Program Director Interview

PD Interview

12 Leading Experts Who Accelerate SIP

Realizing the next-generation energy management with IoE

Establish platform technology required in mass integration of renewable energy sources for social implementation

In Japan, the Greenhouse Gas (GHG) emission reduction goal by 2030 from the 2013 level was significantly increased to 46%, raising expectations for IoE (Internet of Energy) essential for energy conservation and mass integration of renewable energy sources. In realizing an IoE society, energy system design and establishment of IoE common platform technology, e.g., a USPM (Universal Smart Power Module) and WPT (Wireless Power Transfer), are urgent tasks. We interviewed program director (PD) KASHIWAGI Takao.

KASHIWAGI Takao

Distinguished Professor and Professor Emeritus, Tokyo Tech
Director, Solution Research Center
for Advanced Energy Systems (AES)

An IoE Society is a society where people really feel the comfort and affluence

Q: Please tell us about the concept and significance of an "energy system for an IoE society?"

PD: An IoE (Internet of Energy) society is a society where the information on supply and demand of energy is connected through the Internet, and one where we can feel the comfort and affluence.

Electrification of society toward the goal of carbon neutrality, especially electrification of automobiles, is becoming increasingly important. Accordingly, we have been implementing sector coupling (integration of sectors) of universal energy networks and transportation management, creating a database, and constructing an energy system design for an IoE society. Our theme should be fairly comprehensive, as it contains climate change issues, energy conservation, and a decarbonized society, etc., based on discussions at the Leaders Summit on Climate in 2021.

Mass integration of renewable energy sources utilizing solar and wind power is important; however, it still suffers substantial fluctuations such as those due to the weather. Therefore, we are working on optimization of energy utilization and development of its component technology, i.e., an energy conversion/transmission system, with conventional large power sources, e.g., hydropower and nuclear power as the baseload power source.

Contributing to the goal of a "46% reduction" from a scientific viewpoint and taking the global initiative

Q: The GHG emission reduction goal by 2030 from the 2013 level was significantly increased to 46%. How can this program contribute to it?

PD: Although it is very difficult, I think the goal is still feasible. Lately, we often hear about "DX (digital transformation)," and digitalization will enable external automatic balancing of the control of energy supply and demand at an optimal level. Therefore, it is a matter of the objective function, in other words, what we will set as the most important goal. If it is to reduce GHG emissions, we should focus on realization of carbon neutrality. If it is to minimize the cost, we can propose the optimal system to achieve it. After all, we highly value optimization of the energy system, according to the objective function, from quantitative and scientific viewpoints.

In this case, the cost becomes an issue in achieving the goal of a 46% reduction; however, we can contribute to cost reductions by using the technology we have been developing through our project. I believe we will be able to take the global initiative if we utilize our technology for mass production.

Q: How do you proceed with economic evaluation for social implementation?

PD: Economic evaluation is important for social implementation.Major factors concerning energy management systems are next-generation power electronics using USPM and wireless power transfer. We are conducting benefit evaluations

of these as revolutionary energy devices and economic efficiency analysis as efforts to develop renewable energy into the main power supply.

Automate charging and flight of UAVs by utilizing wireless power transfer system

Q: What is a USPM (Universal Smart Power Module)?

PD: It is a new high-speed digital power converter with features such as high efficiency, low cost, and high versatility. A USPM enables a manufacturer without technical know-how in designing power electronics devices to enter the global market, rapidly accelerating energy conservation and integration of renewable energy sources utilization. Specifically, Japan has the advantage in gallium-based materials such as GaN (gallium nitride) and Ga_2O_3 (gallium oxide). Professor AMANO Hiroshi was awarded the 2014 Nobel Prize for the invention of blue light-emitting diodes using GaN for the first time in the world. Professor AMANO has also greatly contributed to our project. We have developed GaN semiconductor power devices with his help, advancing blue light-emitting diodes to power electronics. Moreover, the power transistor using Ga_2O_3, which is being developed by a venture company, one of the participants of our project, has produced great results and it was awarded the Grand Prize in the semiconductor device sector at "Semiconductor of the Year 2020" (sponsored by Sangyo Times, Inc.).

As mass integration of renewable energy sources requires a semiconductor power device made of gallium-based materials and a USPM, In other words, technology that utilizes the unique and excellent properties of gallium plays an important role. This is because it is required to act just like a smart inverter, manage the system properly, and control electric power consumption with optimal efficiency. As Japan has a major national goal, we expect significant results from technology our project can offer.

Q: Can you tell us about WPT (Wireless Power Transfer)?

PD: WPT has various usages, for example, inspection of power transmission lines, which are the infrastructure to support carbon neutrality. We are conducting a demonstration experiment to verify if unmanned aerial vehicles (UAVs) can inspect power transmission lines. Utilization of wireless power transfer makes power charging easier, enabling a long-duration flight with the minimum amount of batteries and safe inspections and patrols. We recognize the increased demand for utilizing UAVs in quickly understanding the status of damage caused by typhoons, etc., in early stages and users' anticipation for earlier practical application. Accordingly, we will accelerate the social implementation of UAVs, while steadily establishing technology for automatic charging and flight of UAVs.

Also, we are developing a WPT system for indoor sensors, provided it is used safely and securely in an environment surrounded by humans. The first wireless power transfer technology in the world is expected to be realized, allowing transmission antennas placed on ceilings, etc., to selectively supply power to multiple sensors which require electricity and to control beams to avoid humans' exposure to electric waves.

Collaboration with local governments for more resilient energy system in the community

Q: How do you collaborate with local governments, etc.?

PD: We regard it as important to demonstrate the effectiveness of next-generation energy management based on actual data. For example, Utsunomiya City is very cooperative in sharing data and advancing the research on a regional distributed energy system. Based on such case study, we plan to formulate guidelines to design a regional energy system. A microgrid, etc., utilizing distributed energy resources is effective for a more resilient energy system and regional management will be important.

Then, sophisticated technology for high-speed digital conversion will be required, as renewable energy is very unstable. This is the area USPM can be effectively used. Also, batteries for electric vehicles including electric buses serve a function as a mobile energy storage system. We can charge our electric vehicles with renewable energy at home and discharge the excess into the charge/discharge device at a store while we are out before coming home. Through such "energy exchange," automobile electrification will be even more useful for effective usage of renewable energy.

Q: Only two years remain for the second period of the program. Can you share the outlook until the end of 2022?

PD: To make achieving the goals, such as 46% reduction of GHG by 2030 and realization of carbon neutrality by 2050, more realistic, we believe development of our technology is essential. As we have steadily made strides forward toward the goals, we will continue advancing technology development based on science in an effort to demonstrate the results for social implementation.