

4. JOINT USAGE/RESEARCH PROGRAM



Joint Usage/Research Center Program “Zero Emission Energy Research”

It is an urgent task to find out the best solutions against the energy and environmental problems for ensuring the sustainable society on the earth. The new energy system for this purpose must be environmentally friendly or ecological one. Here, we should consider not only the energy sources but also the efficiency in each phase of energy usage. The former should be good quality and enough quantity. The latter should be considered including the so-called “three Rs (Reduce, Reuse and Recycle)” in the energy system.

- Reduce of energy consumption, environmental pollutants such as greenhouse gas, waste-heat, hazardous waste, etc.
- Reuse of waste heat/energy, etc.
- Recycle fuel, etc.

To realize them, only the extension of the present technology is not enough. Interdisciplinary studies with innovative ideas are indispensable to realize the energy system for the next generation.

We propose a new concept of Zero Emission Energy as a typical model of Advanced Energy. IAE Zero Emission Energy Research aims at the realization of environmentally friendly energy system for sustainable society with minimum emission of environmental pollutants and with maximum utilization of energy and resources. Since FY2011, we had operated a project, “Joint Usage/Research Program on Zero Emission Energy”, which is the program authorized by the MEXT. We started the second term of the Program from FY2016 and the third phase in FY2022. Here, we aim to (1) promote interdisciplinary joint usage/research studies for Zero Emission Energy Science & Technology, (2) promote education & practical training for young researchers and (3) explore future horizons of Advanced Energy System for sustainable development. IAE provides many unique & attractive facilities for Joint Usage/Research not only in the field of advanced plasma & quantum energy but also in the field of soft energy.

Many researchers have participated in this program. In FY2025, there were 84 Joint Usage/Research collaboration subjects (including 5 workshops) on Zero Emission Energy, with more than 350 visiting participants, including graduate and undergraduate students, from 50 universities and institutions all over Japan. Researchers from 6 foreign universities also participated in the program. The results of these collaborations are summarized in the report "IAE Joint Usage/Research Program on Zero Emission Energy 2025". If you are interested in this collection, please contact the office of Zero

Emission Energy Research.

Regarding the international symposium that has been held annually for the past 15 years, it has been decided to change its schedule to a biennial basis. In the years when the international symposium is not held, a ZE Annual Meeting focusing on research outcome reports by principal investigators will be organized instead. The first ZE Annual Meeting was held on December 11, 2025, and attracted approximately 200 participants. This year’s annual meeting consisted of four oral presentations and approximately 80 poster presentations and was marked by active and fruitful discussions.

We are also operating “Zero Emission Energy Network” to share the knowledge of Advanced Energy and Zero Emission Energy with researchers in the fields of energy science and technology, because world-wide activities for Zero Emission Energy Research are indispensable for the realization of sustainable society.



Poster of the annual meeting

List of Zero Emission Energy Joint Usage/Research Subjects in FY 2025

(Subject, Principal Researcher, IAE Key Person)

Chemical dicing of semiconductors by non-metal catalysts, Kazuhiro Fukami, Hiroshi Sakaguchi

Development of Innovative Neutron Shielding Materials for Miniaturization of Fusion Reactors, Ryuta Kasada, Juro Yagi

Study on development of compound-based anode for K-ion battery and on compatibility with ionic liquid electrolyte, Yasuhiro Domi, Takayuki Yamamoto

Structural analysis of lignocellulosic biomass by NMR spectroscopy toward decarbonized society, Hiroshi Nishimura, Masato Katahira

Emission properties and photoinduced electron-transfer reactions of photosensitizers bound to the reaction site of enzyme, Hiroshi Takashima, Eiji Nakata

Elucidation of the highly efficient energy production system utilized by intracellular organelle, Reiko Sakaguchi, Eiji Nakata

Study on textile degradation by using infrared free electron laser, Takayasu Kawasaki, Heishun Zen

Research on the Creation of Functional Peptides to Control Cell Proliferation Based on Complex Structures, Hideki Kusunoki, Takashi Nagata

The quantitative estimation of coherent phonon on wide-bandgap semiconductors, Kyohei Yoshida, Hideaki Ohgaki

Determining the conditions of heat treatments for extending the lifetime of nuclear reactors (4), Yoshitaka Matsukawa, Kazunori Morishita

Elucidation of the mechanism of electronic conduction in lithium ion conductive solid electrolytes by rf-GD-OES analysis, Kazuya Sasaki, Juro Yagi

Control of behavior of organic fluorescent molecules via strong Mid-IR irradiation, Yusuke Tsutsui, Heishun Zen

Structural basis of G-quadruplex recognition by the replication initiator ORC, Shou Waga, Yudai Yamaoki

Experimental verification of hydrogen adsorption and desorption behavior for advanced neutron multipliers, Jae-Hwan Kim, Juro Yagi

Novel Na-storage materials based on construction of electrode-electrolyte interface, Hiroyuki Usui, Toshiyuki Nohira

Effect of mechanical alloying treatment on thermal changes on oxide dispersion strengthened alloy powder, Noriyuki Iwata, Juro Yagi

NMR analysis for the development of biomolecules that control the growth of plants or microorganisms, Taiichi Sakamoto, Takashi Nagata

Development of Organic Luminescent Materials for Luminescent Solar Concentrators, Masaki Shimizu, Hiroshi Sakaguchi

Innovative Approach for Lignin Utilization: Precise Reaction Behavior Analysis by Selective Stable Isotope Labeling Technique, Yasuyuki Matsushita, Masato Katahira

Tunable Surface Engineering of Electrochemically Grown Quantum Dots via Free Electron Laser Irradiation in the IR Range for PSCs, Sukrit Sucharitakul, Hideaki Ohgaki

Construction of fluorescent biosensor for visualizing zinc finger structure of transcription factor Sp1 participating in metabolic reaction control, Shunsuke Tajima, Eiji Nakata

Dynamic process of trivalent/tetravalent cerium valence change in multi-component oxide garnet crystals investigated by photoinduced transient absorption spectroscopy, Mamoru Kitaura, Heishun Zen

Hydrogen isotope release behavior of accident-tolerant hybrid ceramics, Keisuke Mukai, Juro Yagi

Enzymatic degradation of crystalline PET using quantum beams, Daisuke Tadokoro, Heishun Zen

Impact of Irradiation on the Structural and Functional Properties of Polymer-Based Nanoparticles for Drug Delivery Applications, Winita Punyodom, Hideaki Ohgaki

Analysis of interaction between TLS and RNA that induces liquid-liquid phase separation caused by TLS, Riki Kurokawa, Masato Katahira

Novel pulsed terahertz source by super-radiance free electron laser oscillator, Kazuyuki Sakaue, Heishun Zen

Structural analysis of noncanonical/damaged nucleic acids, Hiroshi Imamura, Yudai Yamaoki

Elucidation of polymerization mechanism and chemical structure of lignin, Takao Kishimoto, Masato Katahira

Fabrication of All-Solid-State Battery by Photo-Induced Chemical Solution Process, Ikuma Takahashi, Juro Yagi

Study of Hydrogen Isotope Separation Technology by Molten Salt, Hisayoshi Matsushima, Toshiyuki Nohira

Study of the crystalline cellulose degradation system consisting of the psychrophilic fungus-type cellulase., Masataka Horiuchi, Takashi Nagata

Enhancing mechanical properties of PCL-based sutures using selective-wavelength mid-infrared free-electron laser irradiation, Sakhorn Rimjaem, Hideaki Ohgaki

Characterization of E.coli-Derived G-quadruplexes Capable of Regulating gene expression., Yoichiro Tanaka, Takashi Nagata

Variation of atomic density distribution of sintered two-phase mixture of tritium breeders Li_8ZrO_6 and Li_2O , Kiyoto Shin-Mura, Juro Yagi

Thermal Expansion Coefficients of $\text{PbWO}_4\text{-BiVO}_4$ -based Oxide Ion Conductors with Oxygen Excess and Oxygen Deficient Compositions, Shigeomi Takai, Toshiyuki Nohira

Selective ablation and surgfeca reaction analysis of composite resin material, Jun Fujioka, Heishun Zen

Fermentative production of a novelpolysaccharide from fishery processing by-products, Minoru Takeda, Masato Katahira

Experimental research on the sophistication of advanced information infrastructure for the operation and maintenance of complex energy systems, Takeshi Matsuoka, Kazunori Morishita

Achieving Carbon-Neutral Organic Coffee Cultivation through Biocontrol, Keonakhone Khounvilay, Hideaki Ohgaki

Renewable Energy (Solar & Wind) Transition in Indonesia: Perspective of Policy and Community Empowerment, Anugerah Yuka Asmara, Hideaki Ohgaki

Electricity Usage Behavior and Habits for Rural and Urban Community to Facilitate Lifestyle Life Cycle Assessment Research, Chia-Kwang Tan, Hideaki Ohgaki

Calcium phosphate coating on aluminum-free magnesium alloys and microstructure evaluation, Takeshi Yabutsuka, Juro Yagi

Elucidation of free electron laser interactions by observing coherent edge radiation, Norihiro Sei, Hideaki Ohgaki

Compatibility of Li-Br/F/I based low-melting point molten salt applied for fusion reactors' liquid blanket, Yasuyuki Ogino, Juro Yagi

Investigation of the physical properties of atomic layer materials induced by structural imperfections, Susumu Okada, Kazunari Matsuda

Exploring Quantum Materials for High-Efficiency and High-Performance Energy Conversion, Satoru Konabe, Yuhei Miyauchi

Highly efficient laser-induced photochemical processes by using machine-learning approaches combined with quantum optimal control, Yuki Yoshi Ohtsuki, Takashi Nakajima

Basic study on pulse water surface discharge with needle electrodes and its improvement, Hiroto Matsuura, Shinichiro Kado

Clarifying the difference in the dynamics of hydrogen and oxygen bubbles during water electrolysis for hydrogen evolution, Kota Ando, Takashi Nakajima

Gas ionization by high-repetition rate infrared pulses, Ryoichi Hajima, Heishun Zen

Development of 3 dimensional radiative distribution measurement system using incoherent digital holography in Heliotron J., Hayato Kawazome, Shinichiro Kado

Development of RNA Editing Technology Targeting Energy-Producing Genes, Masatora Fukuda, Eiji Nakata

Fabrication of high-quality tin chalcogenide single-crystals and evaluation of their physical properties, Sakiko Kawanishi, Yuhei Miyauchi

Enhancing optical thermometric sensitivity of single-walled carbon nanotubes by oxygen doping, Shun Aota, Yuhei Miyauchi

Synthesis and optical properties of semiconductor moiré superlattices, Wenjin Zhang, Yuhei Miyauchi

Structural studies on hierarchical molecular architectures created in microfluidic device, Munenori Numata, Eiji Nakata

Generation and sustainment of high-energy density plasmas via the interaction between high power laser and structured medium, Yasuaki Kishimoto, Hiroshi Sakaguchi

In-situ measurement of periodic nanostructures on semiconductor surface induced by mid-infrared free electron lasers, Masaki Hashida, Heishun Zen

Development of an On-Site Simple and Rapid Detection Method for Virus and Viroid Infections., Masaki Hagihara, Eiji Nakata

Towards Zero-Emission Agriculture: Advanced Hyperspectral Imaging for Early Detection of Coffee Paramyothecium Leaf Blotch, Ratchadawan Cheewangkoon, Tomijiro Hara

AFM/EM imaging of intracellular metals with nanostructures constructed via signal amplification systems, Ippei Takashima, Eiji Nakata

Innovation of Decision-Making Processes in Transcience Issues romoting Social Cohesion, Hirotomo Iwakiri, Kazunori Morishita

An artificial-nucleic-acid probe for live-cell imaging of energy metabolism, Shinichi Sato, Eiji Nakata

Residential Microgrid Design and Management with Open-Source Tool and GIS, Vannak Vai, Hideaki Ohgaki

Efficient removal of infected layers by FEL irradiation of Gram-positive bacteria infected layers, Toshizo Toyama, Heishun Zen

Study and experiment of the high-energy electron generation by the high-power laser-irradiation to the structured target, Ryutaro Matsui, Kazunari Matsuda

Whole genome analysis and culture method development of Thai coffee leaf rust fungus, Rampai Kodsueb, Yumiko Takatsuka

Developing the in-situ technique to measure the size of radioactive fragments during nanosecond pulsed laser decontamination, Atsushi Kosuge, Takashi Nakajima

High-resolution observation of exciton transport in atomically thin layered materials, Masaru Sakai, Kazunari Matsuda

Application of Model Inclusive Learning to Fusion Plasma Science - Equilibrium Reonstruntion of Plasma -, Yasuaki Kuroe, Shinji Kobayashi

Analysis of direct energy conversion method using charge separation by cyclotron motion, Nobuhiro Nishino, Shinichiro Kado

Regulatory systems of biological functions elucidated through the transport mechanisms of polysulfide, Takayuki Shimizu, Eiji Nakata

Analysis of the Base Pair Opening/Closing Dynamics in DNA Triplex Structures under Molecular Crowding Conditions, Tomoki Sakamoto, Yudai Yamaoki

Study on the mechanism of direct conversion of cellulosic materials into glucose under microwave irradiation condition, Sadatsugu Takayama, Juro Yagi

FEL irradiation-induced changes in biofilm formation by human resident bacteria., Tetsuro Kono, Hideaki Ohgaki

Elucidation of inhibitor action mechanism of Na⁺-transporting NADH-quinone oxidoreductase and development of new inhibitors, Takahiro Masuya, Eiji Nakata

Study on ultrafast measurement of relativistic electromagnetic fields, Masato Ota, Heishun Zen

Regulatory systems of biological functions elucidated through the transport mechanisms of polysulfide, Takayuki Shimizu, Eiji Nakata

Analysis of the Base Pair Opening/Closing Dynamics in DNA Triplex Structures under Molecular Crowding Conditions, Tomoki Sakamoto, Yudai Yamaoki

The 2nd KU-FEL User Meeting, Mamoru Kitaura, Heishun Zen

Biothermology Workshop 2025, Reiko Sakaguchi,
Eiji Nakata

Distributed Workshop on "Physics and control of
non-linear and non-equilibrium plasma based on the
concept of broad-band energy science", Yasuaki
Kishimoto, Kazunari Matsuda

22nd International Workshop on the Ceramic
Breeder Blanket Interactions (CBBI-22), Keisuke
Mukai, Juro Yagi