

Kyoto University

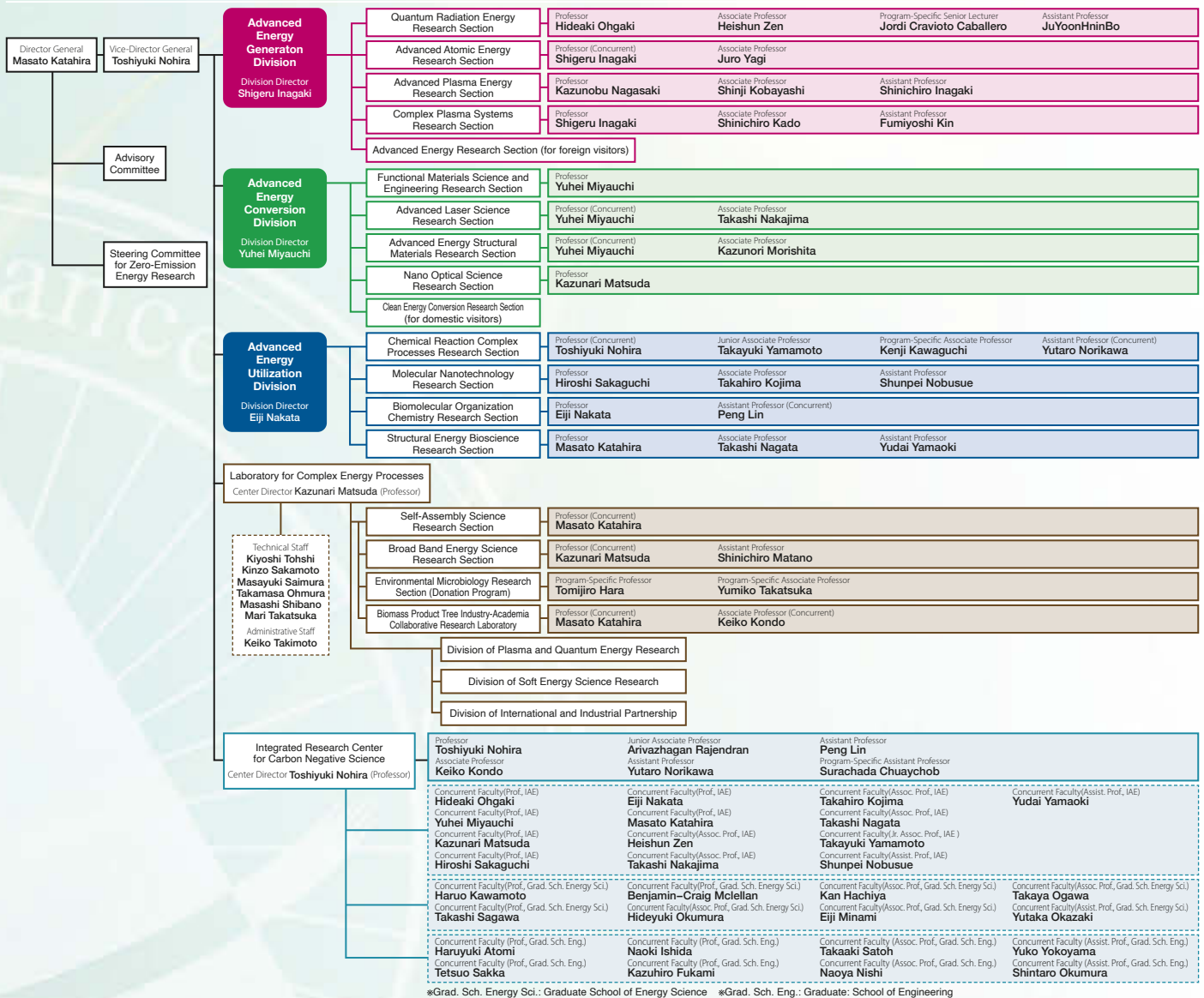
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# Institute of Advanced Energy



2025

## Organization Chart



## History

### Institute of Advanced Energy



Engineering Research Institute



10th Anniversary of Kyoto University Engineering Research Institute



Institute of Atomic Energy



10th Anniversary Ceremony of the Institute of Advanced Energy

Research Center in Faculty of Engineering  
Engineering Research Institute with 5 Divisions

Plasma Physics Laboratory (Faculty of Engineering)  
Moved from the Main Campus to Uji Campus

Renamed to Institute of Atomic Energy with 8 Research divisions

Plasma Physics Laboratory

Institute of Advanced Energy  
Laboratory for Complex Energy Processes

National University Corporation Kyoto University

Laboratory for Complex Energy Processes reorganized

Start of "Joint Usage/Research Program on Zero-Emission Energy" (2011–2015)  
Start of "Joint Usage/Research Program on Zero-Emission Energy" (2016–2021)  
Start of "Joint Usage/Research Program on Zero-Emission Energy" (2022–2027)  
Integrated Research Center for Carbon Negative Science

1914

1941

1959

1960

1965

1966

1968

1969

1970

1971

1972

1975

1976

1980

1981

1983

1996

1999

2004

2006

2010

2011

2016

2022

► Heliotron A  
► Heliotron B  
► Heliotron C

► Laboratory for Nuclear Reactor Safety Analysis  
► Heliotron D

► Magneto Plasma Research Laboratory  
► Heliotron DM

► Heliotron E  
► High Temperature Liquid Sodium Heat Transfer Experimental Facility  
► Heliotron DR  
► Plasma Energy Direct Energy Conversion Laboratory

► Heliotron J  
► Laboratory for Photon and Charged Particle Research, DuET, KU-FEL  
► Laboratory for Energy Nano-Science Research

► NMR



Heliotron J



DuET



KU-FEL



NMR

## Greetings



Director

**Masato Katahira**

"The times have finally caught up with us." I am aware that this may be an irreverent attitude, but I would like to say that we at the Institute of Advanced Energy, Kyoto University, think this way. Going back 14 years, in 2011, our Institute started a Joint Usage/Research Center project certified by the Minister of Education, Culture, Sports,

Science and Technology of Japan (MEXT). The Center's name is the "Zero-Emission Energy Research Center," and its mission is to investigate energy that minimizes the emission of harmful substances such as carbon dioxide. It's hard to imagine now, but when we started this Center project, there were quite a few skeptical opinions about the significance and importance of this mission. This Center project received high end-of-term evaluations in both the first term from 2011 to 2015 and the second term from 2016 to 2021. We believe that the significance and importance of this mission have been widely recognized in society, and that the contribution of our Institute in this mission has been highly rated. In response to them, we are currently implementing the third phase of the Center project from 2022 to 2027. The times have caught up with us, but in order to stay ahead of the times, we have established the Integrated Research Center for Carbon Negative Science (ICaNS) in 2022, which investigates "Carbon-Negative Energy" that is a further advance of "Zero-Emission Energy".

The Institute of Advanced Energy was established in 1996 with the aim of investigating the state of energy by going back to the laws and principles of nature, and

creating new energy theories for the next generation and cutting-edge technologies. The Institute has 14 research fields in three divisions, each named energy generation, conversion, and utilization. In addition, the Institute has "Laboratory for Complex Energy Processes", which have equipment for common use in the above-mentioned Joint Usage/Research Center project and support the Center project, and the aforementioned ICaNS. The Institute has established two priority multidisciplinary research areas as its core. One is "plasma/quantum energy," which aims to realize nuclear fusion, and the other is "soft energy," which aims for highly efficient energy use and conversion based on biological energy usage principles and material science.

Each research field of this Institute functions as a collaborative course with the Graduate School of Energy Science, Kyoto University, and a considerable number of master's and doctoral course graduate students are assigned, allowing them to work in a cutting-edge research environment. We also contribute to undergraduate education by providing lecture classes throughout Kyoto University. Furthermore, since 2019, we have been carrying out the MEXT's project, "Formation of an International Collaborative Laboratory at the International Center for Advanced Energy Science Research and Education", together with the Graduate School of Energy Science, expanding the scope of our educational and research activities internationally.

Under the Kyoto University's academic culture of freedom, Vice Director/Center Director Toshiyuki Nohira, Center Director Kazunari Matsuda and all of our faculty and staff will strive to contribute to research activities as well as education and international corporation, as a research Institute that is ahead of the times. We appreciate your continued support.

## Mission and Goal

The Institute of Advanced Energy (IAE) was established to promote researches to sophisticate the generation, conversion, and utilization of energy. Our goals are

- (a) to conduct pioneering research on advanced energy science and technology,
- (b) to propose solutions to energy and environmental issues associated with rapid global population expansion, and
- (c) to contribute to the sustainable progress of humankind.

We perform a comprehensive approach towards development of next-generation energy systems, which have the potential to replace existing energy systems, with two viewpoints, Quality (harmonization with the environment) and Quantity (social infrastructure). In order to secure sustainable energy resources or systems, our research activities emphasize improving the performance of energy systems, developing new energy resources, and realizing systems for effective

use of energy resources, which can be termed as the Zero-Emission Energy System. Moreover, through these endeavors, we aim to foster scientists and engineers who possess advanced knowledge and skills in the energy science and technology.

To meet our objectives, we strive to further explore the research field of Advanced Energy or Zero-Emission Energy by innovating an energy system with high social receptivity and a system capable of incorporating various sources of energy. The human and research resources at IAE are consisted of diverse academic backgrounds. This characteristic provides a unique opportunity to promote interdisciplinary researches coordinated by seemingly different research fields. By taking advantage of these activities, IAE serves as a hub for advanced energy research in Japan and around the world.

These activities will further develop the advanced energy research to contribute to the next generation and contribute to the sustainable growth of society.

# Major Projects

## Joint Usage / Research Center



(MEXT)

### Joint Usage / Research Center for Zero-Emission Energy Research

- ▶ Leader: Director of IAE
- ▶ Project Period (the 3rd Term) : FY2022 – FY2027

This project promotes inter-university researches for “Zero-Emission Energy System”, which can give the solution for energy-resource, global-environmental problems and the climate change issue. This project leads the interdisciplinary researches of energy relevant fields, education and training of young students and researchers in the field of advanced energy science. The "A" evaluation has been given at the mid-term evaluation held in 2024 by MEXT.



## Fundamental Facility Type Collaboration Research Program (National Institutes of Natural Sciences)

- ▶ Leader: Prof. Kazunobu Nagasaki
- ▶ Project Period: FY2025 – FY2027

In fusion research in Japan, we have decided to launch Fundamental Facility Type Collaboration Research with the National Institute for Fusion Science (NIFS), based on the successful bilateral collaboration research program. Various limits such as stiffness of the temperature profile due to plasma turbulence excitation are imposed on the design of magnetic confinement fusion reactors. The Laboratory for Complex Energy Processes aims to achieve limit-free plasmas by utilizing a magnetic confinement plasma experimental device, the Heliotron J.

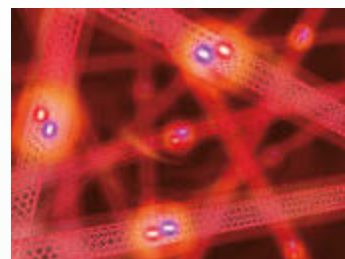


## Grant-in-Aid for Scientific Research (S) in Ministry of Education, Culture, Sports, Science and Technology (MEXT)

**Research project: Establishing a scientific foundation for harnessing quantum thermo-optical properties of nanomaterials for advanced energy conversion**

- ▶ Project Leader: Prof. Yuhei Miyauchi
- ▶ Project Period: FY2024 – FY2028

We have previously shown that carbon nanotubes (CNTs) possess a distinctive quantum thermo-optical property, wherein they convert high temperature thermal energy into narrowband near-infrared light, and have been conducting basic research to apply this property to highly efficient thermophotovoltaic power generation from both sunlight and high-temperature heat sources. In this project, we will overcome the conventional limitations in the heat resistance of CNTs and related nanomaterials and elucidate previously uncharted thermo-optical properties of nanomaterials at very high temperatures. This will provide a scientific foundation for harnessing the quantum properties of nanomaterials in energy science and technology of heat and light, which require operation in high temperature environments.



## Grant-in-Aid for Scientific Research (S), Japan Society for the Promotion of Science

**Research project: Creation and application of a robotics-assisted moiré quantum platform**

- ▶ Project Leader: Prof. Kazunari Matsuda
- ▶ Project Period: FY2025 – FY2029

We construct the innovative fabrication technology of extremely thin two-dimensional materials with several atomic layers, including two-dimensional semiconductors, which is becoming possible due to advances in robotics and data science. Moreover, we build up the science of new moiré quantum platforms based on moiré physics in two-dimensional material heterostructures, and try to create a new research trend that bridges this to quantum science and technology.



## Collaboration between industry, academia and government

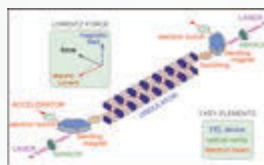
Multi-Scale Testing and Evaluation Research facility (MUSTER), KU-FEL, and NMR Facilities are open for industries to evaluate materials performance from the viewpoint of multi-scale structure; atomic size, defect size, grain size, etc. to understand the materials behavior in practical applications.

## Advanced Energy Generation Division

We promote the development of socio-friendly and fundamental “zero-emission energy system” that should be an inevitable issue sustainable future of humankind, and innovative energy sources with particular function including their application technology.

### Quantum Radiation Energy Research Section

Research on Generation and Application of New Quantum Radiations, i.e. Compact MIR Free Electron Laser, Table-Top THz coherent radiation, and Laser-Compton Gamma-ray. International collaboration research on renewable implementation in ASEAN.



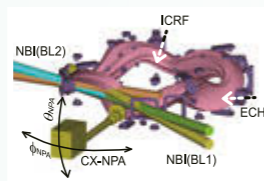
### Advanced Atomic Energy Research Section

We design and develop the zero-emission energy system powered by fusion, from its generation to utilization, and analyze it from environment, socioeconomics, and sustainability aspects.



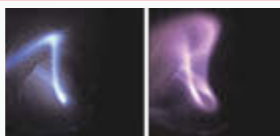
### Advanced Plasma Energy Research Section

High-power microwave systems, high-power neutral beam injection for plasma heating and current drive, and plasma diagnostics using microwaves, beam emission spectroscopy, and X-rays are being developed by controlling charged particles and electromagnetic fields.



### Complex Plasma Systems Research Section

Various collective phenomena appear in complex plasmas where many structures coexist. Fusion plasma is a typical complex plasma in which collective effects induce new structures and thus the plasma is constantly changing. We aim to understand the laws of this plasma wandering in order to generate fusion energy.

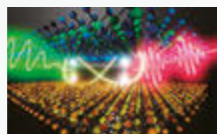


## Laboratory for Complex Energy Processes

This Laboratory is a core research center for strategic and multidisciplinary collaboration studies in IAE, offering cooperative project activities in the field of the advanced energy. The Center has three divisions: (1) “Division of Plasma and Quantum Energy Research”, for fusion and related advanced energy studies, (2) “Division of Soft Energy Science Research”, that promotes innovative functional materials based on nanotechnology and biotechnology, and (3) “Division of International and Industrial Partnership” that promotes and enhances activities and relationship with foreign and domestic research partners including industry and private sector. Corresponding to the two research areas, “Self-Assembly Science”, “Broad Band Energy Science”, the Donation Program “Environmental Microbiology”, and “Biomass Product Tree Industry-Academia Collaborative Research Laboratory” research sections belong to the Laboratory.

### Broad Band Energy Science Research Section

We are engaged in research aimed at new applications of energy over a wide range of spatiotemporal scales. Especially, we involve in research into new photonics and quantum technologies that exploit the unique physical properties manifested in nanoscale semiconductors.



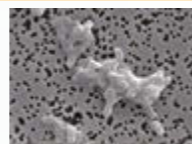
### Magnetic Confinement Plasma Device, Heliotron J

Experiments of Heliotron J are focusing on the optimization studies of “helical-axis heliotron” configuration, which is original to Kyoto University in its design concept with special regard to the realization of the high-performance, steady-state fusion reactor.



### Environmental Microbiology Research Section

As one of the creating methods for sustainable society, we confront the development of practical applications utilizing “enzymes” that are highly energy utilization efficiency in substance catabolism.



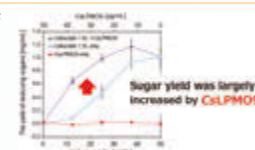
### KU-FEL

The KU-FEL generates tunable laser light in mid-infrared (3.4~26μm) range for advanced researches in energy science.



### Biomass Product Tree Industry-Academia Collaborative Research Laboratory

We aim at the development of new conversion process and sustainable circular use of biomass.



### NMR machines

NMR machines, an 800 MHz machine linked with liquid chromatography and mass spectrometer and two 600 MHz machines, are operated for the biomass study.



## Advanced Energy Conversion Division

Aiming at the efficient conversion of energy functions and the generation of new energy functions, this division studies fundamental energy-material interaction and its applications, efficient energy-conversion processes, and the development of functional energy materials.

### Functional Materials Science and Engineering Research Section

Our research focuses on the physical properties of nanoscale/quantum materials and their applications in energy conversion/utilization technologies. In particular, materials science and engineering for highly efficient use of solar light and thermal energy are the subjects of interest.



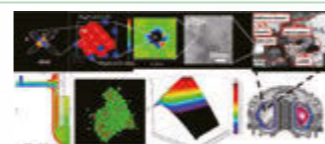
### Advanced Laser Science Research Section

Our research interest is to explore, understand, and then control/utilize the various responses of materials, such as atoms/molecules, nanoparticles, and thin films, to the irradiation of lasers.



### Advanced Energy Structural Materials Research Section

Innovative structural materials R&D with focusing on nano-meso structural control, and basic research for understanding materials performance and behavior.



### Nano Optical Science Research Section

We are studying about development of novel optical science and its application for energy based on nano-science from the viewpoint of solid state physics, material science, and device engineering.

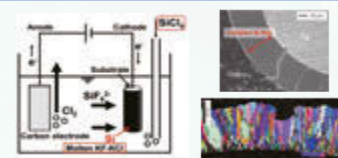


## Advanced Energy Utilization Division

The aim of division is the establishment of ‘Emergent Materials Science’ having a similar concept seen in energy related processes in nature, efficiently converting ‘soft energy’ into ‘electricity’ and ‘valuable chemicals’ without huge consumption. The research projects ongoing cover the researches of energy-related materials sciences, chemistry and biosciences for the development of new technologies for renewable energy conversion and utilization.

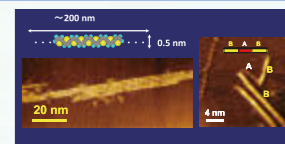
### Chemical Reaction Complex Processes Research Section

We are studying materials and systems to realize renewable energies like photovoltaics as the major primary energy source for human beings. We are conducting innovative researches that cover the phases from basic research to applications mainly based on electrochemistry.



### Molecular Nanotechnology Research Section

Nanoscience and technology, ultimate method for producing new materials assembling from single molecules, are studied for energy sector such as organic transistors and solar cells.



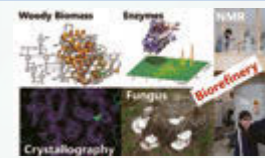
### Biomolecular Organization Chemistry Research Section

Our research group is exploring the design and the construction of biomacromolecules “tailored” for pursuing highly efficient energy utilization.



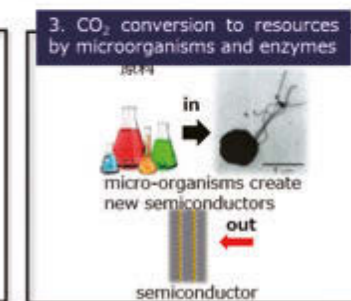
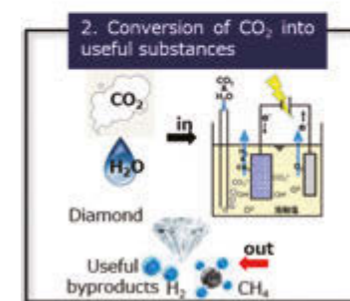
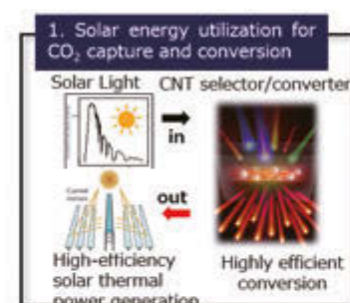
### Structural Energy Bioscience Research Section

We study development of efficient utilization of woody biomass and understanding of life phenomena related to diseases on the basis of structural biology.



## Integrated Research Center for Carbon Negative Science

To develop carbon-negative technologies, we are engaged in research to convert carbon dioxide into useful materials using renewable energy, biomass, etc.



# Education

The Institute has been established in 1996 upon the start of Graduate School of Energy Science. All research staffs at the Institute have joint appointments with the graduate school. Recently, due to the special efforts by all concerned, such as “Asian CORE (Center Of Research and Education)”, “Global COE Program (Energy Science in the Age of Global Warming)” that started in 2008, and other cooperation programs, more applicants than the quota for the Graduate School have applied for admission.

Accordingly the number of graduate students studying at the Institute steadily increases. Moreover from the characteristic facts such as the increasing number of graduate students studying for the doctorate and high ratio of foreign students with respect to Japanese students, the institute achieves educational and international contributions. There are a lot of students who are attracted by the large and state-of-the-art experimental devices, international exchange programs, a variety of research sections and the research itself at the Institute. An effort has also been made to send graduate students abroad to attend international conferences and do researches at the earliest possible opportunity. This effort indicates that the Institute has a high level for educations and developments of human resources.

## Admissions

### Procedure for acceptance of graduate students at IAE

There are twelve laboratories that accept students at the IAE, we focus on research that aims towards the next generation of advanced energy among a wide range of academic fields spanning physic, chemistry, biology and engineering, as well as education that trains and produces students capable of originality and international activity. In order to study at the IAE, it is possible to either be admitted into an affiliated laboratory of the Graduate School of Energy Science, or to be enrolled as a research student.

IAE is divided into different Departments. To join a lab in a given department, a student must come to an agreement with the lab supervisor. If that supervisor does not hold the title of professor, then the student must also receive additional permission from a IAE professor based on the advice of the lab supervisor. It is recommended that Applicants consult the lab supervisor prior to taking the entrance examination.

## International Activities

### International Exchange Promotion: ASEAN-JAPAN

► Leader : Prof. Hideaki Ohgaki

International exchange promotion activities among ASEAN countries have been promoted in IAE with the Joint Graduate School of Energy and Environment (JGSEE), Thailand. We have also cooperated with RMUTT, Thailand, to co-organize the Eco-Energy and Materials Science and Engineering Symposium (EMSES) since 2001. In 2015, the Japan ASEAN Science and Technology Innovation Platform (JASTIP) was adopted in JST SICORP, and we have been promoting the

collaboration research platform. In 2017, UNESCO selected Kyoto University as “UNESCO Chair” in water, energy, and disaster prevention to promote international collaborative education. Using JSPS Core-to-Core program, JST SATREPS and e-Asia program, we have been promoting international collaboration research and education with ASEAN.



Group photo of Kick Off Symposium of STI Coordinator training program in Bangkok, Thailand (2025.3.3)

## Faculty Member

[2024]

Professor	Associate Professor	Junior Associate Professor	Assistant Professor	Program-Specific Researcher	Technical Staff/Administrative Staff	Total
9	13	2	10	1	12	47

## Adjunct Member

[2024]

Visiting Research Scholar	Research Support Staff	Research Scientist	Management Staff	Total
2	3	11	21	37

## Students

[2024]

Under Graduates	Master Course	Doctor Course	Total
8	66	44	118

## Budget

[FY2023] [unit: 1 million yen]

others	Donation	Industry-Academia-Collaboration	Grant-in-Aid for Scientific Research	Cost of equipment	Personal expence	Total
2	81	307	194	375	398	1357

## Research Presentations

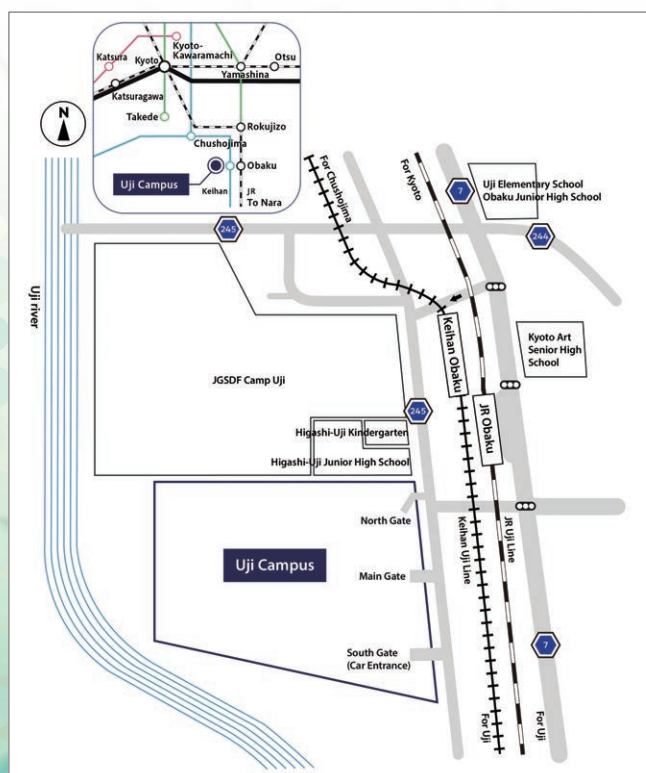
	2022	2023	2024
Original papers	93	85	87
Proceedings	14	12	12
Review papers	9	6	1
Books	1	7	1
Others	4	4	4
Presentations	318	328	290
Total	439	442	395

## The number of applicants to the collaboration program of the Laboratory for Complex Energy Processes

Category	2024
A1: Division of International and Industrial Partnership	5
A2: Division of Soft Energy Science Research	3
A3: Section of promotion for international collaborative research	4
Total	12

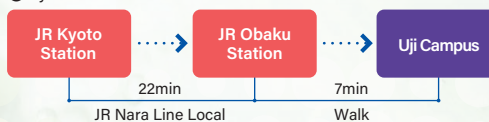
## The number of applicants to the collaboration program of Joint Usage/Research Center on Zero-Emission Energy

Category	2024
(A) Core research subject	39
(B) Research subject	33
(C) Facility usage	5
(D) Workshop	5
Total	82



### ACCESS

#### ① By JR Line



#### ② By Keihan Line



### INFORMATION



**Institute of Advanced Energy  
Kyoto University**

Gokasho, Uji, Kyoto 611-0011 Japan

Phone.+81-774-38-3400 FAX.+81-774-38-3411

e-mail:office@iae.kyoto-u.ac.jp



<https://www.iae.kyoto-u.ac.jp/new-iae/en/>