

How Can We Encourage Energy Innovation? - Energy Systems for Achieving Carbon Neutrality

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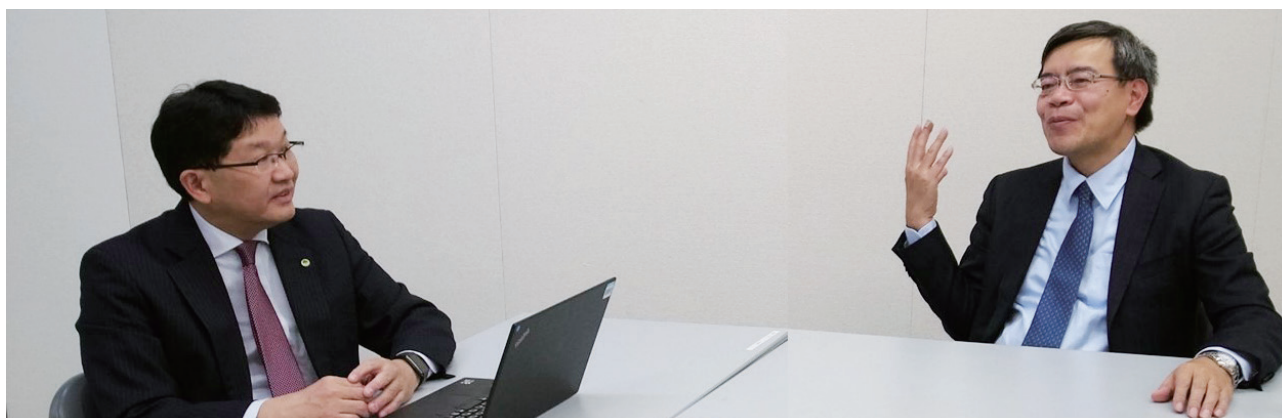
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Issues and Policies Surrounding Energy Supply and Demand in Japan

In this third part of our “Listening to Key Persons” series, we spoke with Keigo Akimoto, Chief Researcher and Group Leader of the Systems Analysis Group at the Research Institute of Innovative Technology for the Earth (RITE), who specializes in the analysis and evaluation of energy and environmental systems and policy recommendations for strategies to combat global warming. Mr. Akimoto is an active member of government expert panels and committees on climate change and energy issues, and is engaged in a wide range of research and policy recommendation activities in energy and environment-related fields. Mr. Yamada asked Mr. Akimoto what kind of policies the Japanese government is pursuing to achieve carbon neutrality, and what kind of energy innovation is required.



■ What Causes a Tight Electricity Supply-Demand Balance?

Yamada: The weather forecast says that snow will fall later today, and there have been many days with relatively low temperatures this winter, so there are concerns about a tight electricity supply-demand balance following on from last year. Soaring electricity prices are also putting pressure on our daily lives and finances. How do you see this situation?

Akimoto: I think that there are multiple factors at play, and they are intricately intertwined. One of those factors is the liberalization of the electric power industry, which Japan has been pursuing for over 20 years. Of course, liberalization has brought major benefits in terms of encouraging market participation and competition among the various industry players. On the other hand, with the introduction of market mechanisms for electricity supply and demand accompanying liberalization, there are less funds available for capital investment in equipment and facilities, which is necessary from a long-term perspective. In other words, the market works on short-term gains and losses, so electric power shortages do not immediately lead to an increase in supply. Especially in the case of large power sources such as nuclear power plants, it takes many years to see a return on the initial investment. Normally, a long-term perspective is essential to achieve an optimal state of electricity supply and demand. One of the root causes of the tight supply-demand balance we are seeing now is that this long-term perspective has not functioned well within the current market mechanism.

Yamada : So, the integration of the electricity supply into the market, which was initiated by liberalization, has made



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it impossible to make optimal investments from a long-term perspective. In addition to these systemic problems, Japan's economic growth has also slowed to a halt, and we can say that is another one of the reasons why investment is not increasing.

Akimoto: The introduction of the Feed-in Tariff (FIT) system for renewable energy—which is aimed at achieving decarbonization—has also further complicated the situation. Increasing renewable energy is crucial in order to achieve carbon neutrality. But as a result of rules to prioritize the use of renewable energy, which has zero marginal costs, existing power sources such as thermal power generation are being forced to withdraw. If the utilization rate of



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facilities declines, then investment will naturally become economically infeasible. Additionally, since the supply of renewable energy is unstable, if the amount of thermal power generation—which is more agile in responding to changes in demand—decreases, then it will not be possible to respond when a situation that exceeds expectations occurs. In other words, we can say that the tight electricity supply-demand balance that we are currently experiencing is, in a sense, an inevitable problem that has arisen in the course of the greater trends of the times.

■ The Situation Surrounding Rocketing LNG Prices

Akimoto: Another issue is that it has recently become difficult to secure supplies of liquefied natural gas (LNG). In particular, the cold winter of 2021 led to an increase in demand for LNG, and countries around the world bought up all the LNG they could get their hands on, resulting in a shortage of supply. The investment issue we touched on earlier is about the inability to secure kilowatts (kW)—that is, future power supply (power generation) capacity. But now we are talking about a shortage of kilowatt-hours (kWh)—that is, the amount of electricity needed now. Moreover, due to the situation in Ukraine, there is a constant, ongoing shortage of LNG. In order to secure it, LNG will continue to be purchased at high prices. I think that we will continue to bear the risks of tight LNG supply, the resulting shortage of kWh, and rocketing electricity prices for some time to come.

Yamada: Power consumption peaks in winter, especially from the evening onward. But if the ratio of variable-output power sources—especially solar power generation, which decreases after evening—in the energy mix increases, then an imbalance between supply and demand will inevitably occur. I feel that it will be a very great challenge to manage the electricity supply-demand balance from evening onward in the winter months, when power consumption peaks. Currently, we have no choice but to rely on power sources such as LNG thermal power generation.

Akimoto: Yes, it's just as you say. As for LNG, major economic powers such as Germany and China have bought up supplies, causing a situation where developing countries have been unable to buy it. From a standpoint of fairness and equity, we must consider how to ensure a stable supply



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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.

of energy for the world as a whole, and consider Japan's role and responsibilities in the international community.

■ Long-Term Decarbonized Power Supply Auctions that Contribute to Future Power Supply Capacity

Yamada: Mr. Akimoto, as a member of the Basic Policy Subcommittee of the Advisory Committee for Natural Resources and Energy, you engage in discussions on Japanese national energy policy. What kind of discussions are being held with regard to ensuring a stable supply of energy?

Akimoto: Against the backdrop of the issues, I mentioned at the beginning, measures to address structural shortages in power supply capacity are being discussed. As one of these measures, the capacity market^{*1} framework was introduced in 2020. However, what is traded under this framework is "capacity to supply power in four-years' time," and actual supply will begin from fiscal 2024 onward. The urgent issue is how to endure the current situation until then.

***1 The capacity market**

The capacity market was established in 2020 to secure power supply capacity (kW) for the whole of Japan in the future, as opposed to the power supply quantity (kWh) traded in the wholesale electricity market. In this market, the power generator is the seller and the power retailer is the buyer. The commodity being traded is power supply capacity for a period of one year, four years in the future. The aim of this system is to secure the power supply capacity that will be needed in four-years' time.

Additionally, even if supply does start in four years, it may collapse the following year as long as it relies on market mechanisms. In fact, prices have fluctuated greatly since the auction started, making it an unsuitable system for power sources that assume long-term operation, such as nuclear power. Large-scale power supplies cannot be built in four years, anyway, and this system does not provide sufficient follow-up.

The "Long-term Decarbonized Power Supply Auction" system has been considered as a response to this, and public applications will begin in fiscal 2023. In principle, the country (or other buyer) promises to purchase power for 20 years and gives a grace period until the start of operation, with the aim of encouraging investment in long-term power sources. As I strongly expressed in the subcommittee, this market includes a wide variety of power sources such as thermal power generation, hydrogen power generation, ammonia power generation, and CCS/CCUS^{*2}, as well as nuclear power. In this way, through competition, the system aims to increase the number of cost-effective power sources that contribute to decarbonization.

However, since a transition is also necessary and it is difficult to proceed with decarbonization all at once, bidding is allowed during the transition stage on the condition that the supplier shows a path to the future for transient power generation, such as dual firing with both hydrogen and ammonia or an LNG combined cycle.

Yamada: have high hopes for this new system, but I get the impression that it is somewhat lacking from the perspective of encouraging necessary investment in nuclear power generation. Even with the government's series of moves toward nuclear power generation, such as restarting nuclear existing power plants, constructing new plants and replacing old ones, and extending plant operating periods—will nuclear power generation be able to survive in a competitive market in the future? If (the government) believes that nuclear power is an indispensable source of power for achieving carbon neutrality, I would like to hope for further support on the policy front.

Akimoto: As you say, these systems alone are not sufficient, and the situation is still unpredictable. However, I do believe that these efforts will lead to greater predictability of investment returns. Personally, I expect that if this mechanism works well, then we will be able to encourage the continuous "metabolism" of power sources, which will contribute not only to the stable supply of energy but also to decarbonization.

■ Looking Ahead to Carbon Neutrality, Pursuing Economic Rationality

Yamada: Turning back to the world stage again, please tell us your impressions of attending the 27th Conference of the Parties to the UN Framework Convention on Climate Change (COP27).

Akimoto: The theme of the metaphorical "homework" taken away from COP26 was to dig deeper into emission reduction targets, but unfortunately this time we saw almost no progress with regard to this. Japan has also set a fairly challenging reduction target of -46% (compared to 2013) by 2030, and partly due to the situation in Ukraine there was no leeway for major powers such as China or developing countries to dig deeper into their targets.

At the same time, a major point of contention was the discussion on "loss and damage." This is a framework in which developing countries seek compensation from developed countries that have emitted large amounts of greenhouse gases, for losses and damages incurred as a result of disasters caused by climate change. However, while emissions from developed countries are decreasing, emissions from China, India, and Russia are also increasing, and discussions on this issue have run into difficulties. In the end, the greatest outcome of COP27 was the agreement to create a fund, as a compromise.

However, although an agreement has been reached, it is doubtful that it will be enforceable. For example, I don't think that the US government will contribute to the fund given the current state of Congress. Since the Paris Agreement, although each country has put forward different arguments, the world had been moving toward a single trend of working to solve the problem of climate change. But now the world is once again moving toward a state of division, as seen in the situation in Ukraine and the US-

*2 CCS/CCUS

CCS: Carbon dioxide Capture and Storage

CCUS: Carbon dioxide Capture, Utilization and Storage

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China confrontation. Practical problem solving is becoming increasingly difficult.

Therefore, now that it is difficult to realize carbon neutrality through international cooperation, I think it is crucial for us to develop cheaper energy supply technologies and move toward decarbonization while at the same time pursuing economic feasibility.

Yamada: That is a very convincing opinion. At present, the realization of carbon neutrality is still often regarded as a cost to reduce greenhouse gases. Certainly, from a short-term perspective, it is a cost, and there will inevitably be some reluctance. From the perspective of 2030 and 2050, though, achieving carbon neutrality is actually an opportunity to create new technologies and businesses, and can be said to be a form of growth strategy. If we regard achieving carbon neutrality as a growth strategy, then the pursuit of economic feasibility is essential. I believe that digital technologies will contribute greatly to this.

Akimoto: The use of digital technologies is very important. Looking ahead, in particular, I believe that managing the supply and demand of energy by successfully linking digital transformation (DX) with green transformation (GX), and making effective use of power-related data and linking it to new value will become very important key themes for Japan's (economic) growth.

■ Electricity Supply-Demand Management Using Digital Technologies

Yamada: You mentioned how utilizing digital technology will be important as we work to achieve carbon neutrality by 2050. Even with the current rocketing of energy prices, we should be able to keep prices down by using digital technologies skillfully to reduce waste. For example, it is

possible to set up a rate pricing plan based on the time of day, in which electricity rates are set higher during the evening, when demand is at its peak. Conversely, prices can be lowered significantly during the day in fine weather, when the amount of power generated by solar power plants increases. If efforts such as this lead to a change in the awareness and behavior of electricity consumers, the use of cheap and clean electric power will increase. If the number of electric vehicles (EVs) increases, home solar power generation becomes more widespread, and storage battery technology advances, then power supply and demand management will have a greater meaning in the future.

Akimoto: Because electricity—by its nature—is difficult to store, there are many situations where it is wasted, especially on the demand side. As you say, if we can optimally manage supply and demand by make skillful use of digital technologies when controlling time-related supply and demand imbalances, or adjusting regional supply-demand imbalances, I believe that this will offer great opportunities for growth.

Yamada: The key to achieving this is the smart meters installed at each home. In Japan, smart meters that measure power usage every 30 minutes have been installed in almost all households. As you know, Japan is the only country in the world to have achieved this so far. From fiscal 2025, we plan to sequentially replace those meters with next-generation smart meters with an even higher resolution of measurement. Going forward, it will be important to analyze the data obtained from these meters and link our findings to new services and solutions. If we can lead the way in this area, I believe that it can become an industrial strategy for Japan and also contribute significantly to achieving carbon neutrality in emerging countries.

○ State of smart meter installation

	Nationwide	Hokkaido	Tohoku	Tokyo	Chubu	Hokuriku	Kansai	Chugoku	Shikoku	Kyushu	Okinawa
Units (10,000 units)	6,917	262.6	492.0	2,840.0	759.2	128.2	1,225.5	338.2	184.6	630.2	56.0
Installation rate	85.7%	70.4%	72.6%	100%	79.5%	69.3%	93.6%	67.0%	69.5%	72.5%	61.5%

Figure 1: [State of smart meter installation]

Source: September 2021 Agency for Natural Resources and Energy, Electricity and Gas Industry Department, New Added Value Creation Utilizing Electricity
Data: Electricity Data and Smart Meters

■ Adding New Value by Combining Data

Akimoto: I think that by combining smart meter data with other Big Data sources, it may also be possible to create new value. After obtaining consent for the use of data, we believe that we can utilize it for CO₂ reduction while applying it to other services, such as in reducing waste due to redelivery by parcel delivery services, or creating optimal store opening plans for supermarkets. In other words, by looking at data on how people actually live in each community, findings can be utilized for energy management and optimal urban planning for entire cities.

The important point here is how we connect data across the board and link it to the creation of new value. To that end, we must actively communicate with other departments and fields and consider new businesses in a cross-sectoral manner. I think that flexible thinking is very important in order to create new value.

Yamada: In that sense, the activities of the Grid Data Bank Lab (GDBL)—which began with the union of TEPCO and Chubu Electric Power—have been taken over by GDBL Corporation, and the use of electric power data obtained from smart meter data is already underway.

Akimoto: In order to create new businesses using electricity data, I think we should design systems that make it easier for venture (startup) companies to enter the market, considering the ease of access to data. Otherwise, even if Japan is ahead in terms of smart meter installation, I am afraid that we will be overtaken by overseas competitors in the field of data utilization.

In view of this, we are focusing on the utilization of data for the development of CASE (Connected Autonomous Share & Service Electric) solutions. In the future, car sharing and ride sharing of fully autonomous vehicles will advance dramatically, and it may become possible to create a world where the car of your choice will come to pick you up when you need a ride. If this becomes a reality, reductions in CO₂ emissions will advance even in the transportation sector, which has been considered a difficult area until now. Since the number of automobiles itself will also decrease, the use of materials such as iron, plastic, rubber, and glass—which have been used heavily in automobile manufacturing until now—can also be reduced. In other words, CASE will cause a

simultaneous shift in the energy supply side and the demand side. In fact, I feel that, unless such dramatic changes occur, it will be difficult to realize carbon neutrality by 2050.

Yamada: With regard to CASE, over the course of five years between 2016 and 2021, Hitachi Europe conducted the world's largest ever demonstrative testing project, Optimize Prime, using more than 8,000 electric vehicles in London, UK. The purpose of this project was to collect data on EVs—owned by companies such as UK energy operator Centrica, UK postal giant Royal Mail Group, and the major US ride-hailing service Uber—to explore optimal charging facility networks and power supply solutions. As a result of this demonstration experiment, we were able to show that the mass introduction of commercial EVs around the world will contribute to the acceleration of carbon neutrality.

Akimoto: That's a very important initiative. Of course, these kinds of developments will transform the traditional business model of the automotive industry. In the future, the focus will shift from the actual cars themselves to initiatives such as transportation system management, which really utilize digital technologies to reduce energy consumption as a whole. It is important to see these changes as opportunities for growth across the country, and for companies to work on them across the board.

■ Nuclear Power is Essential for Energy Security and Stable Supply

Yamada: By the way, Mr. Akimoto, how do you regard the position of nuclear power generation in the energy mix with a view to achieving carbon neutrality?

Akimoto: Naturally, there are pros and cons to nuclear power, and I fully understand that there is some strong opposition to it, especially after an accident like the one at TEPCO's Fukushima Daiichi nuclear power plant. But I believe that we must assess all of the risks comprehensively based on the situation we are facing. In other words, how should we regard not only the risk of a nuclear accident but also the risks of climate change, energy security, stable supply, and economic viability? Nuclear power also an overwhelmingly superior power source to all others, despite the risks involved. In terms of economic viability, it is a relatively cheap source of power, and I still think that nuclear power is a necessary power source.

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Japan is poor in terms of energy resources, and has little flat land area available that is suitable for renewable energy. Hydrogen must also be imported from overseas. In addition, the manufacturing industry is strong in Japan, and power consumption is higher than in other countries. Energy is essential to sustaining the economy, and nuclear power is a very important means of generating it. Therefore, Prime Minister Kishida's August 2022 announcement of the government's direction of new construction, expansion, and replacement of nuclear power plants is a very correct decision, and it is necessary to move forward firmly.

Yamada: As a practical problem, though, I believe that the framework of the long-term decarbonized power supply auction system that I mentioned in the earlier of this discussion alone makes it difficult to build new nuclear power plants. Without new expansion and replacement, it will be difficult to secure a level of 20% nuclear power in the energy mix, as stated in the government's proposal.

Akimoto: Yes, that's very true. I think that it is necessary, for example, to introduce a scheme such as the RAB (Regulated Asset Base) model, which collects costs from consumers through regulated rates using the fully distributed cost method. In addition, since it is difficult to build completely new nuclear power plants, I think we have no choice but to think in the direction of expanding existing nuclear power plants.

In the future, if only Japan's electricity prices continue to rise under strict emission reduction targets, then companies may begin to relocate their manufacturing bases overseas. This could lead to a vicious cycle of declining demand for electricity, making it increasingly difficult to invest in nuclear power, and leading to a further increase in electricity prices. Of course, we should reduce our consumption of primary energy to decarbonize, but on the other hand, I think that we should aim to raise demand for electricity demand and supply electricity at affordable rates.

■ Long-Distance HVDC Power Transmission that Contributes to the Optimization of Distributed Power Generation and Transmission and Distribution Networks

Yamada: On the other hand, in the utilization of renewable energy, distributed power sources and transmission

and distribution networks are also major issues. The transmission and distribution grid networks of general power transmission and distribution companies are based on a consignment fee system, and the necessary costs can basically be recovered as electricity charges. Looking ahead, if power sources are decentralized due to the widespread adoption of renewable energy and on-site power generation—which does not utilize the transmission and distribution grids of general electric power companies—increases, then there is concern that the utilization rate of transmission lines will decrease. This will make it difficult to collect consignment fees, and, as a result, there will be a vicious cycle in which consignment fees will rise even further.

Akimoto: Currently, the Organization for Cross-Regional Coordination of Transmission Operators (OCCTO) is considering what kind of power grid should be built to achieve cost-effectiveness when renewable energy accounts for 50% in the energy mix. It is estimated that it will cost 6–7 trillion yen to augment the power grid, and it will not be easy to do it. However, we believe that this is an essential investment in increasing the percentage share of variable output power sources in the energy mix. In any case, it necessary to come up with a comprehensive plan, including how to make effective use of distributed power sources, and how to allocate demand. As one possible solution, we have high hopes for seabed DC transmission and long-distance, high-voltage DC (HVDC) transmission.

Yamada: High-voltage direct current (HVDC) systems are exactly what Hitachi is working on. However, since the costs involved in developing these systems are enormous, there is



Chubu Electric Power Grid Hida Shinano Frequency Conversion Facility: Hitachi delivered a high-voltage direct current (HVDC) system to this facility. Hitachi Energy products are used in the AC filters.

the challenge of how to reduce the risks involved in financing and investment recovery. Hitachi has the power transmission and distribution systems of Hitachi Energy (formerly the power grid division of ABB), but there is also the problem of how to adapt these overseas technologies for use in Japan.

Akimoto: This is exactly what the government is currently discussing, and I believe that it is necessary to provide support—including public financing—for the early development of these systems. Also, from an economic feasibility standpoint as I mentioned in the earlier of the discussion, I think that it is important for us to actively utilize overseas technologies from a medium to long-term perspective, while ensuring reliability.

There are only a few countries in the world that boast such technological capabilities aside from Japan. So, I think that Japan should continue to lead the way in carbon neutrality while creating new solutions with these technologies. In particular, we have high expectations for Hitachi, which is engaged in comprehensive infrastructure business operations, with nuclear power, renewable energy, and

digital solutions. I hope that you will present new systems that can manage supply and demand as a set, and help to change society for the better as we aim to achieve carbon neutrality.

Yamada: We will do our best to meet your expectations. Thank you very much for your time today.



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

- (Chapter 1)

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