ICEF 2022

9th Annual Meeting

Autumn, 2022 (tentative)

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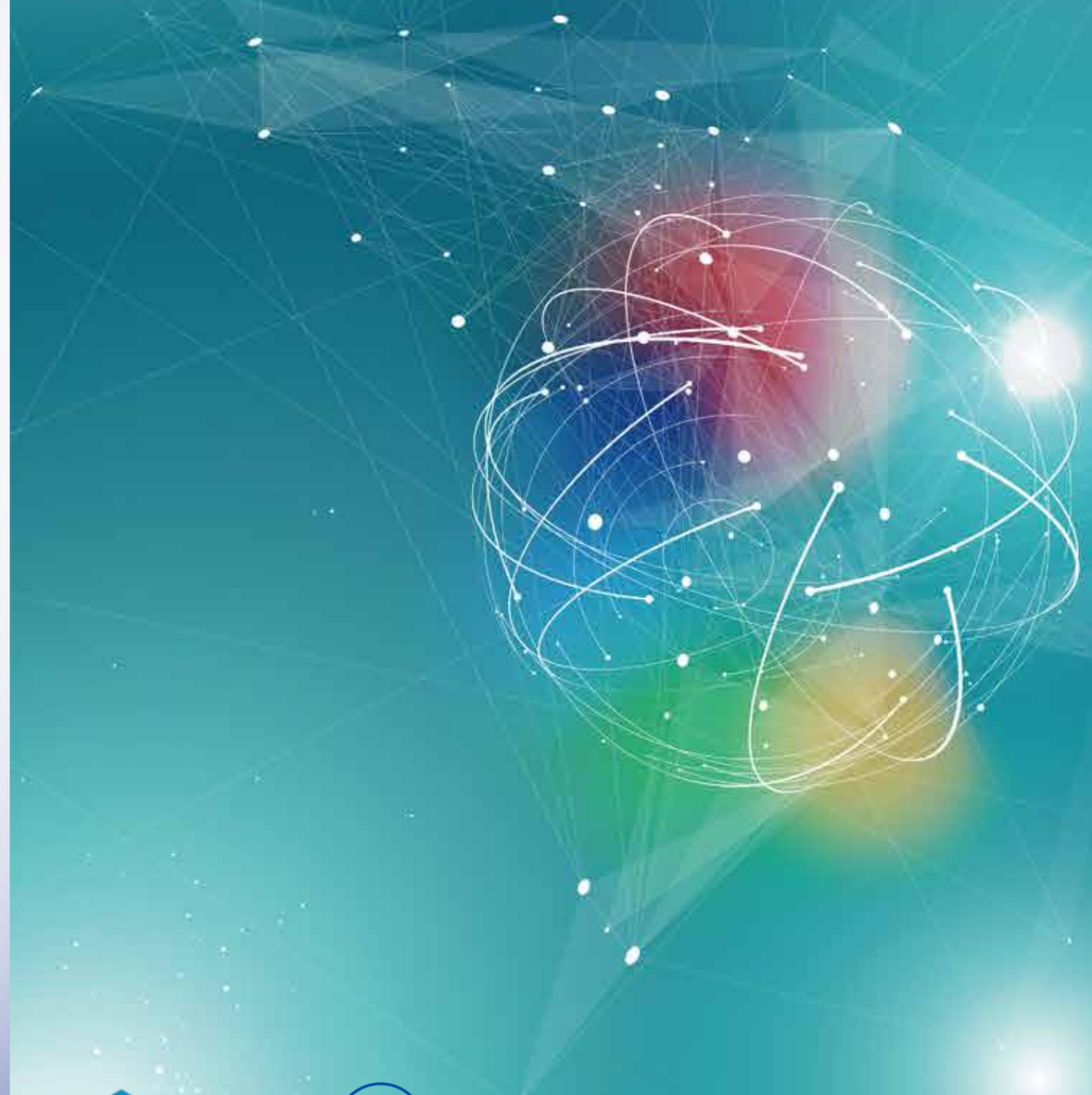
Innovation for Cool Earth Forum

ICEF 2021 Report



METI Ministry of Economy, Trade and Industry

NEDO

Innovation for Cool Earth Forum
ICEF 2021 Report

Contents

What is ICEF?

Every year since 2014, the Government of Japan's Ministry of Economy, Trade and Industry, and NEDO have hosted the Innovation for Cool Earth Forum (ICEF) to gather leading international figures in Tokyo to discuss how to combat climate change through technological innovation.

ICEF's mission is to nurture discussion and collaboration among participants and to disseminate the industry's latest innovations in energy and environmental technologies by providing a place where experts can share their knowledge on how to tackle the 21st century's greatest environmental challenge.

A distinguished steering committee, consisting of members from all around the world, strives to bring the best minds together to develop a program which address forces of change while ensuring they are based on solid evidence.

Participants are invited from industry, academia, and governments to exchange knowledge, to challenge each other, and to listen to renowned speakers discuss the latest developments in social and technological innovation.

The conference is a great opportunity to meet a wide range of high-level and committed participants, and a place to learn about the latest technological innovations from Japan and around the world.

8th Annual Meeting

Overall theme

Pathways to Carbon Neutrality by 2050: Accelerating the pace of global decarbonization

Virtual Forum

Wednesday, October 6, 2021- Thursday, October 7, 2021

Co-hosts

METI Ministry of Economy, Trade and Industry
NEDO
MOFA Ministry of Foreign Affairs
MEXT Ministry of Education, Culture, Sports, Science and Technology-Japan
MAFF Ministry of Agriculture, Forestry and Fisheries
Ministry of the Environment

Institutional Partners

IEA
BloombergNEF
UNIDO

Participants

More than 2,000 participants from governments, international organizations, the business sector and academia representing 87 countries and regions

Outcomes of ICEF 2021

- Innovation Cases
- Roadmap Projects on Carbon Mineralization
- Statement from the Steering Committee

ICEF's Official YouTube Channel

Program

DAY 1（Wednesday, October 6）

9:00-11:15 Side Events

NEDO Moonshot R&D Program Symposium
"Future Prospect for Direct Air Capture and CO_2 Utilization"

14:35-15:05 Opening Session

Message from HAGIUDA Koichi
(Minister of Economy, Trade and Industry)

Video Message from HIROSE Naoshi
(Vice-Minister for International Affairs, Ministry of Economy, Trade and Industry)

Opening Remarks

Keynote 1
Dialogue between Dr. Fatih Birol
(IEA Executive Director) and
Mr. TANAKA Nobuo (ICEF Chair)

15:10-16:40 Plenary Session 1

Policy Innovation

16:50-17:50 Technology Session 1

Sustainable Food System for 2050

DAY 2（Thursday, October 7）

9:00-10:00 Technology Session 2

Energy System Integration

Side Events

Roadmap Projects
"Carbon Mineralization"

10:10-11:10 Technology Session 3

Nuclear Power as a Power Source for Decarbonization

11:20-12:20 Technology Session 4

Negative Emission Technologies

13:20-13:25 Keynote 2

Video Message from Mr. Michael Bloomberg
(Interview by Mr. TANAKA Nobuo (ICEF Chair))

13:30-14:45 Plenary Session 2

Behavioral Innovation for a Decarbonized Society

15:00-16:00 Technology Session 5

Digital Technology to achieve Efficiency and Decarbonization

15:00-17:00 Side Events

The co-hosted event by UNIDO
"Achieving global carbon neutrality
– collaboration with developing and emerging nations"

16:15-17:30 Plenary Session 3

Private Sector's Responsibility for Achieving Carbon Neutrality

17:35-18:05 Closing Session

Closing Remarks
Roadmap Announcement
Statement from the Steering Committee
Final Thoughts on the Event

Opening Remarks

Minister of Economy, Trade and Industry

HAGIUDA Koichi

It is a great pleasure that ICEF 2021 is being held today as part of Tokyo "Beyond-Zero" Week. As you know, the Japanese government has declared its aim to achieve carbon neutrality by 2050, so we are working hard to attain this goal and contribute to global carbon neutrality.

To achieve carbon neutrality, it is important that each country seek various pathways based on their own situation, instead of adopting the same solutions for everyone.

Not only will research and development play a key role in increasing the number of innovative solutions, but the dissemination of these solutions around the world will also be important.

ICEF 2021, which starts today, is crucial for crystallizing the idea. The number of international conferences which are being held during Tokyo "Beyond-Zero" Week has increased from six last year to eight this year. This reflects Japan's serious commitment to carbon neutrality.

To tackle climate change, ICEF provides a platform for global leaders in industry, government, and academia to hold discussions and disseminate important innovations in the energy and environmental fields. Also being discussed are technologies that are essential to a carbon neutral future, such as decarbonization in the digital field, negative emission technologies, which allow countries to take various pathways to achieve decarbonization.

Today, we are privileged to have many participants from diverse backgrounds joining us from around the world, including those from government agencies, international organizations, industry associations, and academia. Furthermore, this year we are excited to have participants 35 years old and younger taking part in each session. I strongly hope that from Tokyo, we can show the world a path forward.

We look forward to working with you all toward a carbon neutral world. I greatly appreciate everyone's tremendous contribution and sincerely hope that today's conference will produce consequential results as we move forward. Thank you very much.

Plenary Sessions

Plenary Session 1

Policy Innovation

The Greenhouse Gas (GHG) emissions temporarily dropped during the initial phase of the COVID-19 pandemic but have since begun to rebound and rise again. Therefore, we must continue to act and implement all possible measures in order to achieve global carbon neutrality (CN) targets. As each country's economic structure, energy systems, CO_2 emission reduction targets, etc. vary, there are different pathways to achieve CN targets. In this session, we discussed the importance of government policy to further implement the decarbonized technologies such as hydrogen and Carbon dioxide Capture, Utilization and Storage (CCUS) to reduce GHG emissions and also to ensure the transition that enables climate-neutral economy happen in a fair way and leave no one behind. By including youth and women into the policy discussion, we can all work together for innovative policy-making in order to achieve our 2050 goals.

TANAKA Nobuo (Moderator)
Chair, Innovation for Cool Earth Forum (ICEF) Steering Committee;
Former Executive Director, International Energy Agency (IEA)

Hoesung Lee (Moderator)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
Chair of the Intergovernmental Panel on Climate Change (IPCC);
Endowed Chair Professor, Graduate School of Energy and Environment, Korea University

Ambassador Patricia Flor (Speaker)
EU Ambassador to Japan

Changhua Wu (Speaker)
Chief Executive Director, Beijing Future Innovation Center

Samantha McCulloch (Speaker)
Head of Carbon Capture Utilisation and Storage Unit, International Energy Agency (IEA)

Natalie Jones (Speaker)
Research Associate, Centre for the Study of Existential Risk, University of Cambridge;
Affiliated Researcher, Stockholm Environment Institute
Strategic Advisor, Centre for Climate Repair at Cambridge

Thetis Georgiou (Speaker)
Young Ambassador on the Future of Europe

KAWASAKI Rena (Speaker)
Chief Future Officer (CFO), Euglena Co., Ltd.

Plenary Session 2 Behavioral Innovation for a Decarbonized Society

Individual behavioral change of all stakeholders in society plays an essential role in achieving carbon neutrality (CN). Currently, households consume 29% of global energy, however, one study found that individual behavioral change across various sectors could reduce projected GHG emissions by 20-37% from 2020 to 2050.

Since human behavior is not always rational, we need to consider how to induce behavioral innovations which will contribute to the reduction of GHG emissions. Behavioral innovation can be defined as causing a fundamental change in human behavior by effectively triggering actions to impact a cause. In this regard, public awareness has only been a pre-condition to behavioral change and social innovations leading to a decarbonized society. The key question is how to maintain public awareness at the present level, and how to "use" this level of awareness toward reducing emissions.

This session discussed necessary changes/pathways for individual behavioral innovation, as well as the effect from the Covid-19 and behavioral change, and also youth involvement.

KURODA Reiko (Moderator)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
Designated Professor, Frontier Research Institute, Chubu University;
Professor Emeritus, The University of Tokyo

Georg Erdmann (Moderator)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
Retired Professor for Energy Systems, Berlin University of Technology;
President of the Board, KSB Energie AG, Berlin

Rob Harrison (Speaker)
Director,
Ethical Consumer Research Association

Matt O'Keefe (Speaker)
Head of Opower at Oracle Utilities

Elisabetta Cornago (Speaker)
Research fellow,
Centre for European Reform

Rakhim Rakhimov (Speaker)
Behavioral Research Associate,
Center for Behavior & the Environment, Rare

Plenary Session 3 Private Sector's Responsibility for Achieving Carbon Neutrality

Just in the last two years, there has been a dramatic increase in the number of countries and regions discussing and setting carbon neutrality (CN) targets. In January 2020, countries and regions declaring CN targets accounted for 34% of the world's emissions, by July 2021 this number reached 70%. To achieve these CN targets, the private sector will play a crucial role by developing and disseminating low-carbon and decarbonization technologies. Additionally, companies will need to update their business models to reflect their long-term CN strategies/activities as a response to the CN demands of customers and disclosure regulations of financial institutions.

This session explored how companies are setting their long-term decarbonized strategies as well as the short-term ones, how they should disclose related information to financial institutions, or how clean technology should be disseminated. The importance of public finance, and the consideration of each regional characteristics was also discussed.

Jon Moore (Moderator)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
Chief Executive Officer, BloombergNEF

Laurence Tubiana (Moderator)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
CEO, European Climate Foundation;
Chair of the Board of Governors, French Development Agency (AFD);
Professor, Sciences Po Paris

Sarah Chandler (Speaker)
Senior Director, Environment and Supply Chain Innovation, Operations, Apple

Julien Perez (Speaker)
Vice President, Strategy & Policy,
Oil and Gas Climate Initiative (OGCI)

Xavier Denoly (Speaker)
Sustainable Development Senior Vice President,
Schneider Electric

TAKAHASHI Kenji (Speaker)
General Manager, Decarbonization Promotion Section, Corporate Strategy Department,
JERA Co., Inc.

Antonina Scheer (Speaker)
Researcher at the Transition Pathway Initiative,
London School of Economics and Political Science (LSE) Grantham Research Institute on Climate Change and the Environment

Technology Sessions

Technology Session 1 Sustainable Food System for 2050

Food system (including production, transportation, processing, packaging, storage, retail, consumption, loss and disposal) is an area where little attention has been paid with regard to climate change measures. However, present estimates suggest that implementing food system have the potential to abate about 20% of the CO_2 reduction required to achieve carbon neutrality (CN) by 2050. In this session, we presented the current and future state of food systems, along with discussing supply chains. Specifically, the discussion involved solutions such as promoting the agriculture technologies (soil intelligence and data platform etc.) for small farmers in emerging markets, and the food information for consumer behavior change to achieve our short-term (until 2030) and long-term (2050) CN goals.

David Sandalow (Moderator)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
Inaugural Fellow, Center on Global Energy Policy, Columbia University;
Co-Director, Energy and Environment Concentration, School of International and Public Affairs, Columbia University

Ismail Serageldin (Panelist)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
Emeritus Librarian of Alexandria;
Founding Director of the Library of Alexandria

ISHII Naoko (Speaker)
Executive Vice President and Director, Center for Global Commons, The University of Tokyo

Brian Bosire (Speaker)
Founder and CEO, UjuziKilimo & Hydrologistics Africa

Uma Lele (Speaker)
President of the International Association of Agricultural Economists (IAAE), elected in 2021;
Institute of Economic Growth, University of Delhi

Technology Session 2 Energy System Integration

The "Energy System Integration" session covered solutions for society-wide energy system integration with a view to achieving carbon neutrality (CN) by 2050 from an energy supply viewpoint. Discussions addressed how sector coupling will shift the conventional linear energy system to an efficient circular system by reaching beyond the energy sector to integrating the electric power sector with non-energy sectors, such as transport and industry, as well as other energy carriers. It was stressed that a coupled system requires both supply- and demand-side flexibility. Each speaker showcased emerging technologies and business opportunities.

YAMAJI Kenji (Moderator)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
President/Director-General, Research Institute of Innovative Technology for the Earth (RITE);
Professor Emeritus, The University of Tokyo

NISHIMURA Kiyoshi (Speaker)
Guest Professor, Business Engineering, Osaka University

Carlalberto Guglielminotti (Speaker)
Chief Executive Officer, NHOA

Luciano Martini (Speaker)
Director, Green Powered Future Mission, Mission Innovation;
Director, Transmission and Distribution Technology Department, Ricerca sul Sistema Energetico (RSE)

Ejeong Baik (Speaker)
PhD Candidate, Department of Energy Resources Engineering, Stanford University

OTSUKI Takashi (Speaker)
Senior Researcher, New and Renewable Energy Group, Electric Power Industry & New and Renewable Energy Unit, The Institute of Energy Economics, Japan (IEEJ)

Technology Session 3 Nuclear Power as a Power Source for Decarbonization

In this session, from a short and medium-long term perspective, we discussed the technical development of existing light-water reactor (LWR) technologies and next-generation reactor technologies with the aim of reaching carbon neutrality (CN) by 2050. Additionally, we touched upon the concerns and social acceptability of nuclear power technologies.

Richard K. Lester (Moderator)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
Associate Provost, Massachusetts Institute of Technology

Eija-Riitta Korhola (Moderator)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
Delegate of the Consultative Commission on Industrial Change;
Advisor in the EU Affairs

Ashley E. Finan (Speaker)
Director, National Reactor Innovation Center,
Idaho National Laboratory

KANZAKI Yurugi (Speaker)
Director, Nuclear Systems Engineering Department,
Nuclear Energy Systems, Mitsubishi Heavy Industries, Ltd.

Myagmarjav Odtsetseg (Speaker)
Researcher (Dr. Eng.), IS Process Experiment Group,
HTGR Research and Development Center,
Japan Atomic Energy Agency

Aditi Verma (Speaker)
Assistant Research Scientist, Department of Nuclear Engineering and Radiological Sciences, University of Michigan;
Visiting Scholar, Project on Managing the Atom,
Belfer Center for Science and International Affairs,
Harvard Kennedy School of Government

Technology Session 4 Negative Emission Technologies

Aiming to achieve carbon neutrality (CN) by 2050, Negative Emission Technologies (NETs), such as Direct Air Capture and Storage (DACCS) and Bioenergy CCS (known as BiCRS or BECCS), are attracting attention. This technology can reduce residually emitted CO_2 from hard-to-abate sectors. This session showed an overview of the current situation regarding cost, potential to install, and making a partnership for NETs and discussed about establishment of legal framework and expanding investment for NETs using market. Also, looking forward to achieving CN, it was explored what short and medium-long term initiatives will be required.

David Sandalow (Moderator)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
Inaugural Fellow, Center on Global Energy Policy, Columbia University;
Co-Director, Energy and Environment Concentration, School of International and Public Affairs, Columbia University

S. Julio Friedmann (Speaker)
Senior Research Scholar, Center for Global Energy Policy,
Columbia University

SUGIYAMA Masahiro (Speaker)
Associate Professor at the Institute for Future Initiatives (IFI),
The University of Tokyo

Shuchi Talati (Speaker)
Chief of Staff, Office of Fossil Energy & Carbon Management,
US Department of Energy (DOE)

AKIMOTO Keigo (Speaker)
Group Leader of Systems Analysis Group, Chief Researcher,
Research Institute of Innovative Technology for the Earth (RITE)

Technology Session 5

Digital Technology to achieve Efficiency and Decarbonization

The "Digital Technology to achieve Efficiency and Decarbonization" session was one of the two ICEF technology sessions that covered solutions to eliminate supply-demand mismatches through digital technologies and optimal management.
This session forecasted how the popularization of digital technologies will change society and expand digital businesses, as well as discussing how such changes may impact energy demand and our ability to achieve our carbon neutral (CN) targets.

Natalie Samovich (Moderator)
MCPV co-founder, Resilient Group;
Head of Research and Innovation, Enercoutim

Antonello Monti (Speaker)
Professor, E.ON Energy Research Center, RWTHAACHEN University

SUGIBAYASHI Tadahiko (Speaker)
Co-Founder/CEO, Nanobridge Semiconductor, Inc.

Kari Dahlgren (Speaker)
Research Fellow, Emerging Technologies Research Lab, Monash University

Areti Ntaradimou (Speaker)
Editor, Smart Energy International

Keynotes

Keynote 1

Dialogue between Dr. Fatih Birol (IEA Executive Director) and Mr. TANAKA Nobuo (ICEF Chair)

Keynote 2

Video Message from Mr. Michael Bloomberg
（Interview by Mr. TANAKA Nobuo (ICEF Chair)）

Side Events

Side Events

NEDO Moonshot R&D Program Symposium "Future Prospect for Direct Air Capture and CO_2 Utilization"

In recent years, Direct Air Capture (DAC) has been drawing attention as an important technology to capture CO_2 from the atmosphere as we aim for carbon neutrality. In 2020, NEDO started technology development projects for DAC and CO_2 utilization within the Moonshot Research and Development Program.
In this symposium, we discussed how DAC can be widely adopted in the future and delved into the opportunities and challenges of new technologies, focusing on technologies being developed in NEDO's Moonshot R&D projects.

YAMADA Hiroyuki (Moderator)
Director General, Frontier and Moonshot Technology Department,
New Energy and Industrial Technology Development Organization (NEDO)

YAMAJI Kenji (Moderator)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
President/Director-General, Research Institute of Innovative Technology for the Earth (RITE);
Professor Emeritus, The University of Tokyo

Graciela Chichilnisky (Speaker)
Co-Founder & CEO, Global Thermostat;
Professor of Economics and Mathematical Statistics, Columbia University;
Director of the Columbia Consortium for Risk Management, Columbia University

Gregory Nemet (Speaker)
Professor of Public Affairs, La Follette School of Public Affairs, University of Wisconsin-Madison

KATO Souichiro (Speaker)
Senior Researcher, Bioproduction Research Institute, National Institute of Advanced Industrial Science and Technology (AIST)

KODAMA Akio (Speaker)
Professor, Faculty of Mechanical Engineering, Institute of Science and Engineering, Kanazawa University

SUGIYAMA Masakazu (Speaker)
Professor, Research Center for Advanced Science and Technology, The University of Tokyo

NOGUCHI Takafumi (Speaker)
Professor, Department of Architecture, Graduate School of Engineering, The University of Tokyo

NORINAGA Koyo (Speaker)
Director, Institute of Materials Innovation (i-MI), Nagoya University

FUKUSHIMA Yasuhiro (Speaker)
Professor, Department of Chemical Engineering, Graduate School of Engineering, Tohoku University

FUJIKAWA Shigenori (Speaker)
Distinguished Professor, International Institute for Carbon Neutral Energy Research, Kyushu University;
Director, Research Center for Negative Emissions Technologies, Kyushu University

Side Events

The co-hosted event by UNIDO "Achieving global carbon neutrality – collaboration with developing and emerging nations"

In recent years, many countries (including Japan, US, and those in the EU) have initiated concrete measures to achieve "carbon neutrality by 2050." Being the leader among emerging economies, in 2020 the Chinese Government announced their intent to achieve carbon neutrality by 2060. However, as Non-Annex 1 Countries (listed under the United Nations Framework Convention on Climate Change) produce 60% of the global CO_2 emissions, urgent measures are required in these countries to achieve carbon neutrality worldwide. Making this a challenge is the fact that energy access is still a problem in many of these countries, so more needs to be done to address this issue in order to achieve Sustainable Development Goals (SDGs).

Against this backdrop, this session provided a platform for government, industry, and academia stakeholders from developing and emerging nations to facilitate constructive discussions on the challenges and opportunities in achieving global carbon neutrality.

YASUNAGA Yuko (Moderator)
Head, Investment and Technology Promotion Office, Tokyo,
United Nations Industrial Development Organization (UNIDO)

OKI Taikan (Speaker)
Former Senior Vice-Rector, United Nations University;
Professor at Graduate School of Engineering, The University of Tokyo

Valli Moosa (Speaker)
Innovation for Cool Earth Forum (ICEF) Steering Committee;
Head of the South African Presidential Climate Change Coordinating Commission;
Former President of the International Union for Conservation of Nature and Natural Resources (IUCN)

Wolfgang Niedermark (Speaker)
Member of the Executive Board,
Federation of German Industries (BDI)

Clara Landeiro (Speaker)
Asia-Pacific Manager,
Climate Technology Centre & Network (CTCN)

Lin Xu (Speaker)
Chairman of the China-U.S. Green Fund

Hicham Bouzekri (Speaker)
Director of Research & Development and Industrial Integration,
Moroccan Agency for Sustainable Energy (MASEN)

YOSHINO Akira (Speaker)
Director, Global Zero Emission Research Center (GZR),
National Institute of Advanced Industrial Science and Technology (AIST)

Closing Session

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2

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❶ Remarks
ISHIZUKA Hiroaki
Chairman, New Energy and Industrial Technology
Development Organization (NEDO)

❷ Roadmap Announcement
David Sandalow
Innovation for Cool Earth Forum (ICEF) Steering Committee;
Inaugural Fellow, Center on Global Energy Policy, Columbia University;
Co-Director, Energy and Environment Concentration, School of International and Public Affairs, Columbia University

❸ Statement from the Steering Committee
YAMAJI Kenji
Innovation for Cool Earth Forum (ICEF) Steering Committee;
President/Director-General, Research Institute of Innovative Technology for the Earth (RITE);
Professor Emeritus, The University of Tokyo

❹ Final Thoughts on the Event
TANAKA Nobuo
Chair, Innovation for Cool Earth Forum (ICEF) Steering Committee;
Former Executive Director, International Energy Agency (IEA)

Statement

ICEF 2021 Statement from the Steering Committee

October 7, 2021

The eighth annual meeting of the Innovation for Cool Earth Forum (ICEF 2021) was held online on October 6 and 7, 2021 (https://www.icef.go.jp/) as an initiative of "Tokyo 'Beyond-Zero' Week 2021," a series of eight conferences that deal with a wide range of energy and environmental issues. More than 2,000 people from governments, international organizations, industry, and academia participated in this online event, representing 87 countries and regions. As a result, ICEF 2021 is releasing the following statement based on a series of discussions under the main theme of "Pathways to Carbon Neutrality by 2050: Accelerating the pace of global decarbonization."

1. Necessity of Realistic Discussions

More than 120 countries have declared their intent of achieving carbon neutrality so far. ICEF welcomes this trend of nation-led decarbonization. Yet, according to the IEA, carbon dioxide emissions temporarily dropped in 2020 in the wake of the COVID-19 pandemic, but they have begun to increase again. The ambitious goals can only be achieved through policy, socio-economic and behavioral change as well as green innovations. We need many more in-depth discussions on what technologies should be introduced in order to realize carbon neutrality, how they should be integrated into industry and society, and in what time frame. Making it happen would also require efforts to change the mindset of companies and individuals, and innovation in government policies.

2. A Variety of Pathways

Economic structures and natural environments vary among different countries and regions, and the energy supply and demand systems affected by them are accordingly diverse. For this reason, realizing the policies and energy mixes appropriate for each country is crucial, and the timing of achieving carbon neutrality may differ depending on the country and region. Therefore, international cooperation needs to be promoted in way that it would be mutually beneficial, based on this understanding of national or regional differences. In this regard, developed countries have important roles to play in supporting developing countries. In the civil society, nobody must be left behind in achieving carbon neutrality.

3. Roles of Innovation

Keeping in mind the importance of 1 and 2 above, ICEF 2021 discussed innovation in both technology and society in the short and long-time frames that will lead to practical pathways to achieve carbon neutrality.

We will need to accelerate multi-facet innovations, i.e. policy, business and behavior. The government will be required to go beyond conventional energy and environmental policies to encourage game changes and paradigm shifts in the private sector. Private sector actors are responsible not only for creating technologies, products and services, but also for taking action to transform the entire supply chain and guide the transformation of the industrial structure. People's awareness as well as behavioral change is required to achieve carbon neutrality. It is encouraging to see many visible and innovative trends in each category, which is mutually interrelated. Every stakeholder must take action to achieve carbon neutrality.

We have been discussing various technological fields that play pivotal roles in the pathways to carbon neutrality, such as renewables and hydrogen. ICEF 2021 focused on five specific technology areas among them, i.e. digital technologies, energy system integration, nuclear power, food systems, and negative emission technologies, and discussed their challenges and possibilities.

- Two fields, digital technologies and energy system integration are strongly related in the carbon neutral society. "Green by digital" has significant potential as a game-changer for both energy management systems and services in the short- and long-term. At the same time, "green of digital" such as semi-conductors to reduce energy demand is required. Energy system integration, with advancement of technologies for sector coupling which interconnect various energy carriers and sectors, can optimize the society-wide energy supply and demand.
- Nuclear energy will also play a role with the development of innovative technologies for existing and future reactors; inter alia, flexible advanced nuclear reactors such as small modular reactors (SMRs) are getting attention.
- Greenhouse gas (GHG) emissions from food systems can be mitigated by technologies and procedural changes in production-distribution as well as agriculture with information and communication technologies (ICT), and in the long-term, consumer's eating behaviors will also have large impact.
- Negative emission technologies, i.e. direct air carbon dioxide capture and storage (DACCS), biomass carbon removal and storage (BiCRS) and carbon mineralization, will be essential in order to neutralize GHG emissions in the hard-to-abate sectors, thus requiring continuous investment to reduce cost of these technologies. The need to research cost and benefits, and associated risks of geo-engineering was also pointed out.

4. In Closing

ICEF 2021 invited the younger generation, who will play a central role in the society of 2050, to the discussions. The intent was to highlight cross-generational dialogue and inclusion to take the next step in better understanding the different perspectives. ICEF will continue to welcome the participation of the younger generation in its discussions to encourage the involvement of diverse stakeholders.
By continuing these activities, we hope that realistic discussions will become further widespread toward the realization of carbon neutrality.

Innovation Cases

"Innovation Cases" is an activity to introduce the latest cases of technology development and diffusion which are expected to contribute to climate change in the fields of energy and environment. The activity helps us to understand the state and trends of innovations, and also provides useful information for creating new innovations in the fields of energy and environment.
This year, 10 notable innovation cases related to each technology session were introduced.

Category Sustainable Food System for 2050

"Farmlogs LITE," a farm management software with satellite data

Source : Farmlogs

Organization Farmlogs

"Farmlogs LITE" provide advises to farmers on the appropriate amount of crops to be planted and the right amount of fertilizer to used according to soil conditions by analyzing soil/crop conditions collected from satellite images and comparing it with accumulated data.
Initially, only data from the National Weather Service and the U.S. Department Of Agriculture was used, but now more accurate data analysis is possible by combining it with satellite images.

Category Sustainable Food System for 2050

"Foodly," a humanoid collaborative robot in food factory

Source : RT Corporation

Organization RT Corporation

Foodly is a dual-armed humanoid robot which is developed and produced by RT Corporation.
With the AI Vision System utilizing deep learning, Foodly can recognize and pick bulked foods one by one then arrange them on the lunch box.
And the robot also can work safely next to each other on the same belt conveyor line as people.
Now some units of Foodly are being tested in several food factories in Europe and Japan.

Category Sustainable Food System for 2050

"OLIO," a mobile app for food-sharing aiming to reduce food waste

Source : OLIO

Organization OLIO

The application helps people share food by connecting those with surplus food to those who need or wish to consume such food. And those donating surplus food can be individuals or companies such as food retailers, restaurants, corporate canteens.
The application was first launched in 2015 and it has 5 million users in over 59 countries as of August 2021.
Portions of food have been shared on OLIO are already about 25 million and the environmental impact of the portions is equivalent to taking over 80 million car miles off the road and 4 billion liters of water saved.

Category Energy System Integration

"Next Pool," 10,000 units aggregated in Virtual Power Plant by Next Kraftwerke

Source : Next Kraftwerke

Organization Next Kraftwerke

The VPP (Next Pool) built in November 2020 has reached 10,000 units.
Next Kraftwerke digitally aggregates distributed power sources from renewable energy owned by consumers via the gateway Next Box, and sells the aggregated power with added value in the trading market.

Category Energy System Integration

"HySTRA," developing technologies for liquefied hydrogen supply chain

Source : HySTRA

Organization HySTRA

HySTRA is working towards creating a CO_2 free hydrogen energy supply chain comprised of hydrogen production effectively utilizing brown coal, transportation, storage and utilization of hydrogen, and establishing and demonstrating the technologies to commercialize the supply chain around 2030.

Category Nuclear Power as a Power Source for Decarbonization

"HTGR," H_2 production with superior-safety nuclear reactor

Source : Japan Atomic Energy Agency (JAEA)

Organization Japan Atomic Energy Agency (JAEA)

HTGR (High-temperature gas-cooled reactor) shuts down and cools core in case of the black-out accident without any equipment or operator actions.
HTGR can supply up to 950℃ of heat, which can be used for various applications such as H_2 Production, high efficient power generation. IS process (thermochemical water-splitting H_2 production) can directly harness the heat from HTGR, which offers a large hydrogen supply and maximum energy security.

Category Nuclear Power as a Power Source for Decarbonization

"NuScale," emission-free & flexibility with safety & cost competitiveness

Source : NuScale Power

Organization NuScale Power

NuScale is a small modular reactor (SMR) with 77MWe capacity for each reactor module. The modules can be incorporated in a multi-module nuclear power plant.
The simple design eliminates reactor coolant pumps, large bore piping and other systems and components found in large conventional reactors.
Modules safely shut down and self-cool, indefinitely, with no need for AC or DC power, operator or computer action, or additional water.

Category Negative Emission Technologies

"Orca," The world's largest climate-positive direct air capture plant

Source : Climeworks

Organization Climeworks

The Orca plant in Iceland is the world's largest plant capturing CO_2 from air launched by Climeworks with Icelandic carbon storage firm 'Carbfix'.
The plant consists of eight large containers similar in looks to those used in the shipping industry, which employ high-tech filters and fans to extract carbon dioxide.
The plant sucks out up to 4,000 tons of CO_2 per year which is the equivalent of the annual emissions from about 790 cars.

Category Digital Technology to achieve Efficiency and Decarbonization

"Project Natick," An underwater datacenter which is reliable, practical and sustainable

Source : Microsoft

Organization Microsoft

In 2018, a data center was set up on the seabed at a depth of 35 meters, and tested for two years, demonstrating that it consumes less energy, generates less waste, consumes less fresh water, and experiences fewer failures.
It was also shown to be less prone to failure and more reliable than onshore.

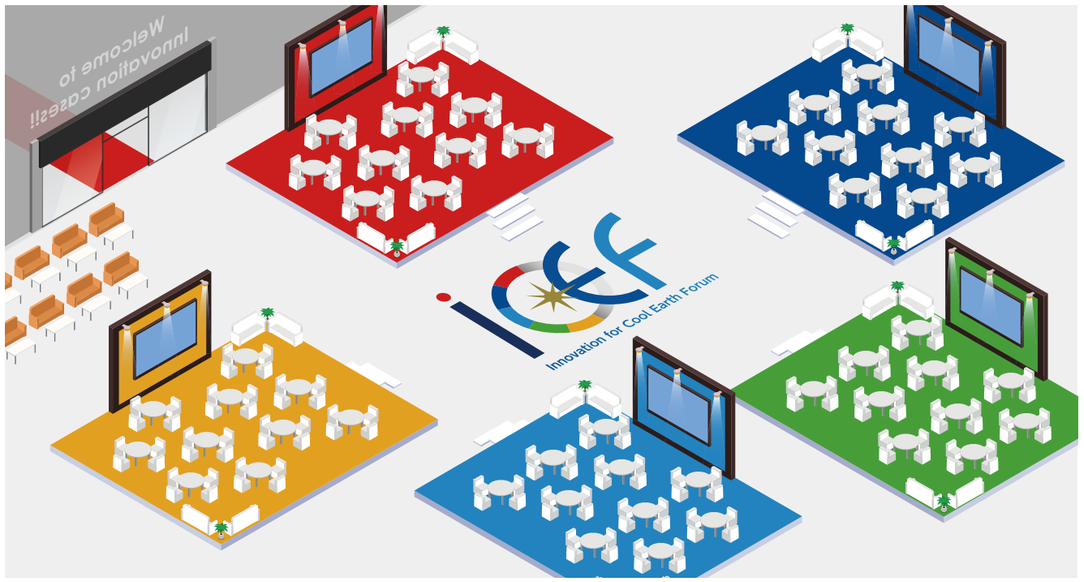
Category Digital Technology to achieve Efficiency and Decarbonization

"Metron-EVA," AI-driven energy management platform to help manufacturers realize Industry 4.0

Source : METRON

Organization METRON

Metron-EVA is an AI-driven energy management platform that helps manufacturers to optimize energy consumption in factories, to cut costs and reduce their environmental footprint.
The solution combines the use of big data, artificial intelligence and the expertise of our energy engineers to allow customers visualize energy usage.



Roadmap Projects

ICEF develops roadmaps on how key innovative technologies can contribute to a transition to clean energy. At the ICEF 2021 side event, the draft version of the roadmap on Carbon Mineralization Roadmap was presented.
The ICEF Carbon Mineralization Roadmap explores the potential for carbon mineralization to contribute to net zero emissions by mid-century. The roadmap provides a primer on the science of carbon mineralization; explores strategies for using carbon mineralization to remove carbon dioxide (CO_2) from the atmosphere; sets forth priority research and development needs; examines policies for promoting the use of carbon mineralization to contribute to climate mitigation; compares carbon mineralization to direct air capture; and offers findings and recommendations.
The draft was released for public comments in addition to the discussion at ICEF 2021. After revision to reflect the comments, the definitive version is to be presented at COP26.

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Messages from Co-Hosts

Ministry of Foreign Affairs
SUZUKI Hiroshi
Senior Deputy Minister for Foreign Affairs

Looking ahead to the COP26 in this fall, as momentum grows for the international society to work together to promote the decarbonization of the world, I would like to express my sincere congratulations to the holding of this year's ICEF which is a valuable opportunity for leaders from industry, government, and academia to gather and engage in state-of-the-art discussions on innovation, including perspectives from government, business, and individuals.
In this year, Japan established the frameworks for cooperation on climate change with the United States, the European Union and Australia, respectively, and promoting innovation is one of the main pillars in all of those frameworks. I believe that it is important to pursue sustainable development and to address climate change issue on a global scale by creating the virtuous cycle of the economy and the environment, by utilizing Japan's technology.
Japan will continue to endeavor for the advancement of the world in cooperation with you by making use of various channel with other countries

Ministry of Education, Culture, Sports, Science and Technology
YANAGI Takashi
Senior Deputy Minister of Education, Culture, Sports, Science and Technology

The Ministry of Education, Culture, Sports, Science and Technology (MEXT), as the co-hosting government agency, would like to congratulate the leaders of industry, academia, and government for holding the ICEF to discuss the issue of climate change in the midst of a severe situation in the world due to the raging new coronavirus infection.
In recent years, there have been many extreme weather events and disasters both in Japan and abroad, and there are concerns that these events will become more frequent and severe due to global warming. Climate change is not only a matter of scientific interest for climate scientists, but is also a top priority for the international community. MEXT is committed to supporting the resolution of climate change issues through the promotion of research and development in the field of environment and energy.

Ministry of Agriculture, Forestry and Fisheries
ARAI Yutaka
Vice-Minister for International Affairs

On behalf of the Ministry of Agriculture, Forestry and Fisheries (MAFF), I would like to express my deep appreciation and respect for the theme of "Sustainable Food Systems for 2050" being taken up in a timely fashion as a topic of discussion at ICEF this year as interest in the food system is growing on a global scale.
In May this year, MAFF formulated the "Strategy for Sustainable Food Systems, MeaDRI (Measures for achievement of Decarbonization and Resilience with Innovation)" to enhance productivity potentials and ensure sustainability in a compatible manner of the food, agriculture, forestry and fisheries industries through innovation.
We will continue to strive for the realization of carbon neutrality by 2050 through the establishment of a sustainable food system suitable for Japan, including the realization of zero CO_2 emissions from the agriculture, forestry and fisheries sectors, and the drastic reduction of chemical pesticides and fertilizers.

Ministry of the Environment
SHODA Yutaka
Vice-Minister for Global Environmental Affairs

COP26 will be held at the end of the month. It is essential that countries increase their 2030 climate ambition to meet the Paris Agreement objective of achieving global decarbonization as early as possible. Another requirement is to finalize the rules for implementing the Paris Agreement. This summit will determine our shift from the "negotiation" phase to the "implementation" phase.
Along with the rules for implementing the Paris Agreement, technological innovations are crucial to achieve global decarbonization. I sincerely hope that this 8th ICEF will provide an opportunity to gather international knowledge to accelerate the pace of global decarbonization.