity utility) or specified electricity transmission and distribution utility.

* In the next update, the announcement of figures for April 2022 is planned at the end of July. However, the update may be delayed due to the aggregation status or other circumstances.

Figure 1: [Summary of Electricity Survey Statistics (List of Statistical Tables) "Demand Relationships]
Source: Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry "Outline of FY2021 Annual Report on Energy (Energy White paper 2022)"

***1** Source: Nihon Keizai Shimbun electronic edition, "Aeon Mall to Switch All Electric Power to Renewable Energy at 160 Locations in Japan" (June 10, 2022)

Tatsuya Yamada
Division General Manager, Energy Business Administration Division and Business Planning & Management Division, Hitachi, Ltd.
Vice President, Institute of Electrical Engineers of Japan, and Regular Member, The Japan Society of Public Utility Economics

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.

Yamada: Companies, which are major consumers that generally use up vast amounts of energy, will take on the reverse role during emergencies, supplying local communities with energy. The idea that companies have the potential to contribute in those ways in regional energy management is very interesting from the perspective of energy resiliency.

Esaki: The example of Aeon mall is an illustration of that. In the town of Ishinomaki in Miyagi Prefecture, which was one of the places hit by the Great East Japan Earthquake, the Aeon Ishinomaki Shopping Center (now known as Aeon Mall Ishinomaki) continued operating without shutting down for even a day despite power outages, and became an evacuation shelter for about 2,500 residents. It hadn't been officially designated as an evacuation shelter, but it had food, medical supplies, parking space and private power generating equipment, so it had all the elements in place to function in that capacity.

In fact, the amount of electricity consumed by the Aeon Group overall in Japan is over seven billion kilowatts, which accounts for nearly 1%* of Japan's total power consumption. In other words, it's clear from the numbers that the power regulating capacity of commercial facilities such as shopping malls can contribute to regional energy management. On the assumption that shopping malls will become evacuation centers for local residents and energy supply hubs during an emergency, they might be able to coexist with local shopping districts.

■ The Keys to Improving the Efficiency of Energy Use are Automation and Transitioning to the Cloud

Yamada: Recently, various research has shown that if several percent of power consumption can be adjusted during peak power demand at times of power shortages, we can get by. At these times, I think the key will be how entities on the demand side utilize digital technologies for this adjustment amount. At the University of Tokyo, immediately following the Great East Japan Earthquake you played a central role in implementing Green University of Tokyo Project, and I heard that this produced significant results. What are the key points in the promotion of DX, and what are the effects of it?

Esaki: With that project, we succeeded in reducing average power usage on campus by around 30% within the short space of several months. At the time, we didn't have in place the infrastructure enabling automated control, so we visualized the status of electricity usage and called on people to conserve energy in an analog fashion. Even so, we managed some significant reductions. That's why if we digitalize that process to adopt automated control, power usage can be adjusted by several percentage points. Last year in Japan the then Minister of Economy, Trade and Industry Koichi Hagiuda called upon the public to cooperate with power conservation efforts, and we overcame the issue with each person making adjustments, but in the future, I think we should shift from those analog-level calls for cooperation to automated control using digital technology.

Additionally, in my lab we worked to shift away from bare metal (physical servers that occupy space) to the cloud, and as a result, we managed to reduce our power consumption by around 70% without any drops in performance. At the time, the NTT Group was conducting similar research, and it demonstrated that by shifting computers with poor electrical efficiency at each of its offices to the cloud, it could reduced its overall carbon footprint. As a result, in 2012, it showed this data to Tokyo Metropolitan Government Bureau of Environment, and recommended energy conservation measures through cloud adoption, in other words the shift on-premise computers to data centers. That has led to the environmental ordinances the Tokyo Metropolitan Government currently has in place, and to energy conservation support programs based on the use of cloud computing.

Yamada: The percentage of energy conservation that can be achieved through cloud adoption is quite a large figure, and I think the impact on users is also large. Major global IT companies are also concentrating on transitioning to the cloud.

Esaki: Google and Amazon tout that they are able to reduce their power consumption by 80% with the use of their own applications, and data centers are operated on 100% renewable energy. As I mentioned with the idea of "sampo yoshi" earlier, going forward I think how companies managed to transform these efforts into stakeholder capitalism will be the key points to DX and GX.

■ UI and UX Will Change With the Opening Up of Technology

Yamada: When pursuing GX on the consumption side in particular, scientific explanations based on data will be important, but in the case of Japan, as we saw in the example earlier, in some ways public calls from a government minister can be more effective than

scientific evidence. It is difficult to link technology with human behavior. For example, even if people can obtain information such as times of day when there is pressure on the electricity supply and different electricity rates, whether or not that can alter the behavior of end users is another question. In terms of linking to people's behavior, UI and UX will be important.

Esaki: I think the role of UI and UX is very large. But at the moment, even if for example you tried to make an application with an attractive interface where your computer autonomously gathers data from the Internet and uses AI to automatically control the voltage of an energy system, it would be difficult to implement because each industry has closed systems that are locked up. It is only when the application, basic software and hardware are all integrated that you can create an attractive interface.

I noticed this issue when I worked on smart buildings, and I bought in a programmer with game development experience to develop the smart building system, and they created an attractive video game-like interface. What wasn't possible using a closed system was achieved at an early stage in 2010 by opening up the API (application programming interface).

It is possible to even change the structure of industry by introducing these experiences from different industries. To develop systems that pose benefits for users and power providers alike, it is important what physical structure and software structure you adopt. We need to bear in mind that if each industry perseveres with its existing business models, we could lose the UIs and UXs that are crucial to changing human behaviors.

Yamada: In the process of opening up systems, since a wide variety of data will be handled, standardizing that data will also be essential. How do you tackle that? And what other barriers are there to implementation, putting aside the issues of people's awareness and technologies.

Esaki: On the issue of standardization, discussions are under way in the Data Linking Infrastructure Working Group of the Council for Science, Technology and Innovation (CSTI). The data that is currently in circulation varies widely, and most of it is still in the form of raw data, and records needed to analyze it are not maintained. As it's probably not possible to arrange this data under a standard data format, in terms of a future direction, we are looking at enabling a transition by introducing the idea of Web 3.0 - a semantic web - where data is structured by appending metadata to it, improving its readability by computers (enabling the handling of data semantics).

But the barrier when we try to do this will be "analog regulations." Even if you try to take things that have traditionally been done by people, such as turning lights or air conditioners on and off or shutting down a machine at a factory, and switch them to computer-based control, there are currently laws and regulations requiring people to perform those tasks. That's why in the Working Group Sub-Committee on Technology-Based Regulatory Reform which I chair the Digital Extraordinary Administrative Advisory Committee, we are in the process of reviewing regulations.

As I mentioned earlier, it will be possible to shift peak electricity demand by simply heating baths during the day or late at night to avoid winter evenings when the supply of electricity is the tightest. In other words, if we are able to change regulations so that things like lighting, air

conditioning and hot water systems in people's homes could be remotely controlled and if computers could automatically control these things, we can easily solve the issue of adjusting electricity demand by several percentage points.

■ Issues and Measures in Open Data Distribution

Yamada: Earlier we heard about the future vision for regional energy management, and how the digitalization of energy management and data utilization are accelerating CN.
I think data integrity will be one of the issues faced when implementing those technologies in society.

Esaki: How do you provide a free data distribution infrastructure with accessibility and trust? That is precisely what the late Prime Minister Abe proposed at the Davos forum in January 2019 with Data Free Flow with Trust, or DFFT. Creating an infrastructure for the free distribution of data, having people connected over a network being able to use that data and discover new value is an Internet approach, but we are now trying to do that with energy systems. Based on the DFFT approach, Japan's Digital Agency has presented a Government Interoperability Framework (GIF). This will enable the government and trusted institutions to create catalogs that describe rules for the structuring of data, and allow them to be referenced globally. The government will also provide an authentication service for that data and operators.

Yamada: Even if the integrity of data itself is guaranteed in that way, since the daily life of a household or production activities in an industry can be revealed based on energy data, confidentiality and privacy will also be called into question. What methods are available to deal with those concerns?

Esaki: There is more than ten years of research into the protection of privacy and anonymization, and the approach that has now emerged is the use of a federated learning system to learn off the data produced by each household or city, and share the training results. That method does not share individual data, but only the feature quantities obtained from the training process.

Yamada: Actually internally we have had discussions with people from other industry divisions about the possibility of a business utilizing data from smart meters. When we asked someone from a business division responsible for the finance industry about the value of the data from factory smart meters, we were told it could be possible to estimate the business performance or fluctuations in production for the company as the data could visualize the operating status of the factory, and we had the sense that the information could pertain to trade secrets. While we could say that the idea had potential to become a business, when we considered electricity consumption information being converted into information on corporate activities and financial information, we realized that the information would need to be handled carefully, including considerations about the methods for controlling it.

Esaki: As with the "Analects and the Abacus" principle advocated by Eiichi Shibusawa, it is important to strike a balance between economics and ethics. There is always a good side and bad side to any technology, and one of the conditions for becoming a trusted company is to strive to only use those good aspects, and to incorporate measures that prevent abuse into the business in advance. Similarly for the automated adjustment of electricity, a program should not be skewed to only favor one side. Hitachi's hesitation in this area is probably due to its sense of ethics. When I look into it thoroughly, what influences the trust in a business is the presence or absence of an ethnical perspective, and in the end I think humans are responsible for that parts pertaining to ethnics. I also think that is the way for Japanese companies to survive.

■ The Global Expansion of Energy Systems and Ensuring Security

Yamada: Opening up data also poses issues for economic security. How is this being discussed from a policy perspective?

Esaki: Avoiding the open distribution of data and instead fortifying it at trusted companies offers greater reliability, but it would mean the data is locked up there. That is why together with the Ministry of Economy, Trade and Industry, we are currently considering a direction where data is distributed and made accessible globally, but with procedures in place to monitor who has accessed what data.

This is basically the same for energy systems. That's

because if you don't make data accessible from anywhere, it will harder to respond when an accident occurs, and you also won't be able to run simulations for economic security. It is important that the integrity of the data distribution infrastructure is assured.

Additionally, when you think about energy optimization at the macro level, power systems being closed off by region as they are now becomes an issue. At the moment there are moves to develop offshore wind power generation in Hokkaido, but to achieve that it will become necessary to expand power systems on a nationwide scale.

I also think there is good potential for expanding those efforts globally. For example, we could relocate large domestic facilities that consume a lot of electricity to trusted countries achieving 100% renewable energy usage. Things that need real-time feedback would have to be in Tokyo, but for example a data center would not be problematic if back and forth communications took slightly longer, so it wouldn't necessarily need to be in Tokyo. By sorting facilities based on their intended use and other factors to distribute them globally, I think optimization at the global level can also be achieved.

Yamada: As a first step of that, there seems to be the idea of promoting decentralization within Japan. Placing a data center in a remote location and pursuing optimization is a change brought about by cloud computing. To take that further and achieve CN, a relaxing of regulations and changes to corporate-side behavior will be needed. With regard to distributing the locations of data centers globally, we first have to considers the risk taking involved with exchanging data outside the country.

Esaki: Under current circumstances it would be difficult to place the systems of one country in another country, but we are now started to see some facilities that had been concentrated in the Kanto region dispersed into the Kansai region. Next would be to further disperse the locations to Hokkaido and Kyushu, and thinking about overseas locations would be the step after that. And then the issue of economic security emerges. At this time, the issues would be whether the country's policies and a company's policies are the same or different, or how another country would cooperate. Particularly in the case of energy as a physical resource, even if you build power systems in Japan, you need the rare earth materials to run them or you won't get anywhere. That is why it is necessary to think about policy and businesses from a global, comprehensive perspective.

■ Sharing Will be the Trump Card for DX

Esaki: This discussion is titled "Initiatives for the Achievement of CN," but to achieve that, I think EP100 (100% energy productivity: increasing the energy efficiency of business) should be pursued instead of RE100 (100% renewable energy use). EP is not simply about turning off lights; it's an approach to switching from fluorescent to LED, and balancing energy conservation activities with improvements to the brightness of the workplace environment. Just like with cloud computing, migrating to the cloud improves security while reducing maintenance and personnel expenses, and it can also bring us closer to CN. I think that is where the incentive for a company to pursue CN lies.

Yamada: To pursue energy management on the consumer side on a widespread scale, I think a DX-based distributed energy platform is needed, but that possesses difficulties as long as it is not an industry.

Esaki: While the same goes for Hitachi, historically the supply of power has started from private generation by companies. Some of them formed electric power companies and were industrialized, and before the war, the industry was placed under government control. After the war, the industry was broken up again. In this way, all industries undergo a cycle of concentration and dispersion while reflecting social conditions, and during that process the structure of industry changes significantly. Take the automotive industry, for example. Recently a growing number of people are utilizing car sharing services instead of buying their own car. In the future, as sharing evolves in various industries, who will buy physical assets, and how will we create cash flow? I think every industry will experience drastic changes that differ from the past.

The way to prevent this ends up being segmentation, in other words closing off a company or industry. First, I think it is crucially important to visualize the available resources and share them with everyone.

Yamada: The sharing economy you described is an

innovation only possible thanks to digital technologies.

Esaki: Digital technology is a precondition for sharing, and sharing actually leads to CN. For example, newspaper companies have long maintained printing facilities and distribution systems in-house, but now articles can be read over the Internet, and because they are shared digitally, these companies have downsized their printing facilities and distribution systems, and drastically cut investments in hardware. In the shipping industry, the COVID-19 pandemic caused shortages in cargo capacity, but the practice of sharing through the pooled use of cargo space contributed to CN and also increased profit margins.

The same goes for PCs. Software has given us the ability to convert digital information in various ways. What used to be done with multiple pieces of hardware can now be accomplished with a single computer. This contributes to CN in extremely big ways when you think about the supply chain overall. In short, utilizing digital technologies to create a sharing economy is an extremely important initiatives in raising EP.

■ The Value of Physical Assets and the Value of Digital

Yamada: While there are things that can be eliminated through digitalization, there are some physical things that will never go away. Hitachi is creating just such things, in the form of energy and power plants, but in the future, how will these values be perceived?

Esaki: As DX requires computers and electricity, there is a great deal of value to possessing hardware assets. GAFA has also realized this, and in recent years it has started to invest in physical assets such as data centers and power plants.

Another significant source of value is in providing energy in a stable way in addition to it being clean energy. In 2021, when China regulated blockchain, blockchain mining machines were relocated to another country, but power outages occurred due to insufficient power in that country. In other words, strong components that can guarantee the mining business are contingent upon modern electric power assets.

Yamada: In the course of these varied discussions we had today, I was reminded of how important it is to use digital technologies in smart ways to improve utilization rates, to use energy and resources in efficient ways, and of how creating value and increasing profitability is key.

Esaki: In the end, what's important is evidence-based policy making (EBPM). Digital technologies are a powerful force for understanding that current situation. In every industry, we are experiencing fundamental changes to the way we work due to digital technologies, and we need to understand that now humans can focus on the work they are supposed to be done. If efficiency does not improve even after digitalization, it is probably because those tools are not being used in the right way. Even if you have a good system, no one will use it if the UI or UX are poor. We have to create interfaces based on users' needs, as this will lead to efficiency improvements. That is that essence of DX.

Yamada: From discussions about policy to the potential of new energy management and key points in the promotion of DX and GX, I think we were able to gain some insight into the future through a wide range of thought-provoking topics. Thank you very much for your time today.

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

■ **(Chapter 1)**
https://www.hitachi.com/products/energy/portal/case_studies/case_020.html

■ **(Chapter 2)**
https://www.hitachi.com/products/energy/portal/case_studies/case_021.html

Published in March 2023 (not for sale)
Publisher: Energy Business Administration Division