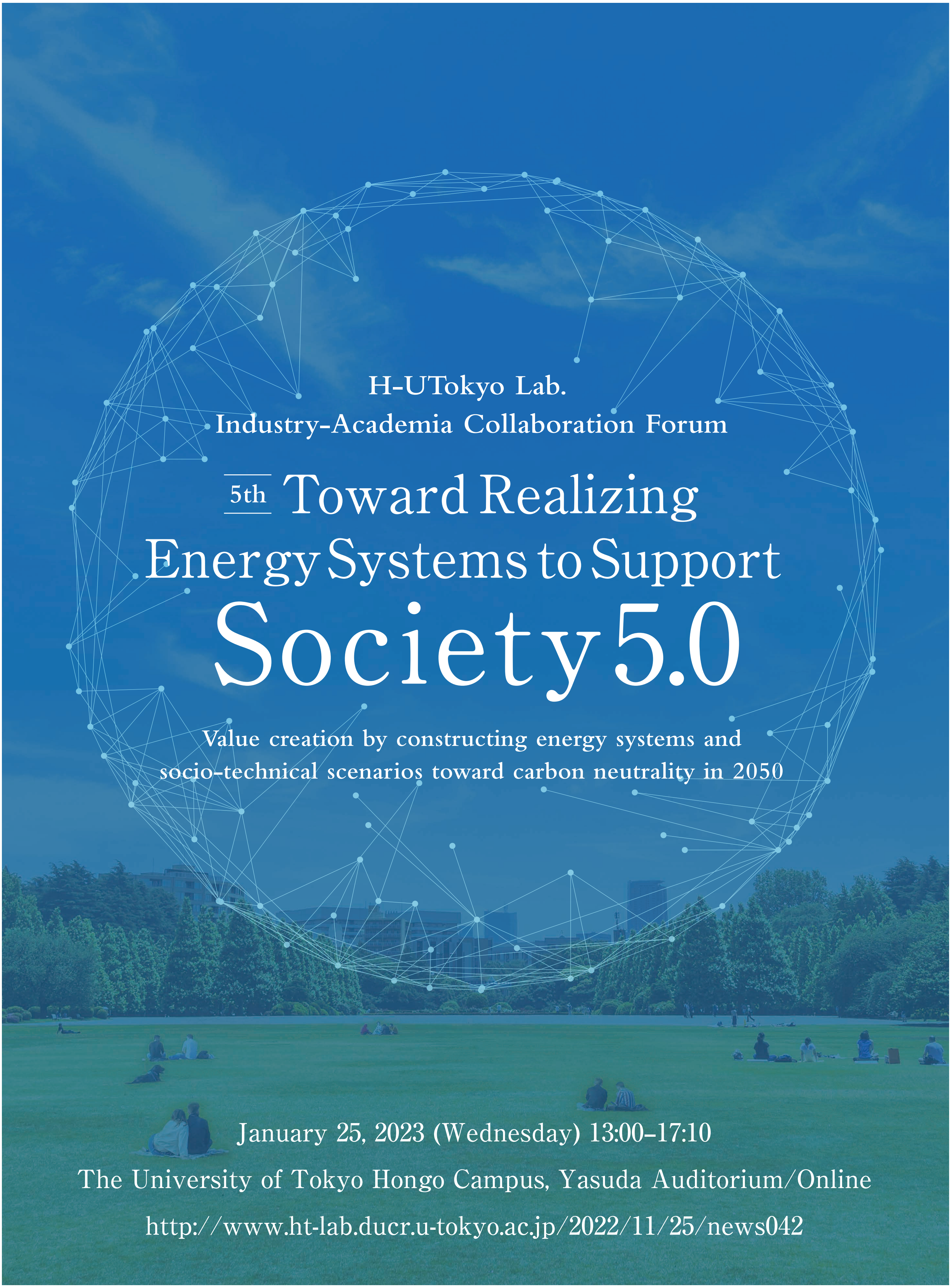


東京大学 THE UNIVERSITY OF TOKYO

H-UTokyo Lab.

HITACHI Inspire the Next

PROGRAM

Facilitators

Shinobu Yoshimura, Vice President, The University of Tokyo, Director, H-UTokyo Lab.

Atsushi Baba, General Manager, Center for Technology Innovation–Decarbonized Energy, Research & Development Group, Hitachi, Ltd.

1 Opening Remarks (13:00-13:10)

Teruo Fujii, President, The University of Tokyo

2 Video Message (13:15-13:30)

Professor Mary Ryan | Vice-Provost (Research and Enterprise), Imperial College London

3 H-UTokyo Lab. Activities and Proposal Overview (13:30-13:45)

Shinobu Yoshimura, Vice President, The University of Tokyo, Director, H-UTokyo Lab.

4 Reports from H-UTokyo Lab. (13:45-15:35)

Part 1 Energy Transitions (13:45-14:05)

○ **Energy transitions and insights based on international and social situations**

Hideaki Shiroyama, Professor, Graduate School of Public Policy, The University of Tokyo

Tomoko Suzuki, Corporate Chief Engineer, Research & Development Group, Hitachi, Ltd.

Part 2 Energy Systems to Support Society 5.0 (14:10-14:50)

○ **S+3E of bulk power systems toward a carbon neutral society**

Akihiko Yokoyama, Professor Emeritus, The University of Tokyo

○ **Energy coordination and control platform to provide a stable supply of energy through coordination of local resources**

Kazuhiko Ogimoto, Project Professor, Institute of Industrial Science, The University of Tokyo

○ **Sustainable energy innovation together with local communities**

Tomomichi Ito, Senior Manager, Center for Technology Innovation–Decarbonized Energy, Hitachi, Ltd.

Part 3 Energy and Social Innovation Led by Digital Technologies (14:55-15:35)

○ **Energy simulations envisioning carbon neutrality in 2050**

Ryoichi Komiyama, Professor, Graduate School of Engineering, The University of Tokyo

○ **Ryoichi Komiyama, Professor, Graduate School of Engineering, The University of Tokyo**

Naoki Yoshimoto, Senior Researcher, Center for Technology Innovation–Decarbonized Energy, Hitachi, Ltd.

○ **Energy policies toward carbon neutrality to achieve a sustainable society and industry**

Hiroshi Ohashi, Vice President, The University of Tokyo

Break (15:35 -15:55)

5 Panel Discussion (15:55-17:00)

『Value Creation through Energy and Regional Innovation Led by Data』

Predictability in management and solutions based on data and premised on energy S+3E is important in making a transition to carbon neutrality. In addition, the use of data in local communities including data on energy customers not only has a large effect on the calculation of Scope 3 greenhouse gas supply-chain emissions but also on regional value creation. This panel discussion will take up value creation through energy and regional innovations based on data.

Facilitators：

Shinobu Yoshimura, Vice President, The University of Tokyo, Director of H-UTokyo Lab.

Tomoko Suzuki, Corporate Chief Engineer, Research & Development Group, Hitachi, Ltd.

Panelists：

Tokunari Anai, Manager, Inter-regional Power Exchange Promotion Office, Corporate Management and Planning Unit, Tokyo Electric Power Company Holdings, Inc.

Yuji Inoue, Manager, Carbon Neutral Strategy Office, Corporate Planning Division, Tokuyama Corporation

Kaname Ogawa, Director, Electricity Infrastructure Division, Electricity and Gas Industry Department, Agency for Natural Resources and Energy

Yasushi Motojima, Deputy Counselor, Planning and Policy Department, and Director, Planning and Coordination Division–Smart City Promotion Office, Aizuwakamatsu City Hall

Mari Yoshitaka, Fellow, Principal Sustainability Strategist, Mitsubishi UFJ Research and Consulting Co., Ltd., Visiting Professor, College of Arts and Sciences, The University of Tokyo

Hiroshi Ohashi, Vice President, The University of Tokyo

6 Closing Remarks (17:00-17:10)

Norihiro Suzuki, Vice President & Executive Officer, CTO, General Manager of Research & Development Group, Hitachi, Ltd.

Hiroaki Aihara, Executive Vice President, The University of Tokyo

Poster Session (17:20～18:10)

A poster session has been set up to enable forum participants to directly discuss current studies. Please stop by!

Venue: Yasuda Auditorium, 3rd Floor Gallery

PROFILE

Teruo Fujii

President, The University of Tokyo

Teruo Fujii graduated from the Faculty of Engineering, The University of Tokyo in 1988 and received his Ph.D. in engineering from the School of Engineering, The University of Tokyo in 1993. After serving as an associate professor at the Institute of Industrial Science (IIS), The University of Tokyo and as a researcher at RIKEN, he became a full professor at IIS in 2007 and Director General of IIS in 2015. He served as Executive Director and Vice President, The University of Tokyo from 2018 and as Executive Vice President, The University of Tokyo from 2019 before assuming his present position in 2021.

Toshiaki Higashihara

Director, Executive Chairman, Representative Executive Officer, Hitachi, Ltd.

Toshiaki Higashihara entered Hitachi, Ltd. in 1977 after graduating from the Faculty of Engineering, Tokushima University. After serving as Senior Manager of Transportation Systems Design Division, Omika Works, Power and Industrial Systems Group, General Manager of Public Utility and Energy Industry Information Systems Division, Information & Control Systems Division, System Solutions Group, Director and General Manager of Information & Control System Division, Information & Telecommunication Systems Group, Vice President and Executive Officer and COO of Power Systems Group, and Senior Vice President and Executive Officer in charge of Medical Systems Business, he assumed the office of Director, Representative Executive Officer, President and COO in 2014. He assumed his present position in 2022.

Mary Ryan

Vice-Provost (Research and Enterprise), Imperial College London

Mary Ryan is currently Professor of Materials Science and Nanotechnology, and Vice-Dean for Research in the Faculty of Engineering. She joined Imperial in 1998 from Brookhaven National Laboratory in the US where she was assistant scientist in the Materials-Environment Interactions Group. She graduated from Manchester University with a Joint Honours degree in Mathematics and Physics and was then awarded a PhD in Materials Science.Her research spans diverse application areas including: energy materials, nanomaterials for bio-sensors and therapies; the mechanisms that lead to human and environmental toxicity associated with nanostructures, and the potential of nanomaterials for environmental remediation (in particular for nuclear waste). She was elected Fellow of the Royal Academy of Engineering in 2015 and is a Fellow IoM3and of the Institute of Corrosion.Her research spans diverse application areas including: energy materials, nanomaterials for bio-sensors and therapies; the mechanisms that lead to human and environmental toxicity associated with nanostructures, and the potential of nanomaterials for environmental remediation (in particular for nuclear waste). She was elected Fellow of the Royal Academy of Engineering in 2015 and is a Fellow IoM3and of the Institute of Corrosion.

Shinobu Yoshimura

Vice President, The University of Tokyo, Professor, School of Engineering, The University of Tokyo, Director, H-UTokyo Lab.

Shinobu Yoshimura received his Ph.D. from the School of Engineering, The University of Tokyo in 1987. Then, after serving as a lecturer and associate professor in the Faculty of Engineering, and as a professor in the Graduate School of Frontier Sciences, The University of Tokyo, he became a professor in the School of Engineering in 2005. He became an Advisor to the President in 2009 and served as Head of the Public Relations Office, Vice Dean of the School of Engineering, and Education and Research Councilor before assuming his present position in 2017. He has been Director of the H-UTokyo Lab. since April 2019. His fields of specialization are computational mechanics and system design science. He has served as Vice President of the International Association for Computational Mechanics (IACM) and President of the Asian Pacific Association for Computational Mechanics (APACM). He is currently a member of the Science Council of Japan, where he serves as Chairperson of Section 3. He is a recipient of the IACM Fellow Award (2014), the APACM Computational Mechanics Award (2013), and other awards.

Hideaki Shiroyama

Director, Institute for Future Initiatives,Professor at the Graduate School of Public Policy and Graduate Schools for Law and Politics, The University of Tokyo

Hideaki Shiroyama graduated from the Faculty of Law, The University of Tokyo in 1989. He became an associate professor and professor at the Graduate Schools for Law and Politics in 1994 and 2006, respectively. He is a professor at the Graduate School of Public Policy (2010–). He has served as Director of Policy Alternatives Research Institute (2010–2014), Dean of the Graduate School of Public Policy (2014–2016), and Vice Director of the Institute for Future Initiatives, The University of Tokyo (from 2019). He concurrently serves as Director of the Institute for Future Initiatives. He specializes in public administration, international administration, science/technology and public policy, and the policy formation process.

Tomoko Suzuki

Corporate Chief Engineer, Research & Development Group, Hitachi, Ltd.

Tomoko Suzuki entered Hitachi, Ltd. in 1992. After working in the research and development of hydrogen manufacturing processes from natural gas and coal and managing a project for creating new businesses through co-creation with customers, she assumed her present position in 2020. She is a member of the Japan Society of Mechanical Engineers (JSME) and Society for Chemical Engineers (SCEJ).

Akihiko Yokoyama

Professor Emeritus, The University of Tokyo

Akihiko Yokoyama received his Ph.D. in Engineering from the Department of Engineering, School of Engineering, The University of Tokyo in 1984. He became an Assistant, Lecturer, and Associate Professor in the Faculty of Engineering, The University of Tokyo in 1984, 1985, and 1989, respectively, and Professor in Department of Electrical Engineering and Information Systems, School of Engineering, The University of Tokyo in 2000. He was also Professor in Department of Advanced Energy, School of Frontier Sciences, The University of Tokyo from 2008 to 2019. After retiring in 2022, he assumed the position of Professor Emeritus, The University of Tokyo.

Kazuhiko Ogimoto

Project Professor, Institute of Industrial Science, The University of Tokyo

Kazuhiko Ogimoto graduated from the Faculty of Engineering, The University of Tokyo in 1979 and joined J-POWER in the same year. He has held his present position since 2008. His fields of research include energy technology strategy as energy system integration, analysis and evaluation of materials and energy supply and demand, analysis and evaluation of dynamic energy supply and demand, centralized/distributed energy management and introduction of reusable energies, diagnosis and evaluation of energy systems, and risk assessment.

Tomomichi Ito

Senior Manager, Environmental Systems Research Department, Center for Technology Innovation–Decarbonized Energy, Research & Development Group, Hitachi, Ltd.

Tomomichi Ito joined Hitachi, Ltd. after completing his graduate studies at Hokkaido University in 2000. He was assigned to the Hitachi Research Laboratory where he was engaged in the development of large-capacity power electronics products for grid connections. He resided in Aachen, Germany from September 2008 to January 2010 as part of a joint research program with RWTH Aachen University. During this time, he worked on increasing the capacity of photovoltaic (PV) simulators for evaluating the performance of inverters used in solar power generation. After returning to Japan, he became head of research themes related to the development of industrial power electronics and energy management products.

Ryoichi Komiyama

Professor, Graduate School of Engineering, The University of Tokyo

Ryoichi Komiyama received his Ph.D. from the Department of Electrical Engineering and Information Systems, School of Engineering, The University of Tokyo in 2003. He has served as a senior researcher at the Institute of Energy Economics, Japan (IEEJ) and as an assistant professor and associate professor at The University of Tokyo. He assumed his present position in 2022. He specializes in the numerical simulation and analysis of energy systems and the analysis of energy and environmental policies.

Naoki Yoshimoto

Senior Researcher, Environmental Systems Research Department, Center for Technology Innovation–Decarbonized Energy, Research & Development Group, Hitachi, Ltd.

Naoki Yoshimoto received his Ph.D. in Engineering from the Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology in 2003. He joined Advanced Research Laboratory, Hitachi, Ltd. in the same year. He has been a member of H-UTokyo Lab. since 2017. He specializes in environmental functional materials, energy management, and the application of renewable energy to construction facilities. He is a Professional Engineer of Japan (Chemistry, Comprehensive Technical Management) and member of the Society of Polymer Science, Japan, Architectural Institute of Japan, Japan Society of Applied Physics, and Chemical Society of Japan.

Hiroshi Ohashi

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

Hiroshi Ohashi completed his master’s course at the Graduate School of The University of Tokyo in 1995 and obtained a doctor’s degree from Northwestern University in the United States in 2000 (Ph.D. in economics). He served as Assistant Professor in the Sauder School of Business at the University of British Columbia in Canada and as Associate Professor of the Graduate School of Economics, the University of Tokyo before assuming his present position in 2022. He specializes in industrial organization theory and energy policies. He has served on various committees including the Advisory Committee for Natural Resources and Energy and the Electricity and Gas Market Surveillance Commission. He has been a recipient of the Ishikawa Prize (Japanese Economic Association), the Enjoji Jiro Prize (Japan Center for Economic Research), and other awards.

Tokunari Anai

Manager, Inter-regional Power Exchange Promotion Office, Corporate Management and Planning Unit, Tokyo Electric Power Company Holdings, Inc.

Tokunari Anai joined Tokyo Electric Power Company (former name) in 1995. He was initially engaged in power systems planning, supply and demand planning, power-source development planning, and power system reforms in the Technology Planning Department. As manager of the Inter-regional Power Exchange Promotion Office of the Corporate Management and Planning Unit in Tokyo Electric Power Company Holdings, Inc., he is engaged in the wide-area power market based on power system reforms, analysis of power systems, expanded introduction of renewable energy, and business strategy measures.

PROFILE

Yuji Inoue

Manager, Carbon Neutral Strategy Office, Corporate Planning Division, Tokuyama Corporation

Yuji Inoue received his Ph.D. from the Interdisciplinary Graduate School of Engineering Sciences (IGSES), Kyushu University in 1997 and entered Tokuyama Corporation in the same year. After working on the manufacture and technology development of polycrystalline silicon and serving as Deputy General Manager of manufacturing at the Tokuyama Malaysia plant, he became the General Manager of Si Manufacturing at the Tokuyama Factory in 2019. He became Deputy General Manager of Tokuyama Factory in 2020 and placed in charge of planning initiatives for reducing CO2 emissions. He assumed his present position in 2021.

Kaname Ogawa

Director, Electricity Infrastructure Division, Electricity and Gas Industry Department, Agency for Natural Resources and Energy

Kaname Ogawa studied abroad at Yale University and obtained a master' s degree in international relations in 2000. He worked at The Mission of Japan to the European Union in Brussels, Belgium for a two-year period beginning in 2008. After returning to Japan, he became an advisor to the Director of the Policy Planning Division, Electricity and Gas Industry Department, Agency for Natural Resources and Energy in 2010. He then worked on energy policies for about three years following the Great East Japan Earthquake in 2011, and in 2015, took on the role of coordinating growth strategies as Special Assistant for Planning in the Economic and Industrial Policy Bureau and Special Assistant to Japan' s Economic Revitalization of the Cabinet Secretariat. From the same year to 2018, he worked on implementing power system reforms as Director of the Electricity Industry and Market Office, Agency for Natural Resources and Energy. From the summer of 2018, he took up tax reforms as Director of the Corporate Affairs Division and pushed through unprecedented tax measures for two years straight such as fundamentally revising vehicle taxes in 2018 and formulating open innovation tax incentives in 2019. He also endeavored to improve work-life balance in the workplace and received the Workstyle Innovation Award as a first for the Corporate Affairs Division in 2019. He assumed his present position in 2020.

Yasushi Motojima

Deputy Counselor, Planning and Policy Department, and Director, Planning and Coordination Division–Smart City Promotion Office, Aizuwakamatsu City Hall

Yasushi Motojima joined Aizuwakamatsu City Hall in 1984. He served in the General Affairs Division (in charge of electronic computing), General Affairs Department in 1991, which was reorganized as the Information Policies Division, General Affairs Department in 2000, and served as Director of the Information Policies Division, General Affairs Department in 2016, which was reorganized as the Information Statistics Division, Planning and Policy Department in 2019. He has been holding concurrent positions as Deputy Counselor, Planning and Policy Department and Director, Planning and Coordination Division–Smart City Promotion Office since 2021.

Mari Yoshitaka

Fellow, Principal Sustainability Strategist, Mitsubishi UFJ Research and Consulting Co., Ltd., Visiting Professor, College of Arts and Sciences, The University of Tokyo

Mari Yoshitaka has worked at IT companies, investment banks in the United States, and other firms. She holds an M.S. from the University of Michigan, School for Environment and Sustainability and a Ph.D. from the Graduate School of Media and Governance, Keio University. She has been engaged for many years in environmental finance consulting both in Japan and overseas and has used her experience to provide advice to a variety of sectors in fields such as ESG investing, SDG business, climate change, and sustainable finance. She holds concurrent posts at MUFG Bank and Mitsubishi UFJ Morgan Stanley Securities. She is a guest lecturer at the Graduate School of Media and Governance, Keio University and serves on the committees of various councils in Japan.

Norihiro Suzuki

Vice President & Executive Officer, CTO, General Manager of Research & Development Group, Hitachi, Ltd.

Norihiro Suzuki entered Hitachi, Ltd. after receiving his master' s degree from the Graduate School of Engineering, The University of Tokyo in 1986. After working in the research and development of digital image signal processing, embedded systems, and other technologies, he was appointed Vice President & Executive Officer and CTO of Hitachi America, Ltd. in 2012, General Manager of Central Research Laboratory in 2014, General Manager of Global Center for Social Innovation, Research & Development Group in 2015, and Vice President & Executive Officer, CTO, and General Manager of Research & Development Group in 2016. He holds a Ph.D. in Engineering.

Hiroaki Aihara

Executive Vice President, The University of Tokyo

Hiroaki Aihara graduated from the Faculty of Science, The University of Tokyo in 1978 and received his M.S. from the Graduate School of Science, The University of Tokyo in 1980. He received his Ph.D. in Science in 1984 (The University of Tokyo). His specialty is high-energy elementary particle physics. He assumed the position of Assistant in the Faculty of Science, The University of Tokyo in 1984, Associate Professor in the Physics Division of the Lawrence Berkeley National Laboratory, University of California in 1991, Professor in the Graduate School of Science, The University of Tokyo in 2003, and Dean of the Graduate School of Science in 2012. He assumed his present position in April 2021. He is the author of “Physics of Elementary Particles” (University of Tokyo Press, 2006).

Atsuhi Baba

General Manager, Center for Technology Innovation–Decarbonized Energy, Research & Development Group, Hitachi, Ltd.

Atsushi Baba joined Hitachi, Ltd. after receiving his Ph.D. from the Department of Applied Nuclear Engineering, Graduate School of Engineering, Kyushu University in 2000. After working in the research and development of inspection technologies for power generation plants and social infrastructures at Power & Industrial Systems R&D Laboratory, Energy & Environmental Systems Laboratory, and Hitachi Research Laboratory, he held various management posts at the Technology Strategy Office and Mechanical Innovation Center. As General Manager of the Center for Technology Innovation–Decarbonized Energy, Research & Development Group (current position since 2021), he is promoting R&D in the environmental and energy fields. He holds a Ph.D. in Engineering. He is a member of the Atomic Energy Society of Japan (AESJ), IEEE, and the Japanese Society for Non-Destructive Inspection.

EXECUTIVE SUMMARY

The H-UTokyo Lab. (Hitachi and U-Tokyo Joint Research) has so far published up to Version 4 of its proposal titled "Toward Realizing Energy Systems to Support Society 5.0." By creating transition scenarios in a variety of domains as starting points by forecasting backward in time (backcasting) from 2050, the Proposal has pointed out that processes toward carbon neutrality require adjustment capacity and a stable power supply to make maximum use of renewable energy as well as innovative carbon absorption techniques in fields that are difficult to electrify. Furthermore, to meet those requirements, it has proposed systems and policies to facilitate transitions in the industrial world. The Proposal has also placed importance on evaluating adjustment capacity and economic performance when attempting to harmonize an energy system with a regional area and on circulating resources and materials as deemed necessary for achieving a sustainable society.

At the same time, dramatic changes in the international situation, such as the sudden invasion of Ukraine by Russia in February 2022, are causing disruptions in society such as steep rises in the price of crude oil, LPG, minerals, electric power, and other resources, tightening in the supply and demand for power, and rising commodity prices. These conditions make it necessary to manage carbon neutrality while also adhering closely to the concept of S+3E (Safety + Energy security + Economic efficiency + Environmental sustainability) to ensure energy supplies and economic security.

At this, the 5th Industry-Academia Collaboration Forum, we will be looking back at the activities of the H-UTokyo Lab. to date while also giving thought on how achieving Society 5.0 to enrich society will affect the energy sector based on data. To this end, we will create energy transition scenarios and compile insights on achieving a carbon-neutral society. In this regard, we have attempted to quantitatively analyze energy systems based on data and conduct simulations linking an urban vision of the future with the supply and demand of energy. We will deepen our discussions on achieving energy systems to support Society 5.0 with a view to analyzing and evaluating complex and intertwined issues in a comprehensive manner and finding solutions.

“Transition Scenarios” for Achieving Carbon Neutrality by 2050

H-UTokyo Lab. has been creating “transition scenarios” to show the pathways to future changes that must take place in energy, industry, and the general public to achieve carbon neutrality by 2050. We have been describing multidimensional “domain scenarios” and examining international cooperation, consensus building, structural switchover in industry, etc. from a wide range of viewpoints based on the analysis of diverse actors and public discussions. We have also been presenting ways of achieving sustainable prosperity taking into account current changes in international geopolitics and initiatives in Japan’s many regions.

Transition scenarios for achieving carbon neutrality by 2050

Achieving carbon neutrality by 2050 in Japan will require long-term and multidimensional reforms in a wide range of fields. This is because the goal of essentially reducing carbon emissions to zero is something that can only be met by structural switchovers in society and the economy through the collective efforts of the government, the corporate world, and the general public.

H-UTokyo Lab. has been creating transition scenarios for achieving carbon neutrality by 2050. Transition scenarios qualitatively describe the pathways to future changes in energy, industry, and the general public deemed necessary to achieve carbon neutrality in Japan.

Interviewing experts, analyzing diverse actors, and describing domain scenarios

H-UTokyo Lab. has been performing analyses from a variety of viewpoints to create multidimensional scenarios. In particular, we have been analyzing a diverse array of actors involved in social transitions while interviewing about 40 experts from the social, private, and public sectors from FY2020 on. We have also been collecting knowledge on issues and long-term outlooks in each domain by conducting analyses and holding public discussions based on studies of existing statistics and reports.

Using this knowledge as a basis to work from, we described the pathways to changes in 14 fields as “domain scenarios” involving energy, industry, and the general public as envisioned for achieving carbon neutrality. Each of these domain scenarios incorporate two cases, “100% renewable energy” and “diverse energy,” in relation to the configuration of power sources in Japan in 2050.

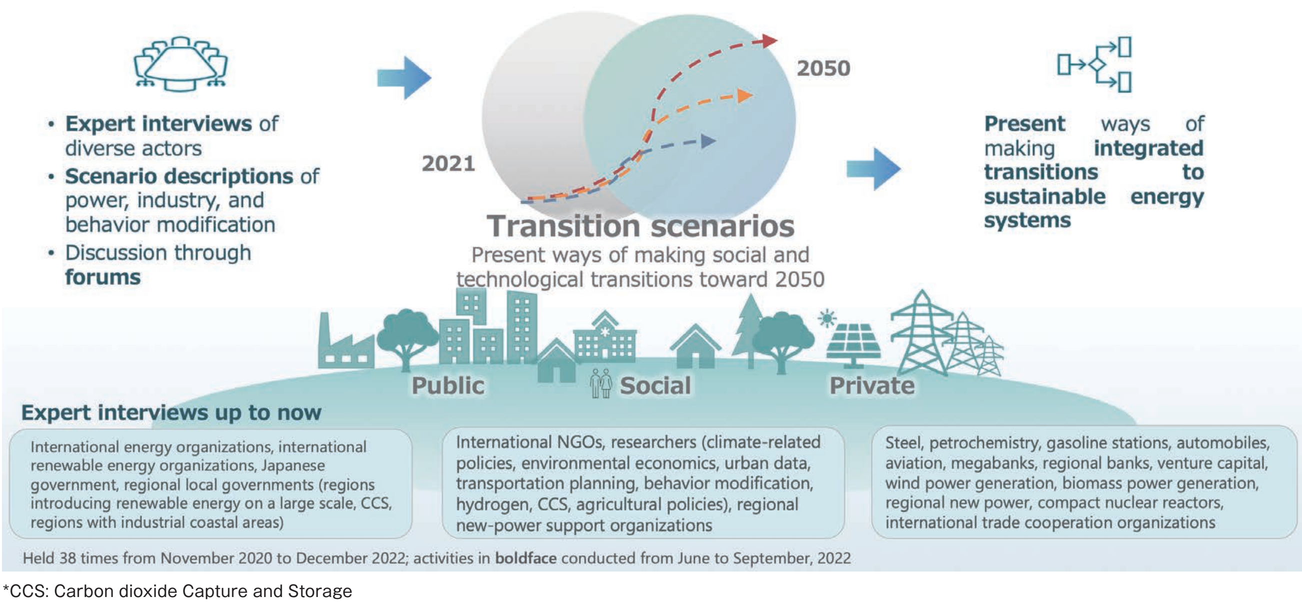
In this way, we are presenting people in Japan’ s diverse regions with approaches to achieving carbon neutrality and sustainable prosperity. These include cooperation that extends beyond national borders, consensus building on measures such as Carbon Capture and Storage (CSS), and fair decision-making involving the participation of the public, the corporate world, and the government, as well as long-term investments in innovative decarbonization methods, structural switchover in industry, and the creation of green jobs.

International geopolitical landscape surrounding energy and decarbonization switchover in Japan’s regions

In 2021–2022, amid the effects of climate change and the COVID-19 pandemic, international geopolitics underwent a major upheaval over Russia’ s invasion of Ukraine and the subsequent energy crisis. In particular, the European Union (EU) drew up energy-saving and renewable energy targets to reduce its dependency on Russian fossil fuels and announced measures to accelerate renewable energy projects and other energy-related initiatives.

In Japan, a variety of regionally led decarbonization projects are underway. In Akita Prefecture, for example, the large-scale offshore wind power generation business is moving forward with the participation of local governments, regional electric power companies, regional banks, and fishermen. Additionally, the Coastal Area Department of Kawasaki City, Kanagawa Prefecture continues to face the challenges of making a large-scale switchover from a chemical complex formed during Japan’ s high-growth period. In either case, there were calls for the government to design a cross-sector system.

In addition, new conditions are arising against the background of the current energy crisis. In particular, what with climate change and tightening in the supply and demand for power, the Japanese government is in the process of changing its nuclear power policies. It has announced, for example, the restarting of idle nuclear power plants, extension of the operating period of aging nuclear power plants, and accelerated development and construction of advanced nuclear reactors. The transition scenario here points out the need for national discussions on such issues as the cost competitiveness of nuclear power in providing a low-priced, stable source of power in comparison to renewable energy and the processing of radioactive waste.



*CCS: Carbon dioxide Capture and Storage

S+3E of Bulk Power Systems toward a Carbon Neutral Society

Accompanying the revision of energy scenarios based on the international situation and the growth of renewable energy along with regional disparities within Japan, the following issues dealing with bulk power systems have been newly identified and measures have been proposed.

(1) Form of transition processes to carbon neutrality considering uncertainty in energy prices and configuration:

・Effects on the growth of renewable energy, on changes in the use of hydrogen, and on stable power supplies given the risks involved in fuel prices have been examined along with the gap between forecasting and backcasting.

(2) Issues and their countermeasures in making a transition to carbon neutrality:

・Measures for achieving a stable power supply and system stabilization through nuclear power, inverter power supply control, and other technologies and measures for strengthening wide-area systems such as by high-voltage direct current (HVDC) power transmission, measures for enhancing congestion monitoring, etc.

・Need for supply-and-demand-based resource usage and cooperation based on the characteristics of local communities

Background

H-UTokyo Lab. has tested the effects of multiple scenarios and measures with the purpose of applying appropriate measures to expand renewable energy and deal with the increasing demand for power. At the previous Forum, we presented the results of studying the following items:

(1) importance of a stable power supply, (2) arrangement of energy storage for achieving a stable supply, and (3) a society in which consumers select decarbonization.

However, subsequent changes in the international situation have brought forth new issues in the form of steep rises in the price of fuel and electric power and a tightening in the supply and demand for power. Under these conditions, we this time present a revision to energy scenarios toward carbon neutrality, extract new issues, and propose appropriate measures to resolve those issues.

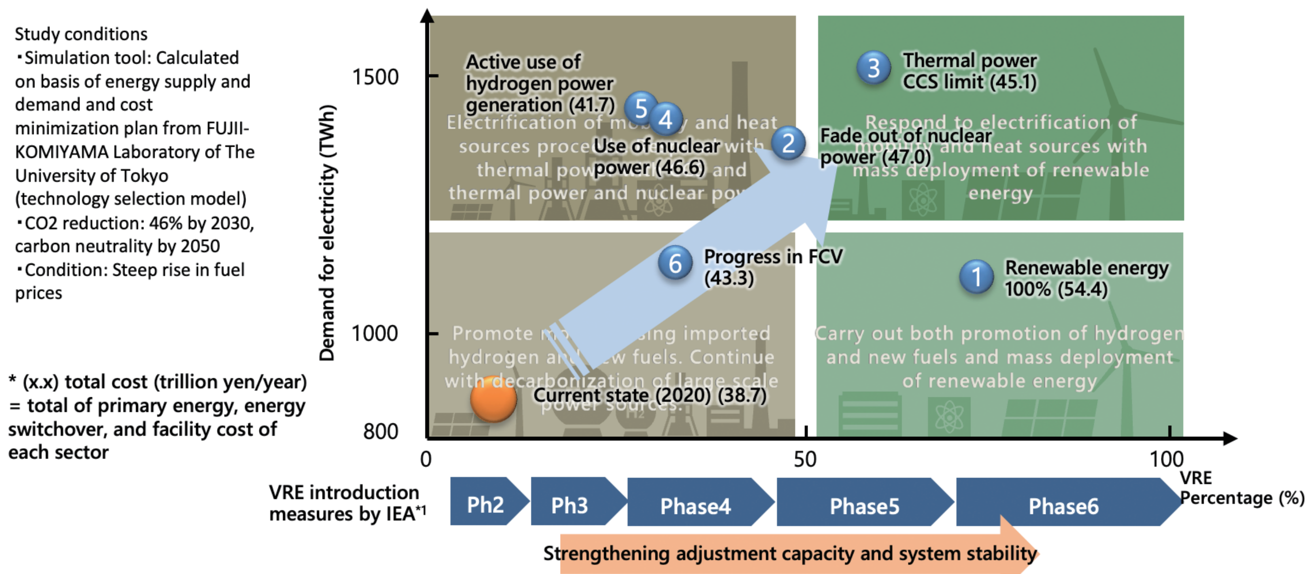
Issues and their countermeasures in transition processes to carbon neutrality considering uncertainty in energy prices/configuration

Taking into account the recent jump in fuel prices, we quantitatively evaluated changes in the supply-and-demand structure of the energy system toward a transition to carbon neutrality by 2050 and examined necessary countermeasures. In this trial evaluation, we used an energy/economy simulation model based on a "technology selection model" researched and developed at the FUJII-KOMIYAMA Laboratory of The University of Tokyo. Specifically, we calculated and studied different power-supply/demand configurations as optimized results by varying CSS, hydrogen, and other settings in transition scenarios toward carbon neutrality.

The results of this study revealed that the steep rise in fuel prices has made early introduction of renewable energy and the securing of a stable power supply into key issues compared with the results of past studies. In this regard, we presented scenarios demonstrating the effectiveness of accelerating the introduction of renewable energy such as solar power and wind power with short lead times, using nuclear power, using hydrogen and ammonia, and manufacturing and using new fuels. We also presented the form of transition processes that achieve consistency with forecasting from the present and backcasting from 2050.

Issues and their countermeasures in bulk power systems in a transition to carbon neutrality

Based on changes in the supply-and-demand structure in a transition of the energy system to carbon neutrality, there is a need for system measures that can provide for a decarbonized power supply and accelerated expansion of renewable energy. In this report, we considered these issues and countermeasures based on system simulations. Countermeasures that we found to be necessary include maintaining system stability in wide-area interconnections to address regional disparities in renewable energy, ensuring inertia and synchronization in the growth of renewable energy, and maintaining frequency at the time of power drop offs. Here, reinforcing the bulk power system through the use of HVDC and other methods and performing pseudo inertia control of inverter power supplies and storage systems were found to be effective. Ensuring adjustment capacity is also necessary, so we can expect regional storage of electric power as well as regional use of electric vehicles (EV) and demand response (DR). Congestion management will therefore be important not only in wide-area systems but in regional systems too. Additionally, to compensate for uncertainty as in long-term insufficient power generation by renewable energy caused by weather conditions, there will be a need for stable supplies of electric power such as nuclear power and the use of long-term energy storage such as hydrogen storage.



*1) IEA "World Energy Outlook 2018"

CCS: Carbon dioxide Capture and Storage, FCV: Fuel Cell Vehicle, VRE: Variable Renewable Energy, IEA: International Energy Agency

Coordination and Control Platform for Achieving S+3E and Value Creation through Coordination of Regional Resources

We present regionally created adjustment capacity and implementation measures toward energy coordination for achieving both value creation and decarbonization.
(1) Adjustment capacity that can be created by local communities and its potential:
Adjustment capacity that can be created by the household and business sectors is 276 TWh and 5.3 TWh, respectively.
(2) Decarbonization measures in household and industry sectors:
Measures with high priority according to the characteristics of regional households and industry are presented based on simulation results.

Background

H-UTokyo Lab. has so far proposed a coordination and control platform and subjected it to a quantitative evaluation. The aim here is to achieve value creation through the intelligent use of regional energy and create a coordination mechanism with bulk power systems. By last fiscal year, we had established a method for evaluating value creation and adjustment capacity targeting detached residential houses and reported the results of a quantitative evaluation.

This fiscal year, in addition to reflecting the recent steep rises in the price of fuel, we present the results of analyzing created value by expanding the target range of the coordination and control platform to the entire household sector and the business sector too. Our aim here is to evaluate the adjustment capacity that can be created by local communities. We also describe measures for achieving smooth progress in decarbonization from a regional perspective.

Regional adjustment capacity and value creation

To evaluate adjustment capacity and value creation that can be achieved by the coordination and control platform, we first selected Machida City, Tokyo as a typical residential district and Iwaki City, Fukushima Prefecture as a typical city including a business sector. Then, for 2030, we analyzed spot market prices using a system supply-and-demand simulator and analyzed the advantages of adjustment capacity using an aggregation simulator. Finally, we evaluated adjustment capacity and reduction in power procurement costs.

The results of this study showed that promoting the adoption of heat pumps in hospitals, where the demand for hot water within the business sector is high, could achieve a demand shift of 105 GWh/year in Machida City and 120 GWh/year in Iwaki City as a reflection of solar-output adjustment capacity. These trial calculations correspond to a demand shift of 32.9 TWh/year nationwide.

This type of adjustment capacity contributes to a reduction in the capacity required by storage batteries used for adjusting supply and demand in the bulk power system and to price stabilization in the power market.

However, 97% of current apartment buildings use gas water heaters, so promoting a transition to heat pumps in this case becomes an issue. Additionally, in the industrial sector, which has the same potential as the household and business sectors to supply adjustment capacity, the electrification of heat sources itself is in a stagnant state, so the steep rise in power rates and tightening in the supply and demand for power are becoming obstructions to electrification even more than before. Industrial decarbonization will require financial assistance for advancing electrification, engineering services for visualizing energy and preventing major obstacles in on-site operations, and the development of promotional measures other than those for electrification based on regional characteristics.

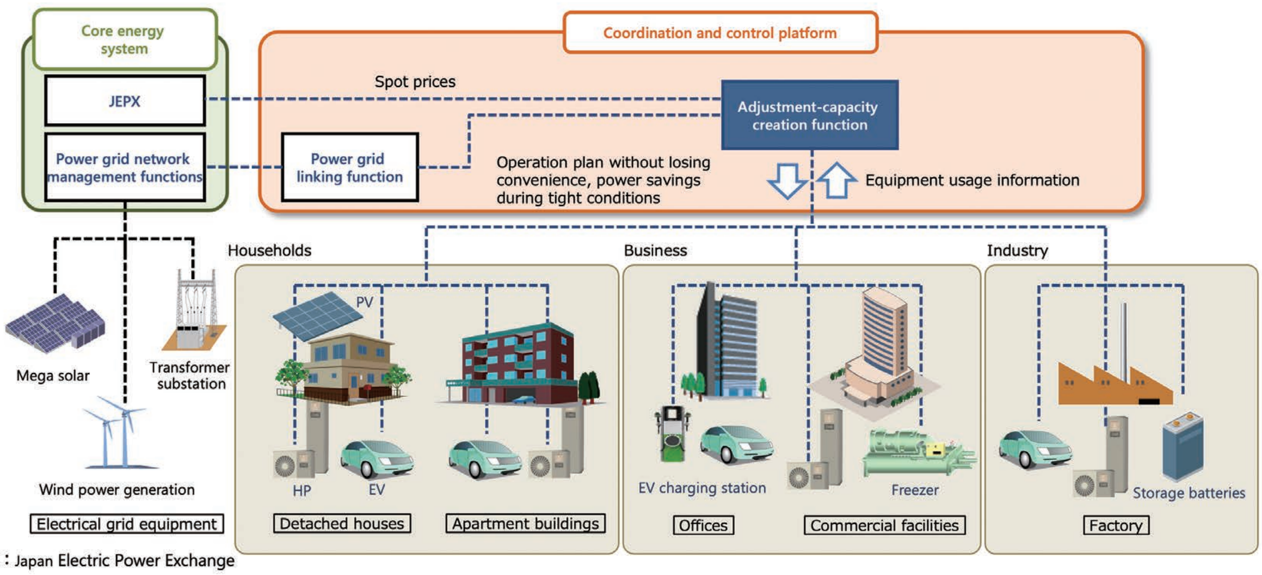
Stepwise transitions to achieve intelligent use of energy

In the case of apartment buildings and hospitals, it is important to promote the introduction of facilities such as heat pumps and EV charging infrastructures that have external control functions and that are capable of being used for energy storage. These can be implemented through financial support received from the national and local governments when constructing or upgrading a hot-water supply system. Local governments should also promote the use of EVs within their regions, construct infrastructures that contribute to the grid, and collaborate with local companies to systematically promote workplace charging, while the national government should offer financial support and a transfer of authority that gives such local activities a high degree of freedom.

In industry, engineering support that advises on stepwise electrification transitions such as partial electrification starting with downstream thermal processes and the sharing of best practices within a region should be promoted as corporate participation under the coordination of the national and local governments.

A number of methods can be considered for accelerating regional decarbonization through the intelligent use of energy such as retrofitting existing household heat pumps to enable remote control of the timing of hot water storage, preventing the need for initial investment through equipment leasing, and energy adjustment using solar heat. It is important to establish a system that can provide a society with multiple options for achieving decarbonization and creating adjustment capacity.

At the same time, electrification is not necessarily the most optimal decarbonization measure when considering resilience in a cold weather region. Measures applicable to such cold weather regions should be implemented including those that secure a means of decarbonization for business use.



JEPX：Japan Electric Power Exchange

Energy and Social Innovation Led by Digital Technologies

At H-UTokyo Lab., we studied a vision of the urban landscape after achieving carbon neutrality by coupling policy proposal AI (analysis based on the system dynamics approach) that performs multifaceted simulations of how the city of the future will look with energy supply-and-demand simulations that can analyze carbon-neutral energy scenarios in detail.
(1) When reaching carbon neutrality, changes for the better appear such as implementing certain measures for halting population decline and invigorating the tourism industry.
(2) In industry, management efforts made by large companies will have proven to be successful by around 2035 and revenues in small and medium-sized companies will suggest continued growth.
(3) The decarbonization transition process including a reduction in the amount of CO_2 emissions and rapid adoption of EVs will make dramatic progress from the years 2034–2036.

Background

When talking about the effects on society and industry associated with carbon neutrality and the transitions required, it should be kept in mind that the relationship between the structure of society and industry and the supply and demand of energy is complicated making the analysis of that relationship difficult. The Habitat Innovation Project at H-UTokyo Lab. has previously studied an urban vision of the future using policy proposal AI, a factor analysis technique based on system dynamics. This time, we performed a study by adding new factors concerning carbon neutrality to the analysis model of this urban vision of the future and simulated the urban vision for achieving carbon neutrality. Here, we performed for the first time simulations that link an urban vision with the supply and demand of energy. This was accomplished by passing conditions such as the energy supply and demand brought about by the obtained urban vision to an energy supply and demand simulator and conducted a multifaceted analysis of the effects associated with carbon neutrality.

Image of a City Achieving Carbon Neutrality

Simulation results suggest that the decarbonization transition process would gain momentum from 2035 on. In a city on its way to achieving carbon neutrality, this process would include expanded introduction of renewable energy with offshore wind power generation at the forefront and expanded adoption of EVs and fuel-cell vehicles in the transport sector. On reflecting these trends in the energy supply and demand simulator, it was found that the process of introducing renewable energy would occur in a smooth manner for solar power generation and wind power generation rather than expanding rapidly in a specific period. It was also found that electrification of the household and business sectors in particular would accelerate and that the use of renewable energy would likewise expand.

From an overall urban vision, improvements could be seen in a variety of indices related to the virtuous cycle of a local community, such as better living conditions for single-person households, promotion of a regional circular economy, effective use of abandoned farmland, and growth of the tourism industry. On the other hand, there were many indices such as those measuring disparities and a sense of well-being that indicated a trend toward maintaining the status quo in everyday life.

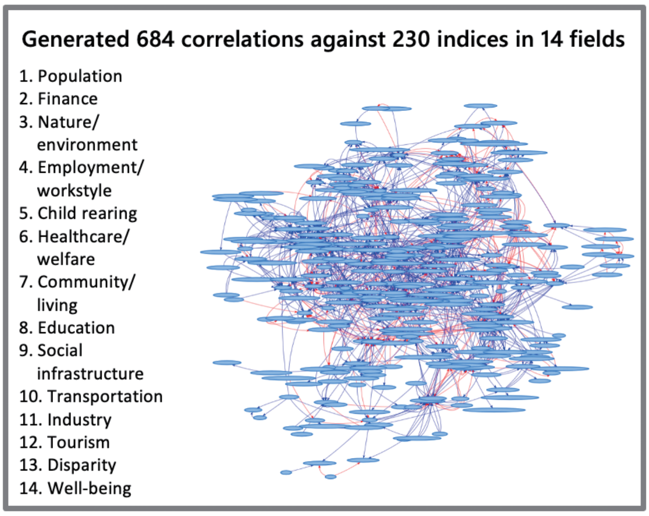
In this urban vision, a total of five turning points could be observed concentrated in the years 2034–2036 and 2043–2046.
The years 2034–2036 encompass the period in which the transition process to decarbonization progresses rapidly. We can therefore think of these years as a critical period toward decarbonization.

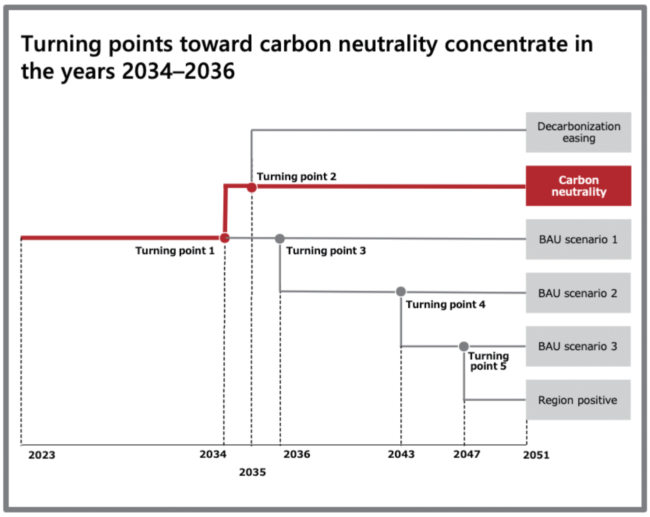
Impact of a transition to carbon neutrality on industry

In terms of profitability in the industrial world accompanying a transition to carbon neutrality, large companies will experience a trend toward declining revenues up to 2030 but will shift to an increase in revenues from 2035 on. Small and medium-sized companies, on the other hand, will experience flat or increasing revenues. Simulation results suggest that economic trends in the industrial sector including a transition to carbon neutrality will advance in a form in which large companies, despite a decline in revenues accompanying the transition, will complement small and medium-sized companies by taking the lead in sharing knowledge and implementing measures toward carbon neutrality. Production of steel, ethylene, and other core materials will decrease slightly, but it is estimated that this decline will stay within the range of a drop in demand brought on by a declining population.

National/urban vision toward carbon neutrality

The above study indicated that a transition process incorporating a national and urban vision is important in achieving carbon neutrality and that the years 2034–2036 in which decarbonization measures will rapidly expand constitute an important period and a major turning point. This detailed study on the decarbonization transition process indicates that it should be possible to prevent excessive installation of solar power generation facilities while reducing energy costs and achieving urban growth.





- Thank you very much for attending today's forum.
- The material presented today will be provided on the H-UTokyo Lab. website at a later date.
  Posting location : http://www.ht-lab.ducr.u-tokyo.ac.jp/2023/01/25/news044/
- Please contact us at the following location if you have any comments on H-UTokyo Lab. activities.
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