

# I<sup>2</sup>CNER

INTERNATIONAL INSTITUTE FOR CARBON-NEUTRAL ENERGY RESEARCH



2024



# Message from the I<sup>2</sup>CNER Director

International Institute for Carbon-Neutral Energy Research (I<sup>2</sup>CNER) was established in 2010 as the WPI Institute, the only institute at that time bearing “Carbon-Neutral Energy” as part of its name, and later joined the WPI Academy member in 2020. To date, I<sup>2</sup>CNER has promoted the societal value of basic research as part of WPI’s “Values for the Future” mission.

Climate change issues such as global warming are becoming more serious recently, and the shift to a carbon-neutral society based on renewable energy has become important and urgent global issue. There are still many difficult challenges exist for shifting from the current energy system that mainly uses fossil fuels to a society based on renewable energy and materials. However, for this, novel energy conversion technology as well as overall design of a social system which uses materials and energy linked each other is required.

Renewable energies such as solar and wind power are widely and evenly distributed energy without regional segregation, and are equally distributed to all people on earth. However, renewable energy has large fluctuations and low energy density, so it is required to develop an effective method for leveling and increase in power density. At I<sup>2</sup>CNER, we are developing innovative materials and processes such as solar cells that efficiently convert solar energy to electricity, and steam electrolysis that can convert to hydrogen as an energy carrier. Considering CO<sub>2</sub> as a carbon resource and also a hydrogen carrier, the efficient conversion process of CO<sub>2</sub> to useful compounds are also developing. In particular, we are working on the development of materials that can separate CO<sub>2</sub> which is diluted, such as in the atmosphere. On the other hand, we are also investigating the development of new interdisciplinary science for innovative photocatalysts such as dye modification and enzyme, which can directly convert solar energy into hydrogen. Finally, underground storage of CO<sub>2</sub> will also be necessary for net decrease of CO<sub>2</sub> emission, and therefore, storage technology and the stability of stored CO<sub>2</sub> underground are further studied. We will contribute to a carbon-neutral society in a holistic approach, by creation of innovative science and engineering with interdisciplinary sciences at different time and distance scales.

I<sup>2</sup>CNER has focused on the creation of highly efficient conversion technology. As a next step, we newly added rapid conversion as a keyword and cultivate a new academic field by integrating disciplines. We aim to contribute to realizing a carbon-neutral energy society by social implementation of the basic research we have developed as the WPI Institute, and also by novel concepts including a scenario and design for renewable society.



**Professor Tatsumi Ishihara**

Director, International Institute for Carbon-Neutral Energy Research (I<sup>2</sup>CNER)



カーボンニュートラル・エネルギー国際研究所(I<sup>2</sup>CNER)とは

# About I<sup>2</sup>CNER



## Contribute to the creation of a sustainable and environmentally-friendly society

Shifting to carbon-neutral energy society is globally required important subjects. I<sup>2</sup>CNER will contribute to realize carbon-neutral society by required novel sciences and also open new research field by interdisciplinary research. On the other hand, securing energy to support a prosperous life is an important global issue and I<sup>2</sup>CNER will propose social system which uses renewable energy by converting to hydrogen or hydrocarbon synthesized from CO<sub>2</sub> captured and lead to establish a carbon-neutral society.

### 世界トップレベル研究拠点プログラム(WPI)

## World Premier International Research Center Initiative (WPI)

The World Premier International Research Center Initiative (WPI) was launched in 2007 by the Ministry of Education, Culture, Sports, Science and Technology (MEXT) in a drive to build within Japan “globally visible” research centers that boast a very high research standard and outstanding research environment, sufficiently attractive to prompt frontline researchers from around the world to want to work in them. I<sup>2</sup>CNER was selected in 2010. In FY 2017, MEXT established the new WPI Academy to take the vanguard in internationalizing and further renovating Japan’s research environment, making it place that expands and accelerates the international circulation of the world’s best brains. The WPI centers that have achieved “world-premier status” will be the initial members of the WPI Academy. They may possibly be joined later by other Japanese research institutes that have amassed research results and created research environments of the very highest world standard.

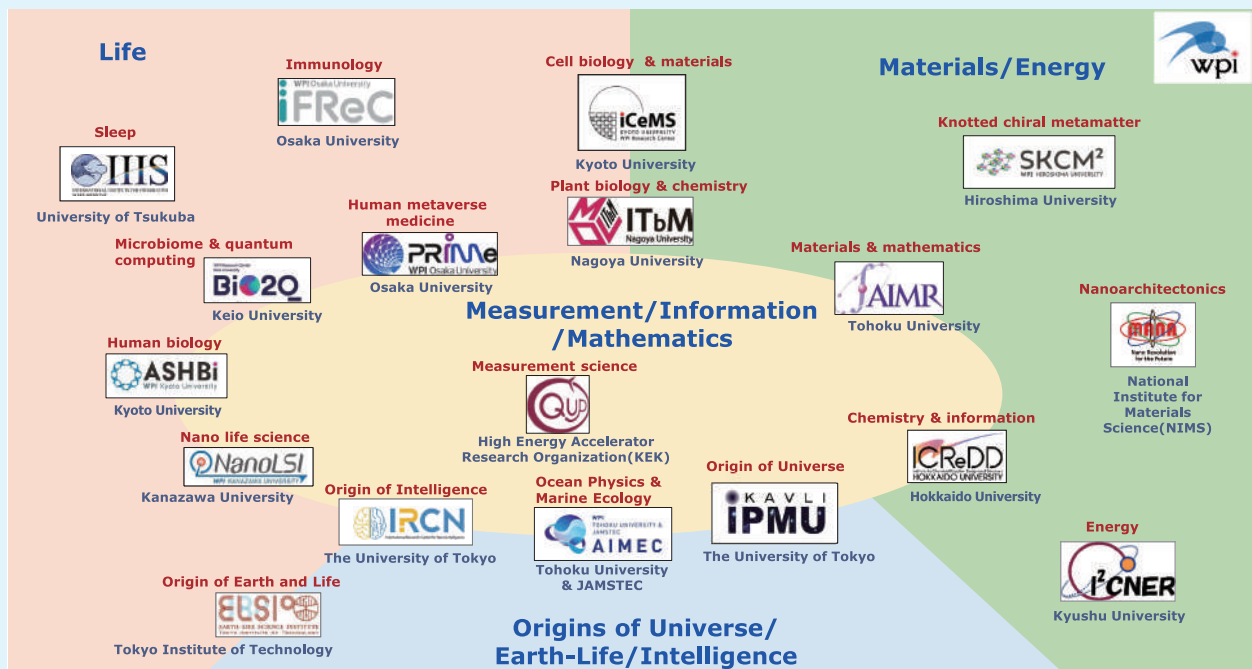
I<sup>2</sup>CNER was certified as having achieved “World Premier” status by the Program Committee and was inducted into the WPI Academy in April 2020.



### WPI Program Mission

- World-Leading Scientific Excellence and Recognition
- Global Research Environment and System Reform
- Values for the Future

## Science Map of WPI Centers



# I<sup>2</sup>CNER Organizational Structure

President of Kyushu University: **Tatsuro Ishibashi**  
Executive Vice President for Research: **Susumu Fukuda**

Director, **Ishihara**

University of Illinois Satellite

Science Steering Committee

Faculty Recruiting Committee

Senior Advisory Committee

Industrial Advisory Board

Assoc. Director  
**Matsumoto**

Assoc. Director  
**Fujikawa**

Admin. Director  
**Chapman**

Platform for International Collaborations and Partnerships

Advanced Energy Materials

Advanced Energy Conversion Systems

Multiscale Science and Engineering for Energy  
and the Environment

Platform for Societal Implementation and Industrial Collaboration

Research  
Center for  
Next  
Generation  
Refrigerant  
Properties  
(NEXT-RP)

Mitsui  
Chemicals,  
Inc.-Carbon  
Neutral  
Research  
Center  
(MCI-CNRC)

Center for  
Energy  
Systems  
Design  
(CESD)

Research  
Center for  
Negative  
Emissions  
Technologies  
(K-NETs)

## Research Units

### Advanced Energy Materials

Develop molecular, nano, and bulk materials based on new science of surfaces, interfaces, and microstructures for applications involving H<sub>2</sub>, H<sub>2</sub>O, and CO<sub>2</sub>

### Advanced Energy Conversion Systems

Development and evolution of systems which either lower carbon emissions, increase energy efficiency, or both

### Multiscale Science and Engineering for Energy and the Environment

Pull together the range of challenges facing Japan and the world's energy transition, namely the transition from largely fossil fueled energy technology to a carbon-neutral or a carbon-free energy supply

## Research Platforms

### Platform for International Collaborations and Partnerships

This platform is intended to maintain and foster I<sup>2</sup>CNER's international identity. Because this platform and the three thrusts are interwoven and the members of this platform collaborate with researchers from the thrusts, this is an effective way to promote interdisciplinary collaborations across the Institute and around the world.

### Platform for Societal Implementation and Industrial Collaboration

The three research thrusts contribute directly to the transition of future I<sup>2</sup>CNER scientific advances to applicable technology transfer through a large and growing network of I<sup>2</sup>CNER industrial interactions. With its strengths in both advanced energy science and energy analysis, I<sup>2</sup>CNER contributes to the achievement of the 2050 carbon reduction goals.

附属研究センター

## Affiliated Research Institutes

### Research Center for Next Generation Refrigerant Properties (NEXT-RP)



<launched in Apr. 2016>

NEXT-RP is an international research center that develops and evaluates next-generation refrigerants to solve global environmental issues and future energy crises. Our essential duty is to find the following next generation refrigerants: (i) Lower ODP (Ozone Depletion Potential), (ii) Lower GWP (Global Warming Potential), (iii) Non-flammable or Mildly flammable, (iv) No toxicity or Lower toxicity.

### Mitsui Chemicals, Inc.-Carbon Neutral Research Center (MCI-CNRC)



<launched in Nov. 2021>

MCI-CNRC, in collaboration with Mitsui Chemicals Inc., will develop and acquire cutting-edge environmental infrastructure technologies that will contribute to carbon neutrality, as well as pursue the practical use and commercialization of these technologies. By carrying out focused and efficient research into the elemental technologies needed to achieve carbon neutrality, the center will speed up the process of getting these technologies adopted in society.

### Center for Energy Systems Design (CESD)



<launched in Nov. 2022>

CESD hopes to promote research on carbon-neutral technologies required for social implementation by collaborating with six research organizations (Hokkaido University, Tohoku University, Tokyo Institute of Technology, Kumamoto University, RIKEN, and National Institute for Materials Science). This center consists of six research teams. The teams of “Light Energy Conversion”, “Electric Energy Conversion”, “Material Conversion”, and “Materials, Storage and Transport” conduct research to enable “high-speed conversion”. The “Energy Analysis” research team is responsible for the design of energy research by back-casting. The “Data Science” research team supports each research team by promoting data science, leading to discontinuous innovation. Not only achieving innovative outcomes, but the center also aims to foster the scientists of the future by making the center a field where young researchers can actively participate.

学内共同教育研究センター

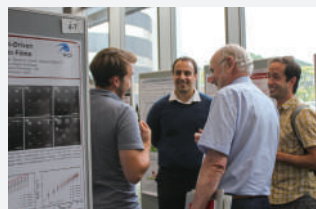
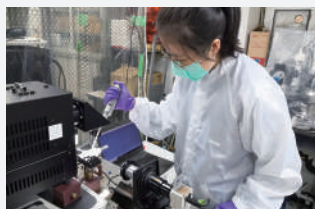
## Centers for Common Education and Research

### Research Center for Negative Emissions Technologies (K-NETs)



<launched in Apr. 2021>

This center aims to develop negative emissions technologies of greenhouse gases, i.e., developing technologies for CO<sub>2</sub> capture directly from the atmosphere, conversion and storage of the captured CO<sub>2</sub>, and utilization of renewable energy. CO<sub>2</sub> can be captured anywhere since air exists ubiquitously on the earth. This nature of ubiquitous existence will enable the construction of an energy-robust society through local production for local consumption of carbon resources and contribute to the control of global warming by underground storage of excess emissions. This research project is supported by the Moonshot Research and Development Program launched by the Cabinet Office of Japan.



主任研究員(PI)の体制

# Principal Investigators (PIs)

## Advanced Energy Materials



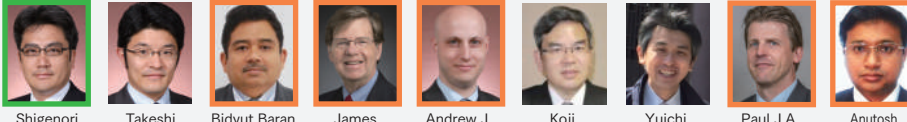
Masanobu KUBOTA, Miho YAMAUCHI, Brian P. SOMERDAY, Petros SOFRONIS, Seiji OGO, Toshihiro TSUCHIYAMA, Yoshinori SAWAE, Cynthia A. VOLKERT

## Advanced Energy Conversion Systems



Hiroshige MATSUMOTO, Tatsumi ISHIHARA, Andrew GEWIRTH, Tsuyohiko FUJIGAYA, Chihaya ADACHI, Thomas LIPPERT, Aleksandar T. STAYKOV, Stephen SKINNER

## Multiscale Science and Engineering for Energy and the Environment

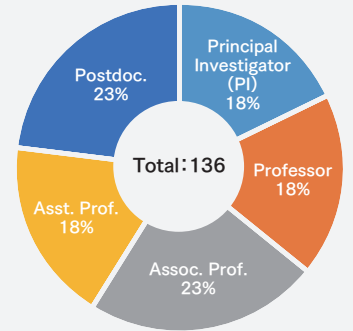


Shigenori FUJIKAWA, Takeshi TSUJI, Bidyut Baran SAHA, James STUBBINS, Andrew J. CHAPMAN, Koji TAKAHASHI, Yuichi SUGAI, Paul J.A. KENIS, Anutosh CHAKRABORTY

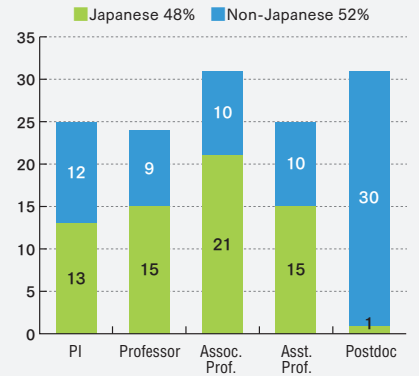
Non-Japanese PIs 12/25=48%

## PERSONNEL

### Researchers



### Japanese/Non-Japanese Researchers



(as of Apr. 1st, 2024)

実績

# Achievements

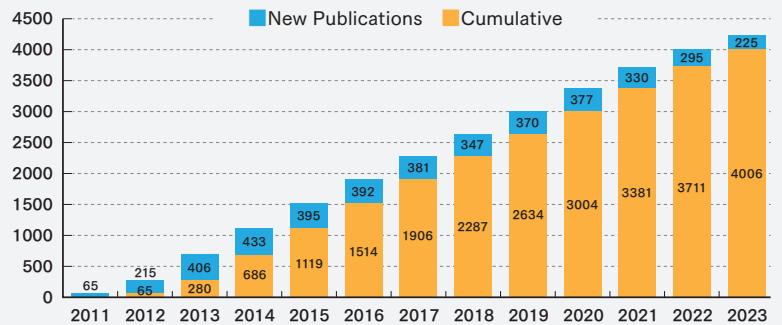
## Publications

 Consistently published in internationally-reputed academic journals

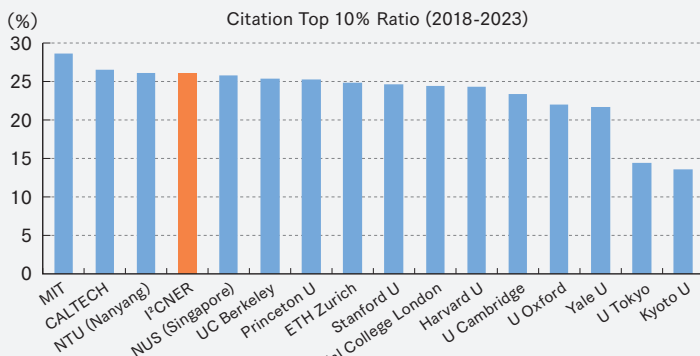
Example of papers published in internationally-reputed academic journals



WPI-I<sup>2</sup>CNER Affiliated Publications

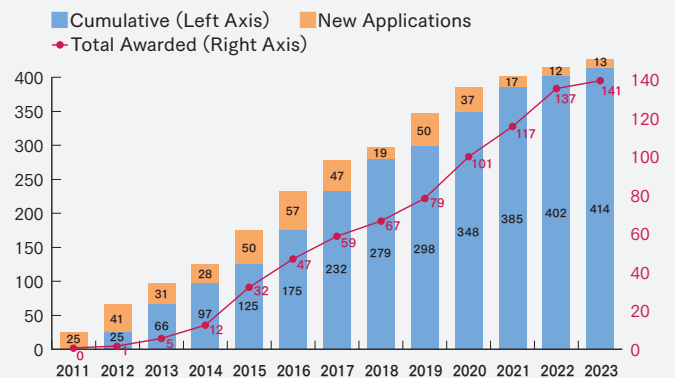


## Citation Top 10% Ratio



Source: Clarivate Analytics (as of Apr. 1st, 2024)

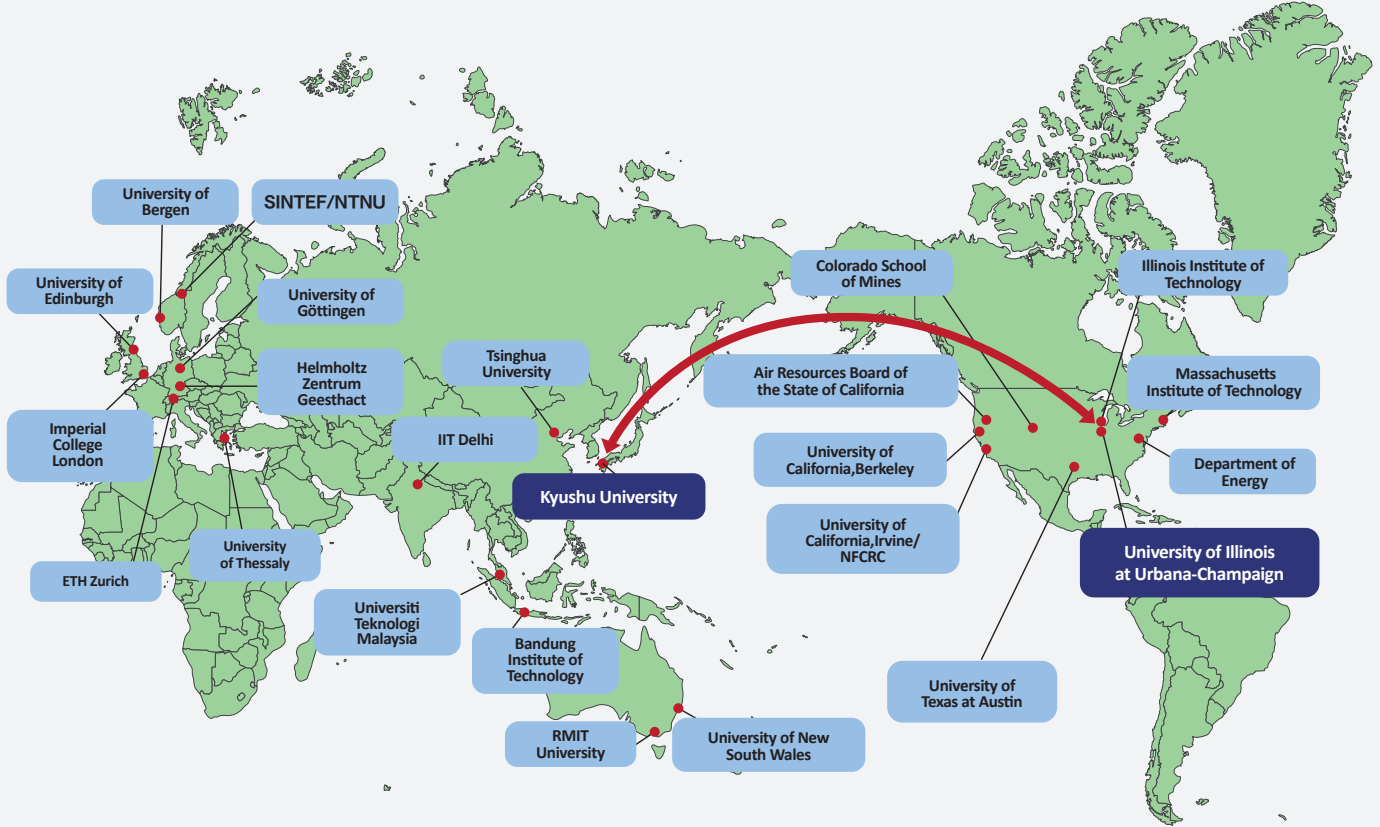
## Patents: Evidence of Technology Transfer



I<sup>2</sup>CNERの国際連携ネットワーク

# I<sup>2</sup>CNER's Network of International Collaborations

To carry out its mission, the Institute established collaborations with internationally recognized research centers and universities. These collaborations involve and promote research interactions and researcher exchanges and visits between the institutions.



イリノイ大学アーバナ・シャンペーン校との連携

## International Strategic Partnership



**KYUSHU UNIVERSITY**

- World leader in hydrogen research and technology
- Best-equipped and most-funded laboratories in the world for research on hydrogen/materials interactions
- Exemplary collaboration and engagement with local, prefecture, and national energy stakeholders

**I ILLINOIS**

- Significant contributions to research of hydrogen embrittlement and materials over the last 40 years
- Research network of excellence with national laboratories and industry
- Tradition of leadership and impact



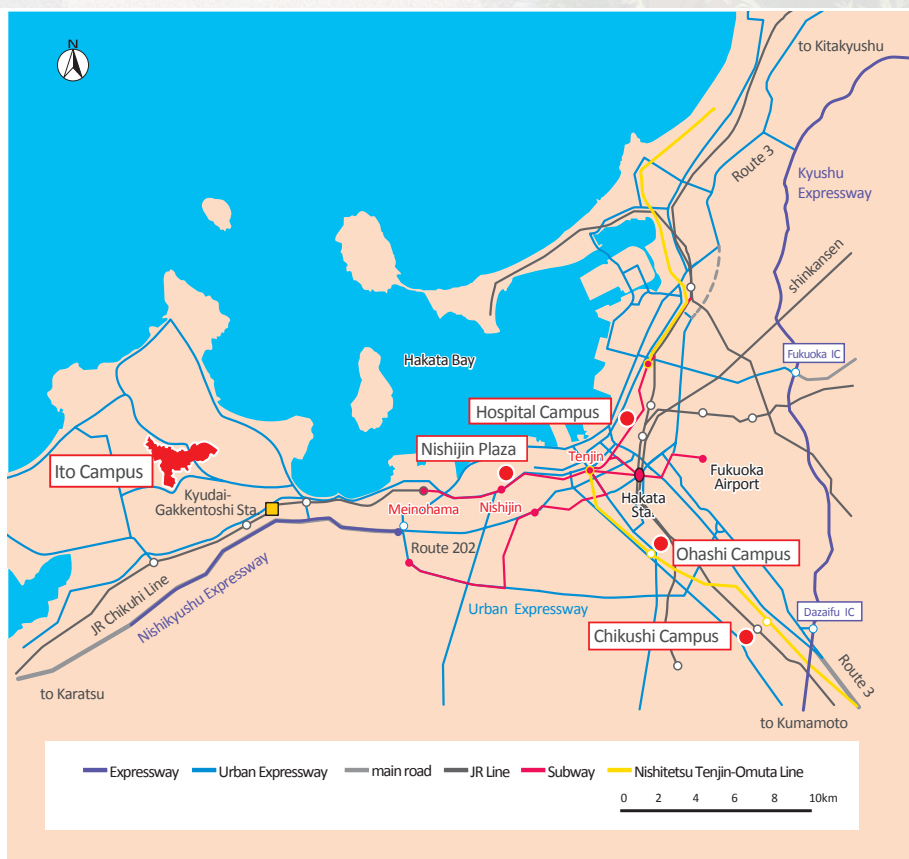
# I<sup>2</sup>CNER

## I<sup>2</sup>CNER's Facilities

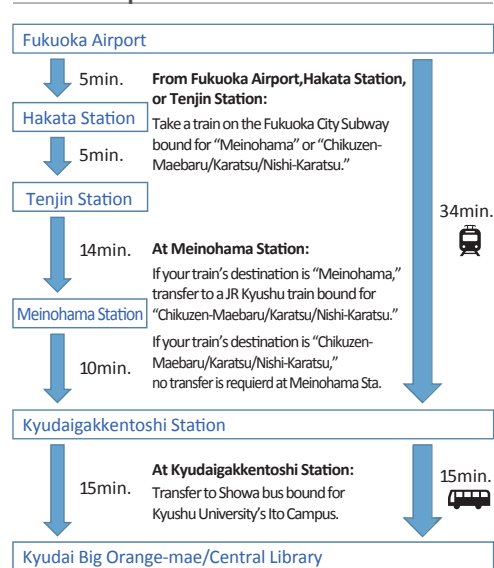
Three years after its inception as the sixth WPI center, in January 2013, I<sup>2</sup>CNER celebrated the inauguration of its first building, located at the center of the Ito Campus of Kyushu University. Since the number of researchers from all over the world has increased significantly, I<sup>2</sup>CNER Building 2, which is four stories tall with a total of 5,000m<sup>2</sup>, was completed in February 2015 in order to maintain the high-quality environment indicative of a top-level research center. Holding true to the I<sup>2</sup>CNER mission and vision for creating a carbon-neutral society, I<sup>2</sup>CNER Building 2 was designed around the concepts of sustainability, harmonization, and consciousness of environmental impact.



Left: I<sup>2</sup>CNER building 2, Right: I<sup>2</sup>CNER building 1



### Access Map



### Contact us

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