International Institute for Carbon-Neutral Energy Research

Introduction to I²CNER

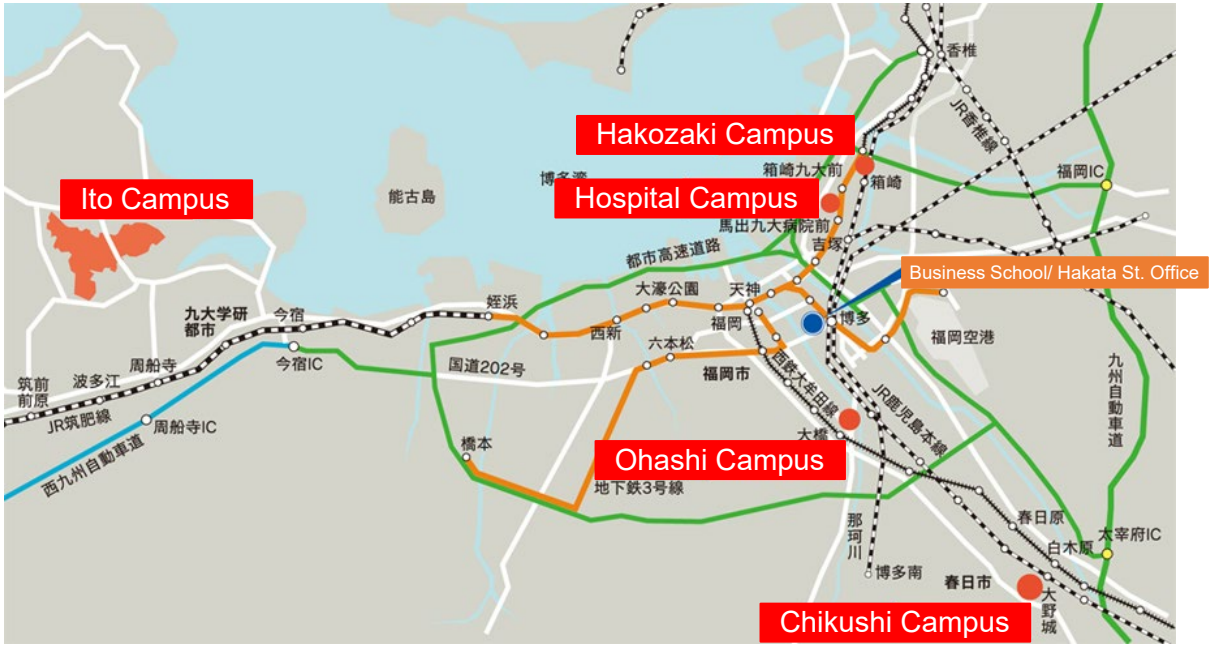
KYUSHU UNIVERSITY

wpi World Premier International Research Center Initiative

ILLINOIS

Where am I from?

Where am I from?



Fukuoka City

Kyushu University

Kyushu University at a glance

17 Faculties

Natural Science

- Information Science & Electrical engineering
- Engineering
- Engineering Sciences
- Sciences
- Mathematics
- Medical Sciences
- Dental Sciences
- Pharmaceutical Sciences
- Agriculture

Humanities and Social Sciences

- Humanities
- Economics
- Languages & Cultures
- Law

- Human-Environment Studies
- Social &Cultural Studies
- Design
- Arts & Science

School of Interdisciplinary Science and Innovation (April 2018)

Kyushu University has announced its plans to open the University's **12th** undergraduate school in April 2018

18,707 Students

2,201 International Students

11,746 (11 Undergraduate Schools)

6,961 (18 Graduate Schools)

8,092 *Academics & Administrative Staff*

University Hospital
1,415 beds

University Library
4.25 million items

University Museum
7.5 million items

International Institute for Carbon-Neutral Energy Research (I^2CNER)

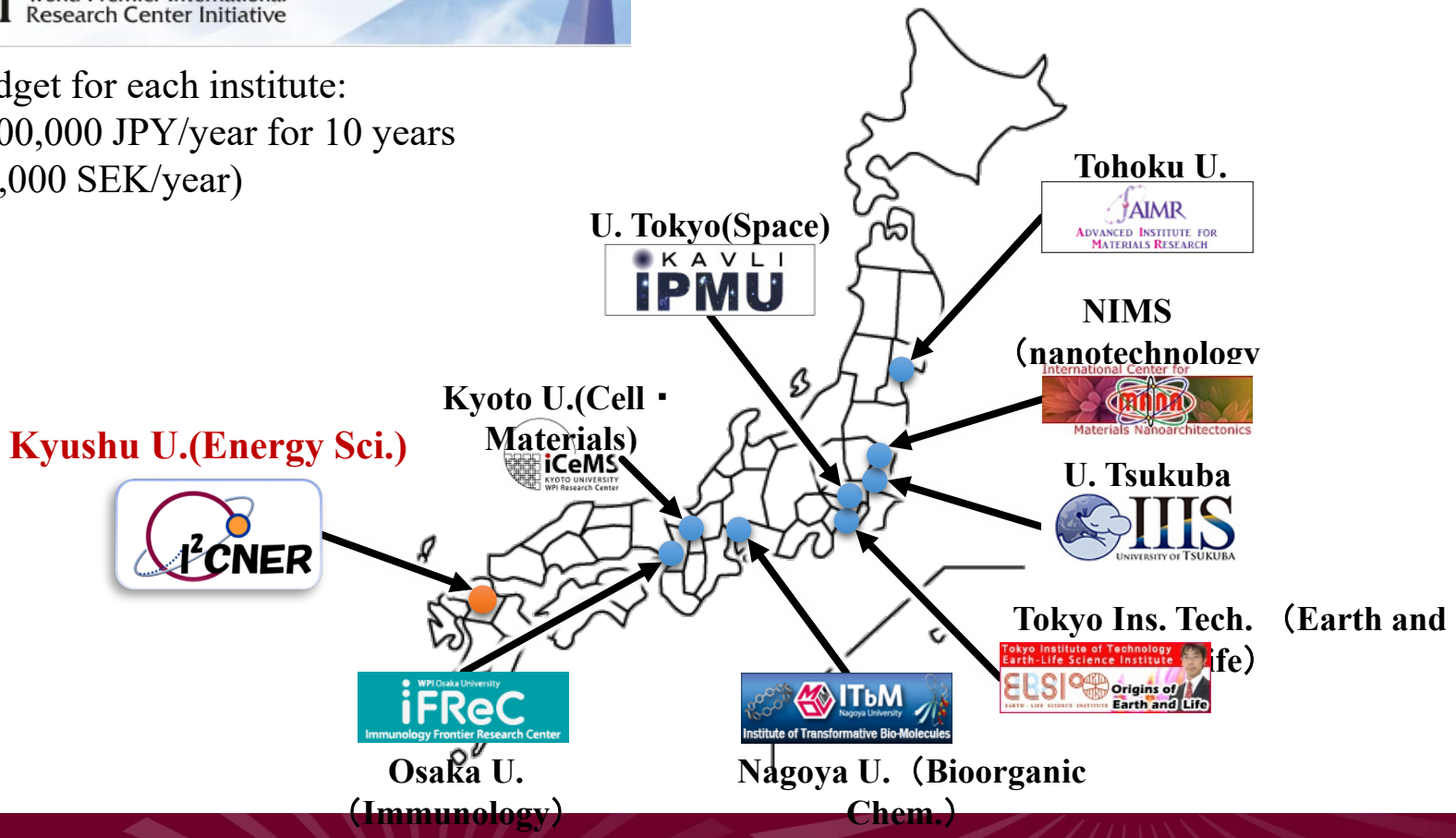
The mission of I^2CNER is to contribute to the creation of a sustainable and environmentally friendly society by advancing fundamental science to reduce CO_2 emissions and establish a non-fossil based energy carrier system.

World Premier International Research Center Initiative (WPI)

The World Premier International Research Center Initiative (WPI) was launched in 2007 by (MEXT) in a drive to build within Japan "globally visible" research centers that boast a very high research standard and outstanding research environment, sufficiently.

wpi World Premier International Research Center Initiative

Annual Budget for each institute:
ca. 1,300,000,000 JPY/year for 10 years
(ca. 94,000,000 SEK/year)



I²CNER's Objective

Vision

Creation of a sustainable and environmentally-friendly society

CNS : **Carbon-Neutral Society**

Mission

To contribute to the advancement of :

- low carbon emission and cost-effective energy systems
- Improvement of energy efficiency

Research Strategy

LCI : **Low Carbon Intensity**

EI : **Efficiency Increase**

I²CNER Organizational Structure

President of Kyushu University: Chiharu KUBO

Executive Vice President for Research: Kazuhide INOUE

I²CNER DIRECTOR: Petros SOFRONIS

Illinois Satellite Institute

Satellite Advisory Committee
I. Robertson, A. Gewirth, K. Christensen

External Advisory Committee

Internal Programs Review Committee

Associate Director:

T. Ishihara

Associate Director:

Y. Takata

Administrative Office Director:

S. Masuda

Industrial Advisory Board

Industrial Research Unit

Science Steering Committee

Faculty Recruiting Committee

SRA Selection Committee

SRA: Super Research Assistant

Research Divisions (Thematic Clusters)

- Molecular Photoconversion Devices
- Hydrogen Materials Compatibility
- Electrochemical Energy Conversion
- Thermal Science and Engineering
- Catalytic Materials Transformations
- CO_2 Capture and Utilization
- CO_2 Storage
- Energy Analysis

(・Applied Math for Energy)

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

Principal Investigators

As of April 1, 2018

Molecular Photoconversion Devices


Tatsumi ISHIHARA


Chihaya ADACHI


Atsushi TAKAHARA


Ken SAKAI


Zenji HORITA


Thomas LIPPERT


Aleksandar T. Staykov

Hydrogen Materials Compatibility


Brian P. SOMERDAY


Petros SOFRONIS


Joichi SUGIMURA


Reiner KIRCHHEIM


Ian ROBERTSON

Electrochemical Energy Conversion


Hiroshige MATSUMOTO


Kazunari SASAKI


John A. KILNER


Harry L. TULLER


Andrew GEWIRTH


Tsuyohiko FUJIGAYA

Thermal Science and Engineering


Yasuyuki TAKATA


Xing ZHANG


Bidyut Baran SAHA

Catalytic Materials Transformations


Seiji OGO


Miho YAMAUCHI

CO_2 Capture and Utilization


Shigenori FUJIKAWA

CO_2 Storage

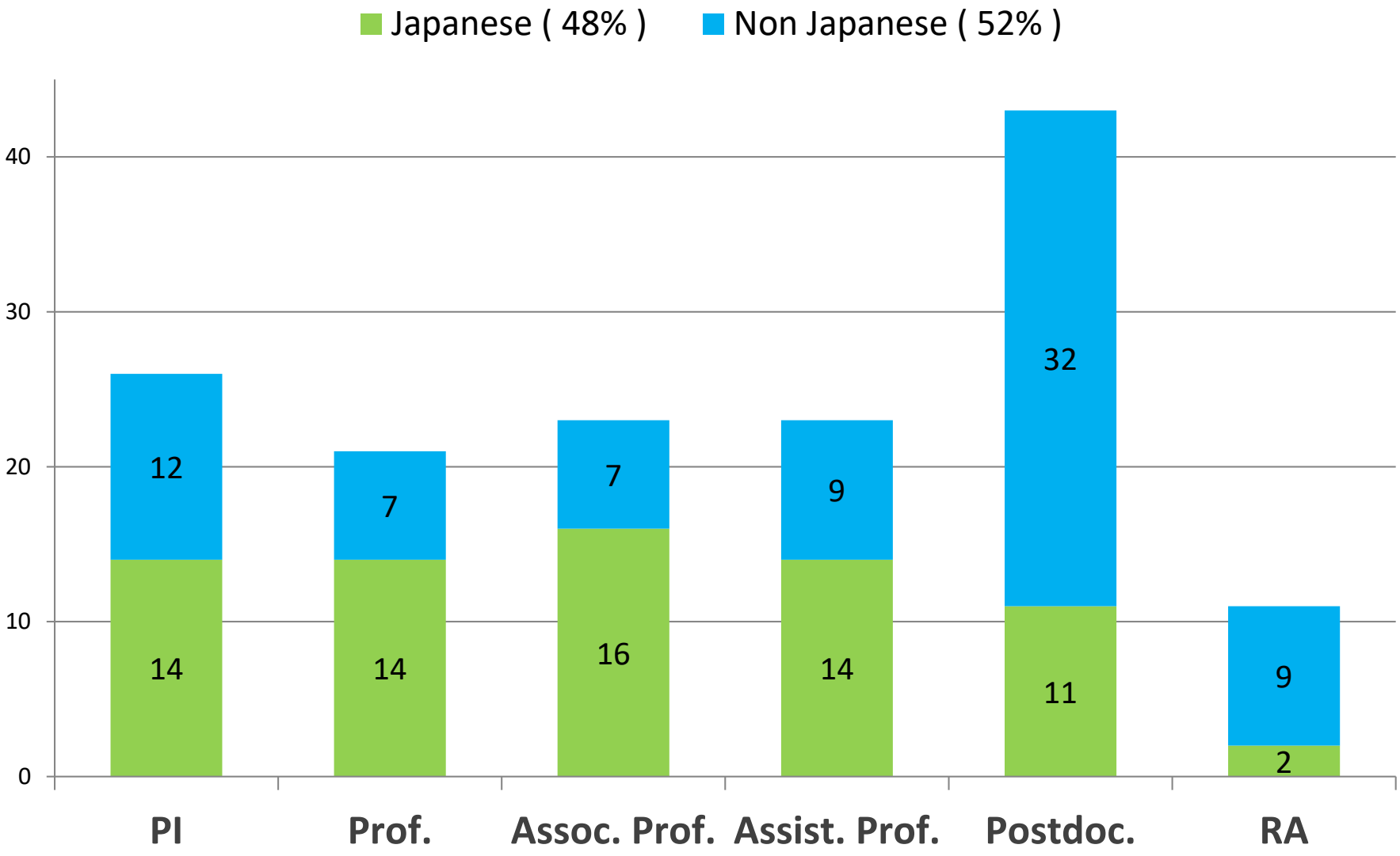

Takeshi TSUJI


Ken CHRISTENSEN

International PIs

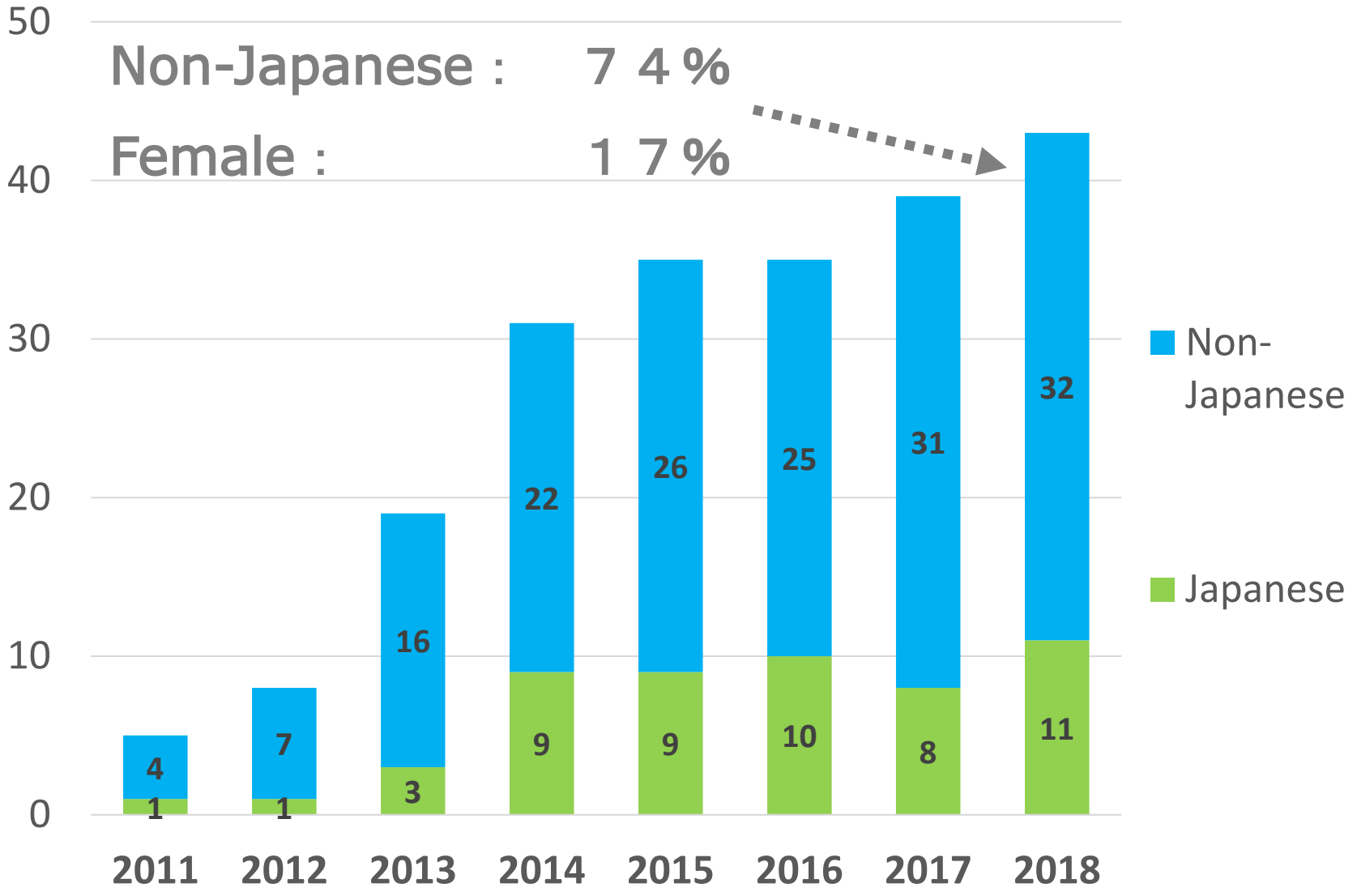
12/26=46%

Japanese / Non-Japanese

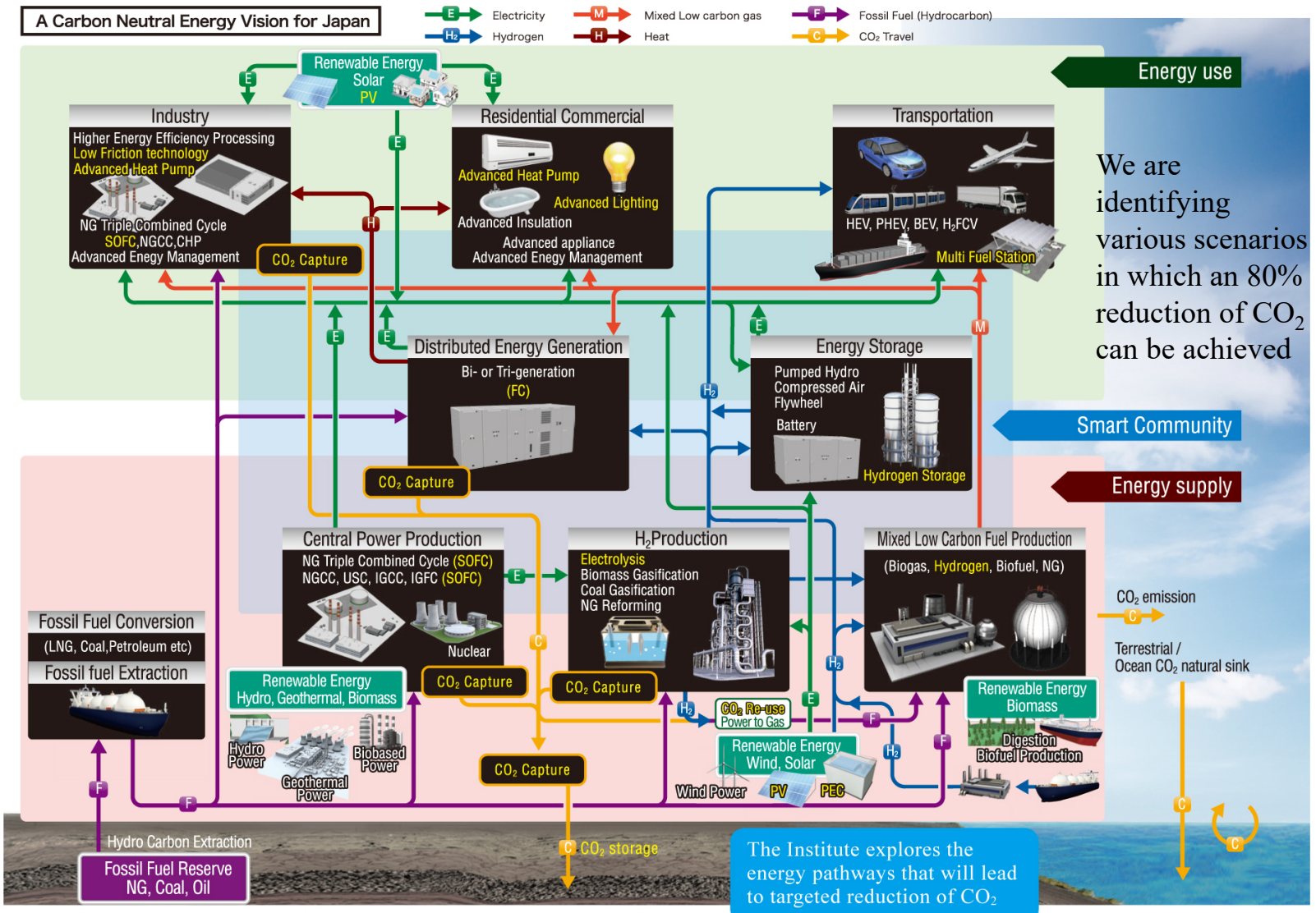


(data : as of April 1, 2018)

Hiring Post-Doc.s

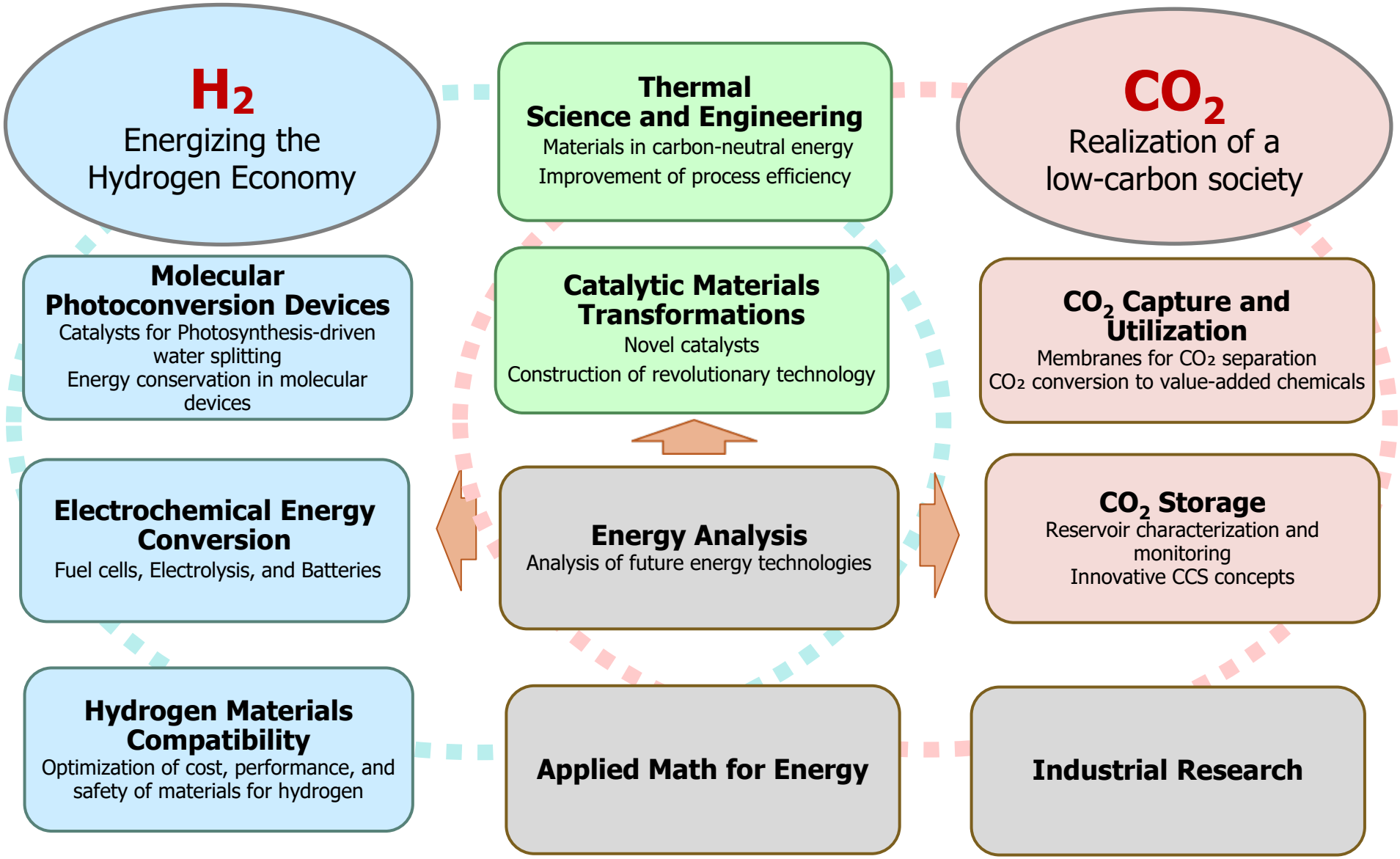


Energy Parameter Space



Parameter Space of Technology Options

I²CNER Research Divisions



Innovative Research (1)

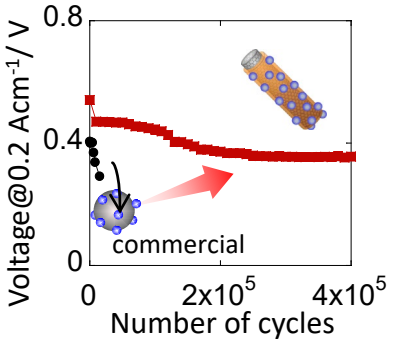
Prof. Tsuyohiko Fujigaya

Electrochemical Energy Conversion Division, Principal Investigator

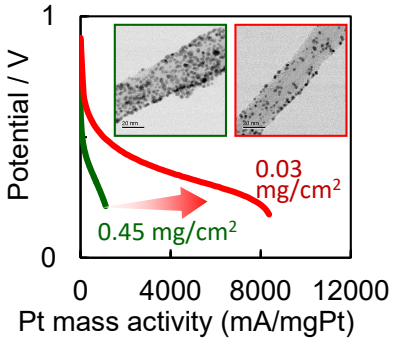
- Achievements

① Development of highly durable CNT-based electrocatalyst for PEFCs

② Development of ultra-low Pt electrocatalyst for PEFCs



①Durability of PEFC using CNT (red) and commercial (black) electrocatalyst.



②Mass activity of PEFC using typical Pt (3.7nm) and small Pt (2.2nm)

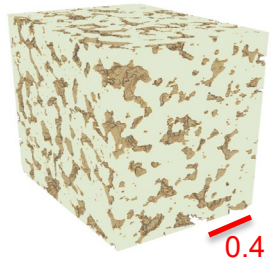
- Relationship with I²CNER roadmap and social impact:

Our achievements enable a reduction in cost and an increase in PEFC activity, which will help with global commercialization of PEFCs to realize low-carbon society.

Prof. Takeshi Tsuji

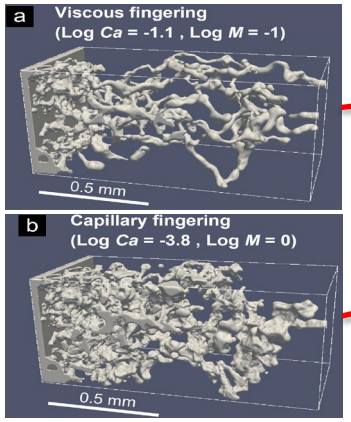
CO_2 Storage Division, Lead Principal Investigator

- Found that CO_2 saturation is controlled by Capillary number *Ca* and viscosity ratio *M* (CO_2/water)
- Identified suitable conditions for effective and safe CO_2 storage in geologic reservoir
- ➢ Contribution to safe and enhanced CO_2 storage

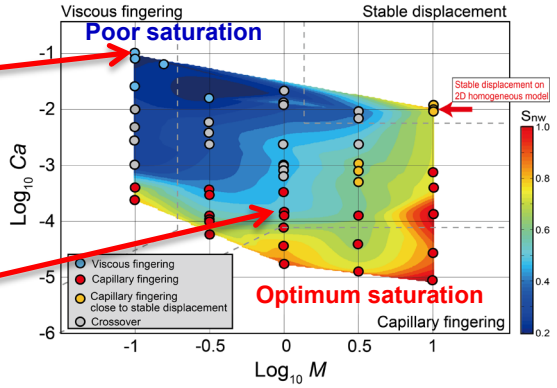


Pore geometry of natural rock (Resolution: 3μm)

$S_{CO2} = f(P, \varphi, \rho, \mu, \ldots)$ → *Scaling* → $S_{CO2} = f(Ca, M)$



CO_2 behavior within the rock pore at different conditions via fluid flow simulation

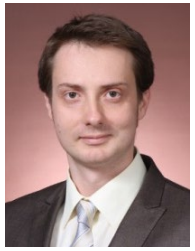


Calculation of CO_2 saturation (color) on the ***Ca-M*** diagram. Dots represent ~50 calculation points

Innovative Research (3)

Prof. Miho Yamauchi

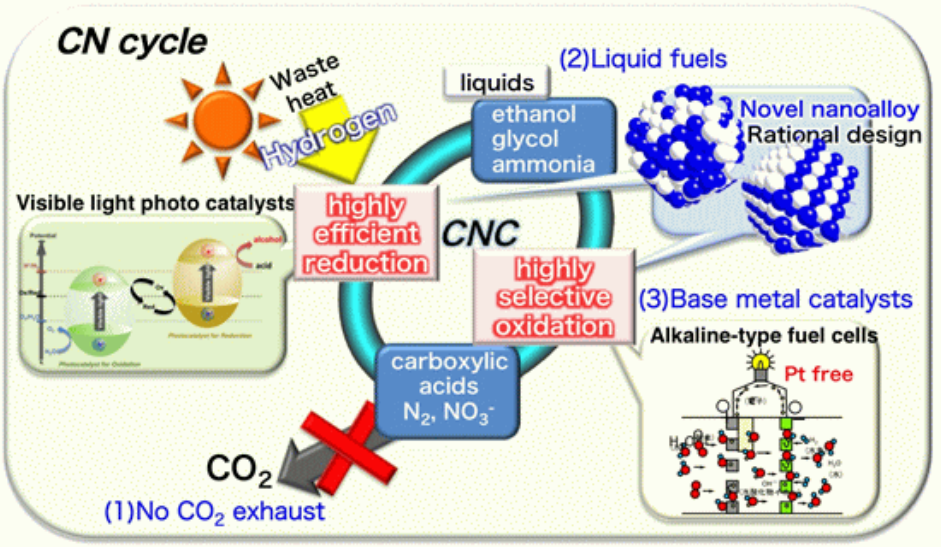
Catalytic Materials Transformations Division
Principal Investigator



Assoc. Prof. Aleksandar T. Staykov

Molecular Photoconversion Devices Division,
Principal Investigator

- Our achievements contribute to the realization of a sustainable society by means of cost reduction of fuel cells and CO_2-free energy circulation.



Conceptual diagram for Carbon-Neutral Energy Cycle

- Computational design of photochemical control of electron transport in molecular wires for applications in photocatalysis (Figure 1)
- Defined the mechanisms for oxygen reduction reactions (ORR) on transition metal free perovskite surfaces for application in electrocatalysis (Figure 2)
- Discovered the relationship between nanoscale support surface curvature and the finite size of the immobilized metal nanoparticles (Figure 3)

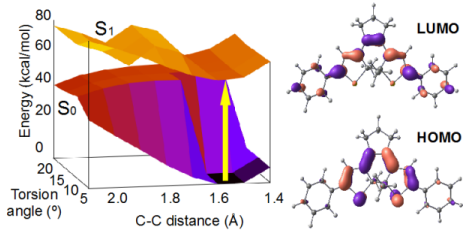


Figure 1. Photoswitching

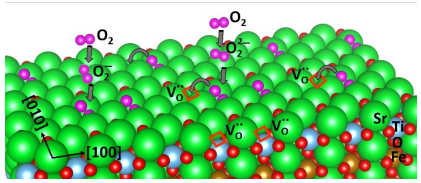


Figure 2. ORR on transition metal free perovskite surfaces

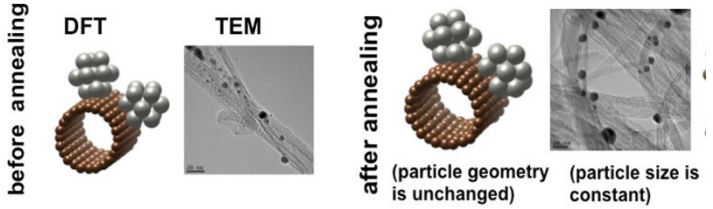
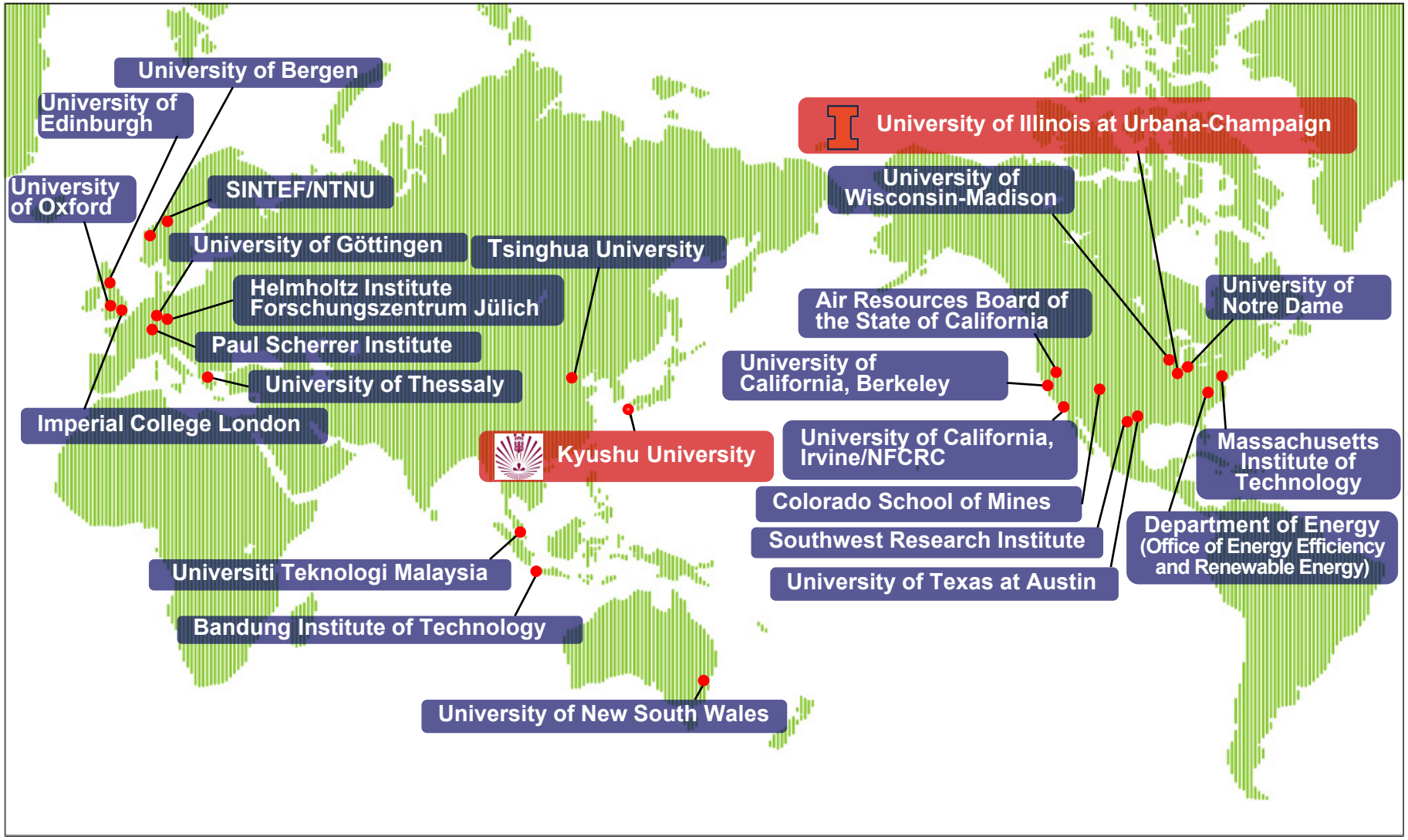


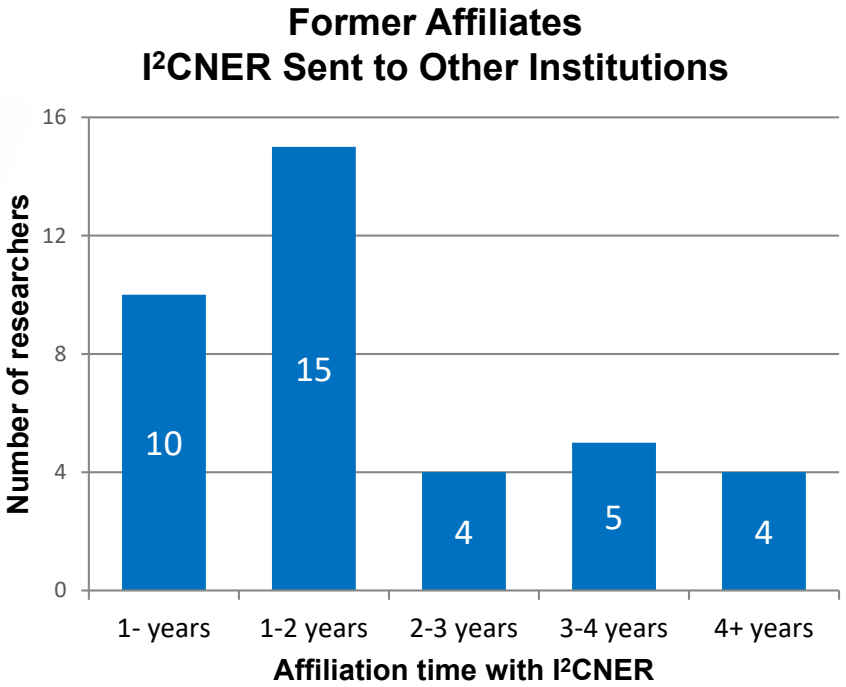
Figure 3. Immobilizing metal nanoparticles on curved surfaces.

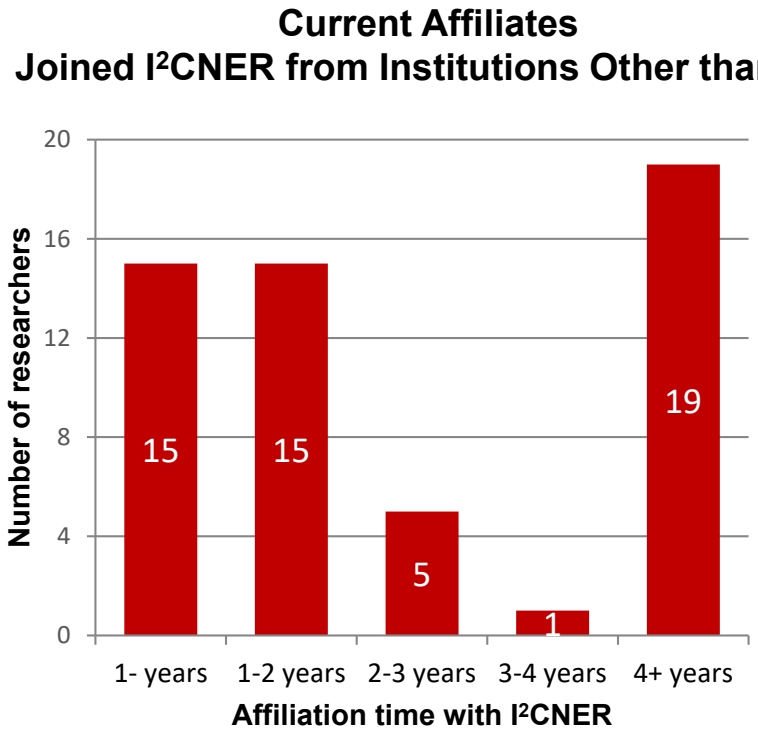
Established a Network of Excellence

- A large scale network of US, European, and Asian Institutions
- New research environment through “chalk-talk” engagement, videoconferencing, etc.



Employment Brain Circulation





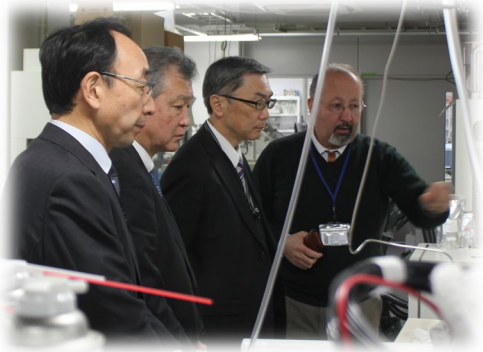
Visitors

	FY2014	FY2015	FY2016	FY2017
Number of visitors	455	424	342	816

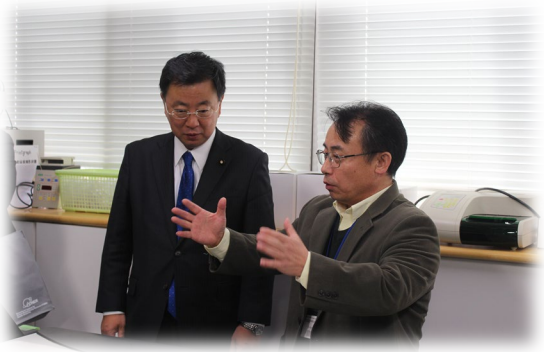
Mr. Yves Brechet,
High Commissioner of CEA,
France Apr. 24, 2018

Mr. Nicholas Hill
U.S. Embassy's Minister
Counselor for Economic Affairs
Apr. 9, 2018

Prof.Gautam Biswas,
Director, Indian Institute of
Technology Guwahati
Jan. 31, 2018



Mr. Fuminori Kishino,
General Maneger, Power and
Industrial Systems Research and
Development Center, Toshiba
Jan. 12, 2018



Mr. Hirokazu Matsuno,
The former Minister of MEXT
Nov. 19, 2017

2019 Annual Symposium

Energy Transitions and the Role of CCS toward a Carbon-Neutral Energy Society

January 31, 2019, I2CNER Hall

The Symposium attracted 150+ participants from 20+ countries.

A World Premier International Research Center

KYUSHU UNIVERSITY