Innovation for Cool Earth Forum

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ICEF 2020 Report

METI Ministry of Economy, Trade and Industry

NEDO

Contents

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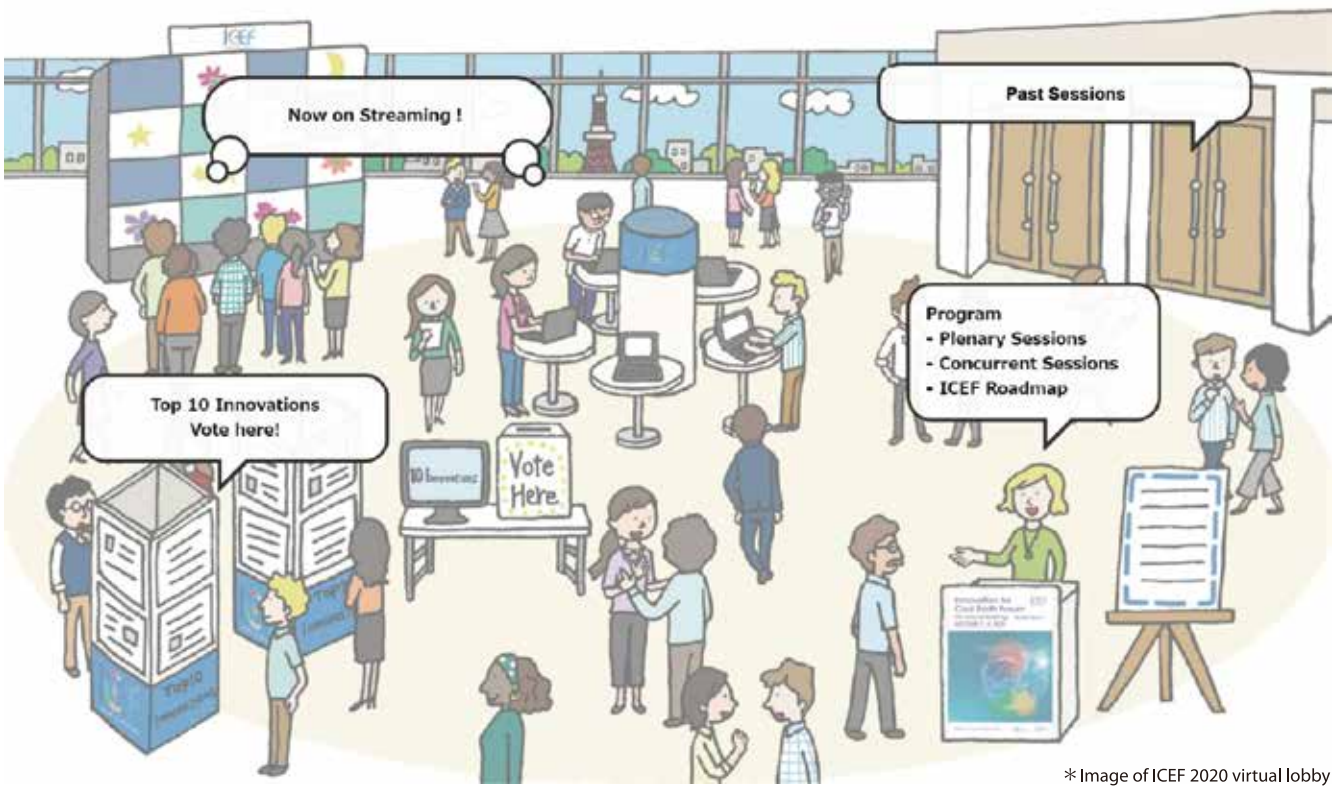
ICEF 2020 Report

What is ICEF?

Japan's former Prime Minister Abe Shinzo announced that the Government of Japan will host an annual global conference, the Innovation for Cool Earth Forum (ICEF) every year in October in Tokyo. ICEF is aimed at providing a global platform to promote discussions and cooperation among researchers, business persons, and policymakers from around the world in order to address climate change through innovation of energy and environmental technologies including their dissemination.

The Steering Committee has been established in order to ensure that ICEF is operated in a manner reflecting the wide range of views of the international communities.



＊Image of ICEF 2020 virtual lobby

7th Annual Meeting

Overall theme

Action toward "Beyond Zero" emissions society in light of COVID-19; with a focus on gender equality

*"Beyond Zero": Aiming for carbon neutrality and reduction of the levels of CO_2 emission already in the atmosphere

Virtual Forum

Wednesday, October 7, 2020 - Thursday, October 8, 2020

*Concurrent Sessions were held from Monday, September 28 to Friday, October 2

Hosts

METI Ministry of Economy, Trade and Industry

NEDO

Co-hosts

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 1,300 participants from governments, international organizations, the business sector and academia representing 80 countries and regions

Outcomes of ICEF 2020

- Top 10 Innovations
- Roadmap on Biomass Carbon Removal and Storage (BiCRS)
- Statement from the Steering Committee

Program

Monday, September 28

12:30-13:30 **Concurrent Session 1**
Hydrogen Production Technologies and Urban Utilization

20:00-21:10 **Concurrent Session 2**
Circular Economy Implementation

Tuesday, September 29

20:00-21:10 **Concurrent Session 3**
International Climate Cooperation - Moving towards Zero Emission Society

Wednesday, September 30

8:00-9:10 **Concurrent Session 4**
Blue Recovery - Beyond Zero from the Ocean

20:00-21:10 **Concurrent Session 5**
Innovations in Nuclear Energy

Thursday, October 1

8:00-9:10 **Concurrent Session 6**
CO_2 Removal

20:00-21:00 **Concurrent Session 7**
Advancements in Digital and Energy Technologies

Friday, October 2

8:00-9:10 **Concurrent Session 8**
Carbon Recycling

13:00-14:30 **Concurrent Session 9**
Behavior and Transportation Demand Change

21:00-22:10 **Concurrent Session 10**
Science Based Agriculture

Wednesday, October 7

11:45-12:00 **Opening Remarks**

12:00-13:30 **Plenary Session 1**
Women for Clean Energy Innovation

16:00-17:30 **Plenary Session 2**
Finance for Innovation

Thursday, October 8

9:00-10:00 **Side Event**
Roadmap Project

16:00-17:30 **Plenary Session 3**
Road to Beyond Zero

17:30-18:00 **Closing Session**
Closing Remarks
Top 10 Innovations Result Announcement
Roadmap Announcement
Statement from Steering Committee
Final Thoughts on the Event

Opening Remarks

Video Message from Minister of Economy, Trade and Industry

Minister of Economy,
Trade, and Industry
Kajiyama Hiroshi

A video with the following message from Mr. Kajiyama Hiroshi, Minister of Economy, Trade, and Industry of Japan (METI) was shown:

In organizing the seventh ICEF I have been looking forward to meeting all of you, the world's leading experts on innovation. However, it was so unfortunate that due to the outbreak of COVID-19 we're not able to invite you to Tokyo in person. Now, at the opening of this year's ICEF held as a virtual conference, I would like to express my sincere welcome to all of you who participated from different countries despite the time difference. My gratitude goes to the members of the steering committee and all those involved in making this event possible.

We're faced with the important task of overcoming the current pandemic of COVID-19 and recovering the economy. In the medium to long-term we must also tackle the issue of climate change. The situation is complex and difficult. However, I see this as an opportunity to rebuild Japan's economy and society. Japan will accelerate its efforts in climate change and demonstrate leadership towards its ultimate goal of global decarbonization. Specifically, through the development of innovative technologies, Japan will aim to reduce CO_2 emissions which have been increasing since the industrial revolution, so we can go "Beyond Zero", that is, beyond net zero emission on the way to making the emissions negative. In addition, we will use this innovation as a source of new growth and pursue a positive cycle of economic growth and environmental protection.

In order to achieve this "Beyond Zero" goal, we must not only conduct research and development and demonstration of technologies, but also promote the use of these technologies in society in the form of products. For example, technologies to isolate and capture CO_2 and technologies to manufacture CO_2-derived concrete products have already been realized. How to combine these technologies and create a market for them will be the key to their implementation throughout society. At the same time, it is important to raise people's awareness of the issues by capturing global trends and communicating Japan's efforts to the rest of the world.

This year, the week beginning today, October 7, will be designated as Tokyo Beyond Zero Week, where world leaders in the fields of energy and the environment will debate the issues in depth. More specifically, six conferences will be held in a concentrated manner this week. We are starting with today's ICEF followed by the RD20 which will establish an environment for the creation of international research collaboration; the TCFD summit, which will discuss mobilization of funds to support the realization of innovation and transition, the Hydrogen Energy Ministerial Meeting, the LNG Producer-Consumer Conference, and the International Conference on Carbon Recycling which will focus on specific issues such as creation of a hydrogen-based society, carbon recycling, and decarbonization of LNG.

I recently had the opportunity to exchange views with Dr. Yoshino Akira, the Nobel laureate and director of the AIST Global Zero Emission Research Center. He said, "We already possess elemental technologies for environmental and energy technologies. Therefore, for the realization of a sustainable society, it is important to combine those technologies with cross-sectoral technologies such as AI, 5G, and IoT. If we combine the excellent ideas that one in 10,000 researchers come up with, we can create rare ideas of the highest level in the world." I find this very encouraging.

ICEF is the place where wisdom from all over the world gathers to discuss and develop new ideas. At last week's ICEF preceding breakout sessions, 49 experts from sixteen countries and regions representing government, industry, and academia engaged in vibrant discussions of innovative technologies to achieve Beyond Zero. At the plenary sessions of the conference starting today, we will summarize the discussions of these experts and further discuss ways to achieve Beyond Zero, taking into account the perspectives of women's participation and finance.

We hope that ICEF will provide an opportunity for stakeholders from around the world to exchange ideas and discuss concrete ways to achieve the positive cycle of economic growth and environmental protection, and the attainment of Beyond Zero globally.

Plenary Session 1

Women for Clean Energy Innovation

In the past, climate change and innovation have been the main focus of ICEF sessions. This year, ICEF aims to clarify the role and significance of gender equality and empowerment of women in promoting innovation, and address how women's empowerment can accelerate the development of climate change countermeasures. This session will focus on the development of a mentoring network that fosters women's abilities, promotion of women's education in developing countries, and the importance of assisting the active participation of women in the combat against climate change.

Tanaka Nobuo (Moderator)
Special Advisor, The Sasakawa Peace Foundation (SPF);
Former Executive Director, International Energy Agency (IEA)

Eija-Riitta Korhola
Delegate of the Consultative Commission on Industrial Change;
Advisor in the EU Affairs

Inkar Kadyrzhanova
Regional gender and climate change adviser, UN Women regional office for Asia and the Pacific

Kathy Matsui
Japan Vice-Chair/Chief Japan Equity Strategist, Goldman Sachs

Laurence Tubiana
CEO, European Climate Foundation

Matsuno Ayaka
Director, Gender Investment and Innovation Department,
The Sasakawa Peace Foundation (SPF)

Plenary Session 2

Finance for Innovation

In order to simultaneously achieve economic growth and significant GHG emissions reduction, it is essential to consider the vital role of finance. Finance will be required to deploy existing low carbon solutions and to develop new, low-carbon technologies for hard-to-abate sectors. It is also very important to consider the impact of COVID-19, the risks and opportunities that exist in recovery stimulus packages, and also to consider the role that gender diversity can play in the transition. This session aims to share the latest viewpoints from a government and public finance perspective, and also ideas from private finance and companies, as to how best to move forward in major developed economies. All aspects of financing will be considered; from financing innovation and project finance through to asset management and financial asset ownership.

Jon Moore (Moderator)
Chief Executive Officer, BloombergNEF

Aleksandra Tomczak
Member of Cabinet of the Executive Vice President, the European Commission Frans Timmermans in charge of the European Green Deal

Isabelle Laurent
Deputy Treasurer and Head of Funding, European Bank for Reconstruction and Development (EBRD)

Mark Christopher Lewis
Global Head of Sustainability Research, BNP Paribas Asset Management

Mungo Park
Founder and Chair, Innovator Capital Limited (ICL)

Plenary Session 3

Road to Beyond Zero

In order to achieve net zero and more ambitiously, beyond zero emissions (in other words, reducing the CO_2 accumulated in the atmosphere) by 2050, technological innovation will be necessary in the fields of electricity, hydrogen and the use of fossil fuels with CCUS. Additionally, there is a need for social acceptance as well as a new social structure that promotes innovation and is dedicated to solving social issues. This session will discuss the current state and challenges of technological and social innovations, their integration, public involvement and finance approach in achieving beyond zero.

Yamaji Kenji (Moderator)
Senior Vice President/Director-General, Research Institute of Innovative Technology for the Earth (RITE);
Professor Emeritus, The University of Tokyo

Fiona Reynolds
Chief Executive Officer, Principles for Responsible Investment (PRI)

Manfred Fischedick
Scientific Managing Director, Wuppertal Institute for Climate, Environment & Energy

Tom Delay CBE
Chief Executive, The Carbon Trust

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

Concurrent Sessions

Concurrent Session 1 Hydrogen Production Technologies and Urban Utilization

With increasing sense of urgency towards climate change and air pollution in developed nations, the uptake of low-carbon hydrogen could soon go into full swing. One of the largest obstacles it faces is high cost, which means requiring innovative technologies in production, storage, transportation, and utilization, as well as deregulation in handling hydrogen and increase in demand. Among these, this session will focus on production and utilization of renewable energy-based low-carbon hydrogen as well as the trends around hydrogen utilization including urban utilization.

Sally M. Benson (Chair)
Professor, Department of Energy Resources Engineering, School of Earth, Energy & Environmental Sciences, Stanford University; Co-Director, Precourt Institute for Energy, Stanford University

François-Régis Mouton
Regional Director Europe, International Association of Oil & Gas Producers (IOGP)

Sunita Satyapal
Director, Hydrogen and Fuel Cell Technologies Office, Office of Energy Efficiency and Renewable Energy, U.S. Department of Energy

Yabe Akira
Fellow, Energy System & Hydrogen Unit, Technology Strategy Center (TSC), New Energy and Industrial Technology Development Organization (NEDO)

Concurrent Session 2 Circular Economy Implementation

In recent years, as awareness of environmental issues has increased, policies and business initiatives aimed at transitioning from linear economies such as production, consumption, and disposal to circular economies that function in a closed system, each of which utilizes repairs and reuse, are actively underway to make consumption sustainable. In this session, we will discuss trends in policy and measures to implement circular economy, business models that voluntarily build circular economy-based effective technological innovation and strategies, and life cycle assessment (LCA) methods and utilization to quantitatively grasp the environmental impact of the entire life cycle for social implementation.

Yasui Itaru (Chair)
Honorary Adviser, National Institute of Technology and Evaluation (NITE); Emeritus Professor, The University of Tokyo; Honorary Adviser, Institute for Promoting Sustainable Societies

Brendan Vidal Edgerton
Director, Circular Economy, World Business Council for Sustainable Development (WBCSD)

Lynette Chung
CSO, Head of Global Sustainability, Covestro AG

Dohi Hideyuki
Director General, Environment and Green Chemistry Unit, Technology Strategy Center (TSC), New Energy and Industrial Technology Development Organization (NEDO)

Tahara Kiyotaka
Director, Research Laboratory for IDEA, Research Institute of Science for Safety and Sustainability, National Institute of Advanced Industrial Science and Technology (AIST)

Concurrent Session 3 International Climate Cooperation - Moving towards Zero Emission Society

In emerging countries that continue to develop rapidly over a long period of time, combatting climate change will require promotion of low-carbon innovations taking into account regional characteristics. This session will explore approaches to climate change issues tailored to the needs of emerging countries, and expectations for the private sector by using the cases of environmental cooperation between Japan and other Asian countries.

Ajay Mathur (Chair)
Director General, The Energy and Resources Institute (TERI);
Member of the Prime Minister's Council on Climate Change

Nuki Agya Utama
Executive Director of the ASEAN Centre for Energy (ACE)

P. C. Maithani
Adviser, Ministry of New and Renewable Energy,
Government of India

Tareq Emtairah
Director, Department of Energy, United Nations Industrial
Development Organization (UNIDO)

Tony Clamp
Director of the Green Climate Fund's Private Sector Facility

Concurrent Session 4 Blue Recovery – Beyond Zero from the Ocean

Achieving Sustainable Development Goal (SDG) 14 — sustainable development for the oceans, seas, and marine resources — will require international cooperation. Aquaculture, offshore renewable energy, coastal tourism, and marine mineral resources have potential for economic growth and job creation. In the offshore renewable energy field, floating offshore wind projects have been introduced, along with the potential for integration of aquaculture facilities. In this session, we will examine technical and economic issues, countermeasures, international cooperation, and potential ways to contribute to sustainable development in regards to marine technology.

Sunami Atsushi (Chair)
President, The Sasakawa Peace Foundation (SPF) ; President, The Ocean Policy Research Institute of SPF ;
Director, SciREX Center, Executive Advisor to the President, National Graduate Institute for Policy Studies (GRIPS) ;
Guest Professor, Research Organization for Nano & Life Innovation, Waseda University

Karsten Stoltenberg
Country Manager Japan,
Equinor New Energy Solutions

Mark Leybourne
Senior Energy Specialist, Energy Sector Management
Assistance Program (ESMAP), World Bank

Ngedikes Olai Uludong
Permanent Representative of Palau to the United Nations

Yamada Masato
Vice President, Regional Manager,
Asia Pacific, MHI Vestas Offshore Wind

Concurrent Session 5 Innovations in Nuclear Energy

Venture companies in various countries are promoting research and development of small modular reactors (SMRs) for nuclear power generators, heat utilization applications and nuclear fusion reactors. This session focuses on the latest status and challenges of technology development for nuclear power generation and heat utilization and will discuss the potential of nuclear power as a CO_2-free energy source.

Richard K. Lester (Chair)
Associate Provost, Massachusetts Institute of Technology

Ashley E. Finan
Director, National Reactor Innovation Center

Jill Engel-Cox
Director, Joint Institute for Strategic Energy Analysis (JISEA)
at National Renewable Energy Laboratory (NREL)

Nakatani Eri
Deputy Director, Nuclear Energy Policy Planning Division,
Agency for Natural Resources and Energy,
Ministry of Economy, Trade and Industry

William Magwood
Director-General,
OECD Nuclear Energy Agency (NEA)

Concurrent Session 6 CO_2 Removal

To aim beyond zero emissions in long term, it is necessary to have technology for CO_2 removal from the atmosphere. CO_2 removal technology such as Direct Air Capture (DAC) is needed to remove CO_2 that has been emitted into the atmosphere and will continue to be emitted in the future. In addition, CO_2 absorption technology will be needed to sequester and store the CO_2 on land such as in farmland and forests, and in the sea such as in seaweed beds and tidal flats. In this session, we will discuss technical and social challenges facing the aim of beyond-zero emissions over the long term based on recent trends in DAC-related technology development, business-based initiatives, and the deployment potential of these technologies.

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

Lori Guetre
Vice President, Business Development,
Carbon Engineering Ltd.

Roger Aines
Energy Program Chief Scientist for Global Security E Program,
Energy and Homeland Security,
Lawrence Livermore National Laboratory (LLNL)

Shirato Yasuhito
Director, Climate Change Research,
Institute for Agro-Environmental Sciences,
The National Agriculture and Food Research Organization
(NARO)

Tiffany Troxler
Associate Professor, Earth and Environment Department,
Florida International University

Concurrent Session 7 Advancements in Digital and Energy Technologies

Today we face the challenge of growing calls for solutions to climate change and other global issues. In this context, we have seen ongoing international debate on designing social systems that will create solutions aligned with the UN's SDGs. More companies and organizations are currently pursuing SDG-oriented activities, including RE100 and we need to engage various stakeholders in making concerted efforts to change and build sustainable social systems. Advancements in digital and energy technologies promise to contribute significantly to this innovative change but also pose new governance and social-steering challenges. The COVID-19 pandemic is disruptive, but properly directed, the stimulus packages underway to restart economies can leverage effects towards sustainability. The list of negative societal consequences is very long, including loss of education for children, multiple burdens for the many working at home while taking care of children and other responsibilities. Another possible legacy of COVID-19 could be an increase in the challenges to achieving gender equity and empower all women and girls. This session will discuss innovations in social systems and the utilization of energy technologies driven by changing energy user needs and advancements in digital technologies that support new trends in the post-pandemic future toward gender and equality for all.

Nebojsa Nakicenovic (Chair)
Executive Director, The World in 2050 (TWI2050)

Anna Piperal
Managing Director, e-Estonia Briefing Centre, Enterprise Estonia

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

Yamazaki Satoshi
Managing Director, Accenture

Concurrent Session 8 Carbon Recycling

Even the industrial sector, where emissions are hard to reduce, is entering a major transitional period with efforts ramping up to promote carbon recycling and transition to low-carbon processes. On the other hand, R&D is underway on utilization of recovered CO_2 in valuable goods and services such as fuel, concrete, carbonate mineralization, chemicals, carbon raw materials, and transport of CO_2 by LNG carriers. Discussion in this session will focus on development trends and issues pertaining to recovered CO_2 utilization technologies. There will also be discussion of LCA analysis results, commercialization trends, and readily adoptable measures that can be taken in a short period of time.

David Sandalow (Chair)
Inaugural Fellow, Center on Global Energy Policy, Columbia University;
Co-Director, Energy and Environment Concentration, School of International and Public Affairs, Columbia University

A.-H. Alissa Park
Director of the Lenfest Center for Sustainable Energy, Columbia University

Andrea Ramírez Ramírez
Professor, Chair Low Carbon Systems and Technologies, Faculty of Technology, Policy and Management, Delft University of Technology

Jennifer Holmgren
CEO of LanzaTech

Ziqiu Xue
Chief Researcher, CO_2 Storage Research Group, Research Institute of Innovative Technology for the Earth (RITE)

Concurrent Session 9 Behavior and Transportation Demand Change

This session will address changing consumer behavior to prevent the spread of COVID-19 and its impact on urban transport demand. Additionally, the session will also involve analysis of the ways in which technological innovations, infrastructure development and regulatory arrangements can cope with any effects on CO_2 emissions resulting from changing consumer behavior in the urban transport. These session themes will cover both short-term and long-term outlooks.

Georg Erdmann (Chair)
Retired Professor for Energy Systems, Berlin University of Technology;
President of the Board, KSB Energie AG, Berlin

Aruturo Ardila-Gomez
Global Lead for Urban Mobility and Lead Transport Economist,
World Bank

Brian Motherway
Head of Energy Efficiency, International Energy Agency

Hayashi Yoshitsugu
President, The Japanese Association of The Club of Rome

Concurrent Session 10 Science Based Agriculture

GHG emissions from agriculture, forestry and land use are equivalent to one-fourth of the world's total emissions, thus shifting to a highly efficient and sustainable agriculture is strongly desired. For efficient and prompt development, the leapfrog agricultural development, which utilizes science based agricultural technologies, is required in developing countries, which account for about 80% of the world's population. On the other hand, not only technological innovation, but also lifestyle changes such as food loss and GHG emissions from livestock are important in developed countries. This session will explore the future outlook of science based agriculture from the perspectives of both developing and developed countries.

Ismail Serageldin (Chair)
Emeritus Librarian of Alexandria; Founding Director of the Library of Alexandria

Chris Argent
Head of Business Sustainability,
APAC Region, Syngenta AG

David Rosenberg
CEO and Co-Founder of AeroFarms

Iiyama Miyuki
Director, Research Strategy Office,
Japan International Research Center for Agricultural Sciences
(JIRCAS)

Olivier Dubois
Senior Natural Resources Officer,
Office of Climate, Biodiversity and Environment, FAO

Closing Session

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

❷ Top 10 Innovations Result Announcement
Yasui Itaru, Honorary Adviser, National Institute of Technology and Evaluation (NITE); Emeritus Professor, The University of Tokyo; Honorary Adviser, Institute for Promoting Sustainable Societies

❸ Roadmap Announcement
David Sandalow, Inaugural Fellow, Center on Global Energy Policy, Columbia University; Co-Director, Energy and Environment Concentration, School of International and Public Affairs, Columbia University

❹ Statement from Steering Committee
Yamaji Kenji, Senior Vice President/Director-General, Research Institute of Innovative Technology for the Earth (RITE); Professor Emeritus, The University of Tokyo

❺ Final Thoughts on the Event
Tanaka Nobuo, Special Advisor, The Sasakawa Peace Foundation (SPF); Former Executive Director, International Energy Agency (IEA)

Statement

ICEF 2020 Statement from the Steering Committee

October 8, 2020

0. Tokyo Beyond Zero Week

We are aware that it is necessary to call for a holistic and systemic approach to tackle challenges of energy and climate change, inviting collaboration among all relevant stakeholders. Sharing global leading experiences or exchanging opinions through conferences, as ICEF does, would help people to realize and identify our current position and possible future options. To this end, we welcome the "Tokyo Beyond Zero Week" organized by the Japanese Government, that seeks to enhance international discussion in this policy area, incorporating 6 conferences to consider all possible pathways to accelerate a virtuous cycle of environment and growth; technological and societal innovation aspect (ICEF), finance (TCFD) and international collaborations of R&D institutions (RD20), as well as special focus on a hydrogen based society (Hydrogen Energy Ministerial Meeting), on the development and deployment of carbon recycling technology (International Conference on CR) and on decarbonized use of LNG (LNG Producer Consumer Conference).

1. Preamble

The seventh annual meeting of the Innovation for Cool Earth Forum ICEF 2020 was held online on October 7 and 8 with preceding sessions from September 28 to October 2. More than 1,300 people from government, international organizations, industry, and academia, from 80 countries and regions, registered and participated in this first-ever online event. The theme of this year's forum was "Action toward "Beyond Zero" emission society in light of COVID-19, with a focus on gender equality."

The world is currently facing an unprecedented situation caused by the COVID-19 pandemic. This global threat underscores the risks of the global threat posed by climate change. We welcome the increased concern expressed by young people. Along with governments' initiatives to restore their economies, a virtuous cycle of environment and growth should be expeditiously put into place, while taking note of IEA's Sustainable Recovery Plan. The economic recovery funds pledged by the governments in response to COVID-19 crisis could be used to build a sustainable future and achieve net-zero emissions instead to rebuild the unsustainable past. To this end, we issue the following statement addressing what approaches are needed and how they should be implemented:

2. Society changing significantly through the unprecedented situation

Due to COVID-19, global CO_2 emissions are projected to be reduced by 8% on a year-on-year basis in 2020. This annual reduction rate is almost equivalent to the rate necessary for the emission pathway with 1.5°C global warming. As such, COVID-19 has made us aware of how daunting this 1.5°C pathway is, since obviously we cannot continue to withstand the economic slow-down and inconvenience in our daily life as experienced now. In this context, we should once again clearly recognize and underline the utmost importance of innovation in addressing climate change.

Recently, the Japanese government formulated the "Environment Innovation Strategy" in order to create, commercialize, and spread progressive innovations in the energy and environmental fields through international cooperation. It is essential to make a transition for the world including emerging countries, to establish a low-carbon society for tackling climate change, and it requires robust relationships across countries, various public and private sectors, and academia. The value of the strategy is summarized in the following sentence: the Environment Innovation Strategy aims to establish innovative technologies that enable the reduction of global GHG emissions toward carbon neutral and further reduction of the accumulated atmospheric CO_2 level, "Beyond Zero" by 2050.

In addition, there is no doubt that women's participation will play a huge role in the promotion of innovations. As COVID-19 accelerates a wider use of IT equipment, which is changing our working style dramatically, it could further empower female participation. Empirical studies also suggest that climate change is not gender neutral, showing that the higher the ratio of female participation, the greater the performance in addressing climate change. It is of great interest to see how women's participation will support endeavors to tackle climate change. We should commit to the development of mentoring networks suitable for women's skills and the promotion of education for women in developing countries.

Finance for innovations matters. All available opportunities, including stimulus packages, should be used for fund raising measures such as public/private investment, funding from partner companies and motivation for self-investment through internal carbon pricing. We are pleased to see the increasing support of business communities for climate-related financial disclosure based on the TCFD's recommendation. Enhanced transparency is expected to lead to effective communication between business and financial sectors, and thereby to improve the market and investment environment. We strongly encourage use of green equity toward sustainable infrastructure. And as for COVID-19 recovery, it is necessary to promote investment for sustainable structural transformation in the energy system and other transformative infrastructure.

Bearing in mind the possible synergy between gender and climate change, it would be worth considering an idea of bridging gender investment and climate change investment, in order to support further effective actions and decisions by companies towards a lower GHG emission society.

3. Discussions and findings from the concurrent sessions

During ICEF 2020, we invited participants to discuss these topics in the 3 plenary sessions as well as 10 concurrent sessions, which were set up in line with the "Environment Innovation Strategy."

(1) Energy transformation

- Hydrogen is an indispensable energy carrier to decarbonize or lower carbon emission in energy consumption. Throughout its entire supply-chain, we should drive technological development as well as policy-making concerning production, storage, transportation and utilization. We should also make substantial progress in international cooperation for deployment of hydrogen infrastructures on a global scale through concerted efforts of both public and private sectors. When countries plan sustainable recovery packages for COVID-19, they should focus on research, development, demonstration and deployment (RDD&D) of hydrogen infrastructure including storage and transport in relation to the deployment of CCS/CCUS, and its use especially in high temperature, such as by steel making applications.

- Demand and deployment of renewable energy is growing year by year, thanks to its significantly reduced cost as well as the strong appeal to investors and corporate image improvement. Some emerging countries are also assessing and investing in power transmission systems suitable for the utilization of renewable energy. Governments and power companies will need to adapt flexibly to new environments by adopting digital technology and infrastructure development, in particular in energy end use where user behavior and demand trends are also essential.

- With regard to nuclear power generation, companies from various countries including ventures are making steady progress in research and development on advanced reactor technologies including small modular nuclear reactors (SMRs) as well as flexible nuclear system. Governments should establish long-term policies/R&D guidelines and provide support to companies including ventures for accelerated development while ensuring safety.

(2) Transportation

- Demand for transportation in urban areas has plummeted due to the COVID-19 pandemic, as work from home and web conferences have become more popular. People are increasingly driving cars or using bicycles to avoid public transportation. Demand for freight transport has declined with the economic downturn yet increased with e-commerce. These changes in consumer behavior give birth to new services and require the development of new technologies to curb emissions in the supply chains.

- All these changes represent a concern for sustainable transport development. Measures should be in place to restore passengers' confidence in public transport through (1) providing information/data to passengers on the operation of public transport, and (2) encouraging strategies for peak shaving in order to satisfy the rules for social distancing. It is important to align short-term stimulus measures for public transport infrastructure development with the long-term decarbonization goal

(3) Industry

- Carbon recycling is an umbrella concept that describes many different processes and products. Some of these processes and products have the potential to contribute to achieving net zero emissions by displacing fossil fuels or storing carbon dioxide for the long-term. Life cycle analysis of the greenhouse gas emissions associated with any product made from recycled carbon is especially important. Much more R&D and policy support is needed to fully develop the potential of carbon recycling.

- We need to enhance circular economy implementation to realize sustainable consumption trends/lifestyles, and to utilize a life cycle assessment to grasp the environmental impact of the entire life cycle. To this end, the model of circular economy shall be established, and the barriers of different sectors need to be transcended so that people will favor switching to reparable or reusable products.

(4) Cross-sectoral

- The ocean has enormous potential to mitigate environmental issues and grow our economy through ocean renewable energy, aqua-culture, coastal tourism, ocean mineral resources, and so on. The off-shore wind market in particular has been growing rapidly. For further acceleration, market competition, public-private-cooperation, and international cooperation will be key.

- Climate change is a global issue requiring countermeasures which meet the needs of emerging countries. In this regard, it is essential to advance international dialogues to promote innovations based on the local situation, and also strengthen relationships between both private and public sectors, and academia, as well as strengthen and create for a knowledge sharing. Promotion of private finance, especially green equity, will be also key to achieve sustainable economic development in emerging countries.

(5) Agriculture, forestry and fisheries/Carbon Sinks

- Agriculture in emerging economies requires leapfrog technologies to tackle the challenges of ensuring food and nutrition security for a growing population. The availability of renewable energy and investment therein will also be crucial for supporting those technological developments. Meanwhile, in developed countries, not only do we need further implementation of advanced agriculture technologies to effectively enhance food productivity, but we also need to change our lifestyles, including reducing wastage and food loss. The selection of production methods using low emission technologies will be essential in achieving sustainable agriculture.

- Technological development relating to carbon sequestration in cropland, CO_2 absorption by forest, and blue carbon as well as GHG emission reduction in agriculture, forestry and fisheries also need to be advanced.

- Technologies to capture CO_2 released into the air (such as DAC) and either use or fixate that CO_2 are attracting attention. Commercializing these technologies will require new investment in science, technology, and projects - all would benefit from a long-term roadmap, shared internationally and funded effectively.

4. Action for Beyond Zero and expectations for women's participation

A virtuous cycle of environment and growth is essential when we tackle climate change. This remains the case even under the unprecedented situation caused by the COVID-19 pandemic. The Environment Innovation Strategy is a comprehensive action plan for this concept. The question is how we should implement it and make advances towards "Beyond Zero." Industry, government, academia, and investors must come together to facilitate research, development and investment, with lessons learnt from this annual meeting, noting that women's participation will further accelerate our efforts.

Roadmap Projects

ICEF develops roadmaps on how key innovative technologies can contribute to a transition to clean energy. At the ICEF 2020 side event, the draft version of the roadmap on Biomass Carbon Removal and Storage (BiCRS) was presented.

This roadmap explores ways to use biomass to remove CO_2 from the atmosphere and store that CO_2 underground or in durable products. We introduce a new term -- biomass carbon removal and storage (BiCRS) – which we believe better describes this topic than the traditional term -- bioenergy with carbon capture and storage (BECCS).

The roadmap explores questions including:

- What is the technical potential for carbon removal and storage using biomass?
- How can these processes avoid harming – and ideally promote -- food security, rural livelihoods, biodiversity conservation and other important values?
- What standards and policies would help BiCRS processes achieve their full potential?

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Top 10 Innovations

"Top 10 Innovations" is an event to elect the most notable recent innovative developments to raise public awareness regarding innovations to counter global warming. This year, 20 nominees from 2 categories, "Research & Development: Commercial potential of the innovation by 2050" and "Adoption & Implementation: Commercial potential of the innovation by 2030," were selected by the Top 10 Innovations working group. Ultimately, ICEF 2020 Top 10 Innovations were elected as follows through votes by ICEF 2020 participants.

Category Research & Development:
Commercial potential of the innovation by 2050

A new development of viable sodium-ion battery

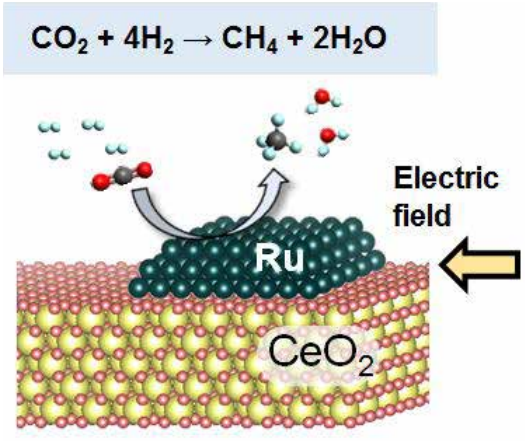
Source : Washington State University

Organization Washington State University and
Pacific Northwest National Laboratory (PNNL)

Researchers at Washington State University and Pacific Northwest National Laboratory have created a sodium-ion battery that holds as much energy and works as well as some commercial lithium-ion battery chemistries, making for a potentially viable battery technology out of abundant and cheap materials. It is able to deliver a capacity similar to some lithium-ion batteries and to recharge successfully, keeping more than 80 percent of its charge after 1,000 cycles.

Category Research & Development:
Commercial potential of the innovation by 2050

A new method which converts CO_2 to methane at low temperature



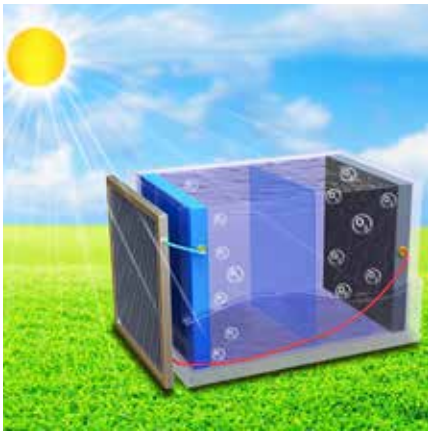
Source : Waseda University

Organization Waseda University

A new method developed by Waseda University is a conversion of CO_2 at low temperature to valuable chemicals such as methane by using Ru/CeO_2 Catalyst. With the new catalyst, CO_2 can be converted into methane more efficiently and quickly in the 100 Celsius degree range. It has drawn great attention for use in supporting carbon capture and utilization.

Category Research & Development:
Commercial potential of the innovation by 2050

Direct solar-to-hydrogen production process with high efficiency by perovskite-silicon tandem absorbers



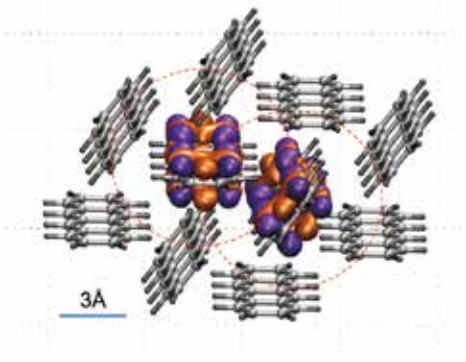
Source : Australian National University

Organization Australian National University

Australian National University researchers demonstrated a perovskite-silicon tandem absorbers for stand-alone solar water splitting. An unprecedented solar-to-hydrogen conversion efficiency over 17% is achieved when a silicon photocathode is paired in tandem with a high bandgap semitransparent perovskite solar cell.

Category Research & Development:
Commercial potential of the innovation by 2050

Dramatic increase in solar cell output (2 electrons with 1 photon)



Source : MIT

Organization Massachusetts Institute of Technology (MIT)

Researchers at MIT have demonstrated a method for getting high-energy photons striking silicon to kick out two electrons instead of one, opening the door for a new kind of solar cell with greater efficiency than was thought possible. The key to splitting the energy of one photon into two electrons lies in a class of materials that possess "excited states" called excitons. With this method, there will be an increase in the power produced by the solar cell — from a theoretical maximum of 29.1 percent, up to a maximum of about 35 percent.

Category Adoption & Implementation:
Commercial potential of the innovation by 2030

The world's highest efficiency fuel cell for residential use

Source : Osaka Gas

Organization Osaka Gas, AISIN SEIKI, Kyocera, Noritz, PURPOSE, and Rinnai

The world's highest efficiency fuel cell called "ENE-FARM type S" has been developed by Osaka Gas along with Aisin Seiki, Kyocera, Noritz, PURPOSE and Rinnai. It has the efficiency of 55% which is highest in the world, also achieved reduction of installation area size and better durability.

Category Adoption & Implementation:
Commercial potential of the innovation by 2030

The world's first liquefied hydrogen carrier building an international hydrogen energy supply chain

Source : HySTRA

Organization HySTRA [Iwatani Corporation, Kawasaki Heavy Industries, Shell Japan, J-POWER, Marubeni Corporation, ENEOS Corporation, "K" LINE]

The world's first liquefied hydrogen carrier "SUISO FRONTIER" manufactured by Kawasaki Heavy Industries was launched as part of the NEDO's demonstration project for "Establishment of Mass Hydrogen Marine Transportation Supply Chain Derived from Unused Brown Coal." NEDO will utilize this carrier to supply a series of international large-scale hydrogen supplies such as brown coal gasification/hydrogen purification/ liquefaction in Australia, liquefied hydrogen marine transportation from Australia to Japan, and liquefied hydrogen cargo handling and storage in Japan. The chain will be demonstrated in 2020.

Category Adoption & Implementation:
Commercial potential of the innovation by 2030

New concrete manufacturing technologies with saving fresh water and reducing carbon footprint

Source : Solidia Technologies

Organization Solidia Technologies

Solidia Technologies has developed sustainable technologies that both lower carbon emissions in the production of cement and use CO_2 in place of water to cure concrete. The manufacture of cement, the binder used to make concrete, emits 8% of the world's CO_2 emissions. Low-energy Solidia Cement lowers carbon emissions and permanently consumes CO_2 in the curing process. Combined, the technologies potentially save 3 trillion liters of fresh water every year and help manufacturers reduce their carbon footprint up to 70%. In August 2019, the company announced the first commercial venture to supply a paver and block plant with reduced CO_2 cement.

Category Adoption & Implementation:
Commercial potential of the innovation by 2030

A new development of Medium Voltage Switchgear without SF6

Source : Schneider Electric

Organization Schneider Electric

A medium voltage switchgear without SF6 "SM AirSet" has been invented by Schneider. The SF6 free switchgear saves 2.4kg of SF6 for each Medium/Large Voltage distribution substation with replacing SF6 with pure air by the company's new shunt vacuum interruption technology (SVI). This combination enables the replacement of SF6 while maintaining the small footprint and cost-effectiveness similar to existing SF6 used switchgear.

Category Adoption & Implementation:
Commercial potential of the innovation by 2030

Future fuel capabilities for shipping and energy sector with first ammonia tests

Source : Wärtsilä

Organization Wärtsilä

Wärtsilä has started combustion trials using ammonia as a fuel, which will help reduce greenhouse emissions in shipping and energy sectors. As part of the tests, ammonia was injected into a combustion research unit to better understand its properties. These will be followed by field tests in collaboration with ship owners from 2022, and potentially also with energy customers in the future.

Category Adoption & Implementation:
Commercial potential of the innovation by 2030

A new technology changing CO_2 to a mineral in concrete manufacturing

Source : CarbonCure Technologies

Organization CarbonCure Technologies

CarbonCure has developed an innovative technology to waste CO_2 captured by industrial gas suppliers into concrete during mixing, enabling the production of stronger, more sustainable concrete, which will then be converted into a mineral through a chemical process. In January 2020, A new low-carbon concrete project has just started at YYC Calgary International Airport.

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Professor Emeritus,
The University of Tokyo
Japan

Messages from Co-Hosts

Ministry of Foreign Affairs

NAKANISHI Satoshi

Parliamentary Vice-Minister for Foreign Affairs, Japan

I would like to express my sincere congratulations to the holding of ICEF with the participation of well-known experts despite the serious situation due to the global spreading of COVID-19.

Looking ahead to the post COVID-19 phase, how we can achieve economic growth and sustainable environment together will be a principal issue.

Promotion of innovation through international cooperation, which is also the aim of ICEF, is an essential element to achieve this. I believe that it is important to address climate change by taking advantage of the innovation, not only in Japan but also around theworld, and to promote solutions on a global scale. As the authority in charge of foreign affairs, we will endeavor to make use of Japanese technology and models for the advancement of the world in cooperation with you.

Ministry of Education, Culture, Sports, Science and Technology

MITANI Hidehiro

Parliamentary Vice-Minister of Education, Culture, Sports, Science and Technology, Japan

On behalf of the Ministry of Education, Culture, Sports, Science and Technology (MEXT), I would like to express how pleased I am to be able to co-host the ICEF, where world-class leaders from multi-sectors have discussions on the issue of climate change.

Through the COVID-19 pandemic, we realized again that it is essential for each sector to fulfill its own responsibility and work together beyond borders and positions for addressing global issues, including climate change. We at MEXT will promote fundamental research, which will be the source of all innovations for de-carbonization, in cooperation with the industry and academic sectors.

Ministry of Agriculture, Forestry and Fisheries

KUMANO Seishi

Parliamentary Vice-Minister for Agriculture, Forestry and Fisheries, Japan

On behalf of the Ministry of Agriculture, Forestry and Fisheries (MAFF), which joined ICEF as a co-cost this year, I would like to express our deep appreciation and respect for agriculture, forestry and fisheries being taken up as a topic of discussion at ICEF for the first time.

While agriculture, forestry and land use account for a quarter of the world's greenhouse gas emissions, they play a significant role as a carbon sink, and the agriculture, forestry and fisheries industries likewise play a significant role in eradicating hunger and combating climate change.

Innovation is crucial for improving both the productivity of the food, agriculture, forestry and fisheries industries and the sustainability of the global environment.

I hope that this conference will provide an opportunity for discussion on how to resolve this issue and to discover new roles for the agriculture, forestry, and fisheries industry.

Ministry of the Environment

MIYAZAKI Masaru

Parliamentary Vice-Minister of the Environment, Japan

I would like to extend my greetings on the occasion of the 7th Annual Meeting of the Innovation for Cool Earth Forum (ICEF).

While the world economy is being hit hard by the novel coronavirus pandemic, Japan held an online ministerial meeting of the "Online Platform" on a Sustainable and Resilient Recovery from COVID-19 this September. At this ministerial meeting, we discussed the technological innovations including zero-emission technology and major changes in lifestyle as necessary elements in redesigning our socio-economic systems.

In an era when responding to the issue of climate change is no longer a cost but a source of new growth, the virtuous cycle of environment and growth will be the catalyst for the vigorous recovery of the world economy.

We sincerely hope that not only technological innovation but also innovation from all perspectives, such as socio-economic systems including finance or individual lifestyles, will lead to the solution of global environmental challenges and to the vigorous economic growth. I expect that the ICEF will be an opportunity to create that global movement.

Innovation for Cool Earth Forum

ICEF 2021
Save the Date

8th Annual Meeting

OCTOBER 6-7, 2021

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